October 16, 2023

To:
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

From:
Palamedes Strategies
429 Boyd Ave
Takoma Park, MD 20912

Re: Response to Maryland's Climate Pathways Report (June 2023 draft)

Palamedes Strategies appreciates the opportunity to provide feedback on Maryland's Climate Pathways Report. Palamedes Strategies is a clean energy advisory firm based in Montgomery County specifically focusing on zero-emission technology, such as hydrogen and fuel cells.

This report will have profound implications for developing strategies to reduce carbon emissions in Maryland as policymakers review and adopt recommendations included in this report. Many practical recommendations are included in the report. However, the information has significant shortcomings that put the success of the recommendations into question. Below are areas of concern, followed by questions about the data modeling, and finally, an in-depth review of the report itself.

I. Summary

In summary, the following aspects need to be addressed.

1. **The report includes a discussion of economic benefits, but the report should show how much each policy will cost regarding CO2 abatement**.
   One metric could be how much $ per ton of CO2 abated each policy will cost. Only such an economic cost/benefit assessment will allow focusing on the low-hanging fruits and comparing effective and less effective strategies. Moreover, the report should clearly identify the cost of electricity, gas, and other energy sources in the assumptions and how those will develop over time. Using reference data sets like EIA isn't feasible, as those data sets do not consider Maryland's higher GHG emissions goals. What are the projected energy costs for residents, industry, and commercial sectors? California is already seeing massive spikes in the price of electricity, ranging between 65ct to 75ct kWh during peak times, and California is only at 40% renewable generation right now. Electricity costs are continuously increasing. It would be necessary for the plan to develop several different scenarios to assess the trade-offs among different policy options, such as continuing gas plans, building new nuclear, mixed generation, etc.

2. **The report assumes unprecedented wind and solar generation growth, despite the challenges these industries are already facing and seeks to decommission natural gas plants within the next six years without detailed analysis of the changes this will require, e.g., energy storage expansion.** The plan proposes to increase the number of intermittent generation and decommissioning baseload power generation. New nuclear power generation is not considered, despite new reactors going online in several other states nationwide. More importantly, the discussion of energy storage is almost entirely absent, even though energy storage, especially long-term and seasonal storage, will be crucial to handle all this additional intermittent generation. Specifically, the PSC and OPC just protested PJM's filing to replace Brandon Short's coal plant retirement with grid upgrades and proposed consideration of energy storage solutions.[1] The report should evaluate energy storage needs in great detail, as the model output shows that half of Maryland's energy generation will be imported by 2030, and depending on how the language is interpreted, the imported energy will be matched by hourly RECs. That's an entirely untested proposal. The report provides no additional information on this proposal nor projects the cost of those hourly RECs on the TWh scale. Consequently, those electricity imports mean many energy jobs will not be located in Maryland.

3. **Maryland's proposed climate strategy is heavily focused on electrification, a risky and untested strategy that could impact two of the three pillars of the energy sector: Reliability and Resiliency.** An all-electrification strategy is pursued in California, which has a much different climate than Maryland. All-electrification poses significant risks to grid reliance and reliability. For example, early results from electric school bus pilots in Vermont show an 80% reduction in range during cold winter days. Any EV driver will attest to those adverse climate range challenges. Battery EVs will not be suitable for all drivers in the State, especially in rural areas. Optionality in customer choices is prudent, and this report doesn't account for that; instead, it mandates many behavioral changes from residents. Requiring people to change their behavior rather than giving them options is not a good or smart policy. On the other hand, incentivizing behavioral change tends to be met with more success but comes at a higher price. The cost of providing incentives, e.g., switching from diesel trucks to zero-emission vehicles, must be identified.

[1] https://www.utilitydive.com/news/maryland-officials-press-ferc-to-reject-pjm-directive-to-exelon-for-785m-i/694203/

II. Discussion

a) Lack of consideration of hydrogen

"Hydrogen is a clean fuel that produces only water when consumed in a fuel cell. Hydrogen can be produced from various domestic resources, such as natural gas, nuclear power, biomass, and renewable power like solar and wind. These qualities make it an attractive fuel option for transportation and electricity generation applications. It can be used in cars, houses, for portable power, and many more applications."[2] In the electricity sector, hydrogen provides increased reliability and decarbonization of power generation through utility-scale electrical generating assets and distributed energy resources like fuel cells[3] or hydrogen turbines for continuous generation or backup power.[4]

Hydrogen has the potential to support utility-scale firm power and long-duration energy storage[5] with electrolytic hydrogen production[6]. Results from California modeling of the electricity grid in a 100% renewable energy scenario identified a significant deficit of renewables production in the winter months[7]. Due to Maryland's colder climate and lower solar and wind resources, this issue would be even more pronounced in this state.

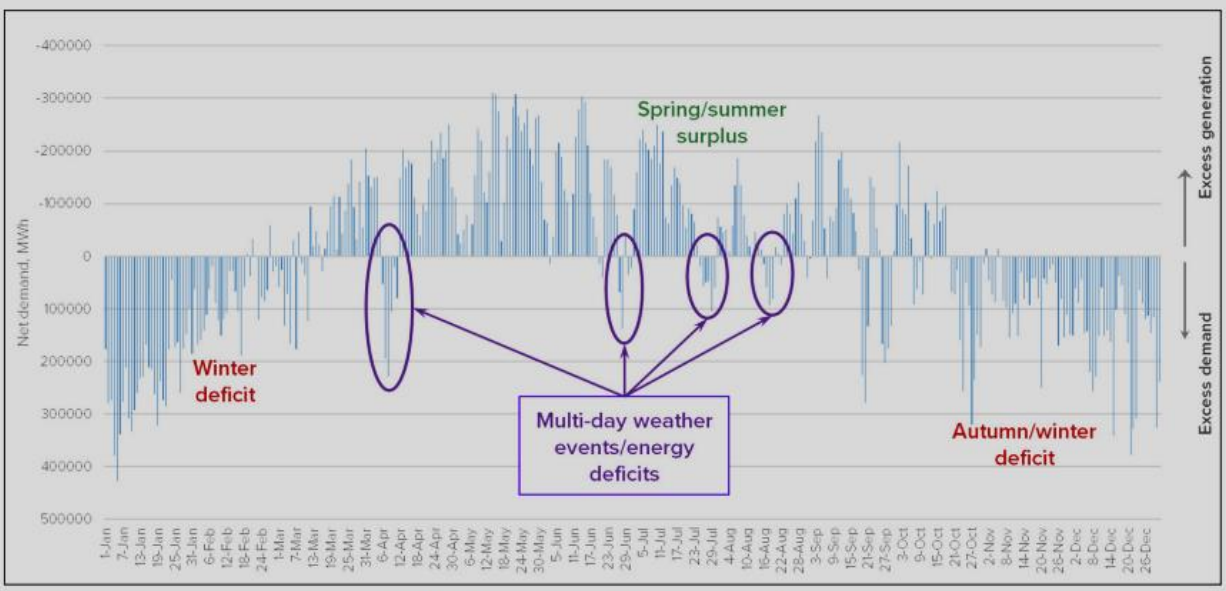


Figure 1. Substantial storage capacity will be needed to support a 100% renewables scenario in California

To meet such challenges, hydrogen energy storage would be necessary to meet these seasonal fluctuations.[8]

---

[2] https://www.energy.gov/eere/fuelcells/hydrogen-fuel-basics
[3] https://www.plugpower.com/fuel-cell-power/fuel-cell-benefits/
[4] Office of Energy Efficiency and Renewable Energy. "Hydrogen: A Clean, Flexible Energy Carrier." https://www.energy.gov/eere/articles/hydrogen-clean-flexible-energy-carrier
[5] Office of Energy Efficiency and Renewable Energy. "Hydrogen Storage." https://www.energy.gov/eere/fuelcells/hydrogen-storage
[6] Office of Energy Efficiency and Renewable Energy. "Hydrogen Storage." https://www.energy.gov/eere/fuelcells/hydrogen-storage
[7] https://solar-media.s3.amazonaws.com/assets/Pubs/PVTP24/Green%20hydrogen%20the%20zero-carbon.pdf, p. 99
[8] https://solar-media.s3.amazonaws.com/assets/Pubs/PVTP24/Green%20hydrogen%20the%20zero-carbon.pdf, p. 100

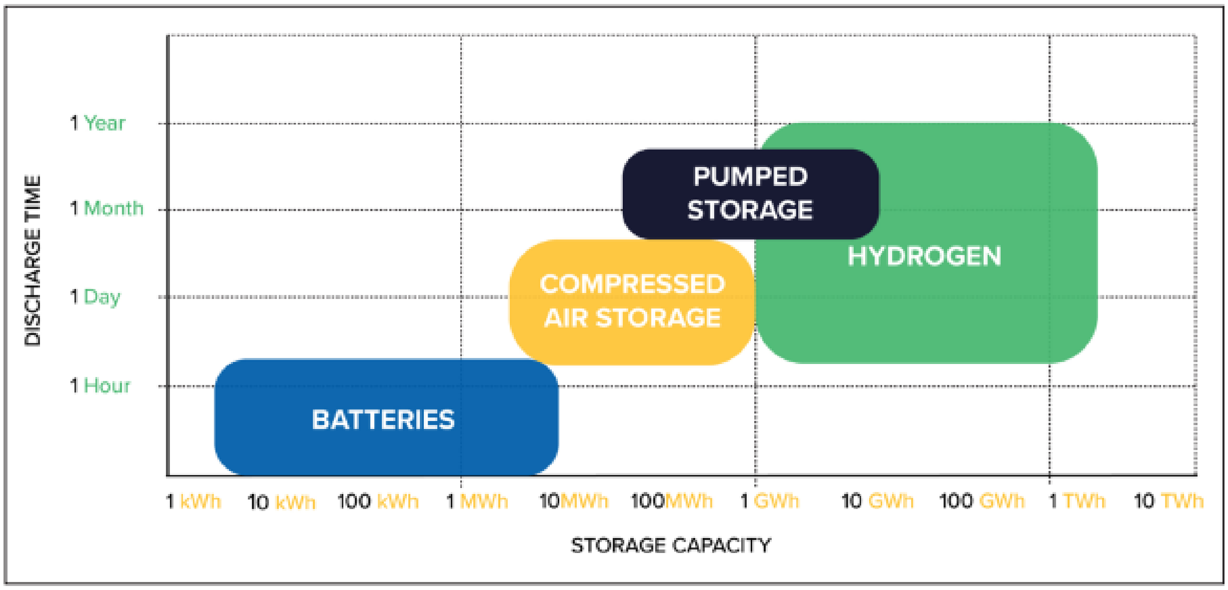
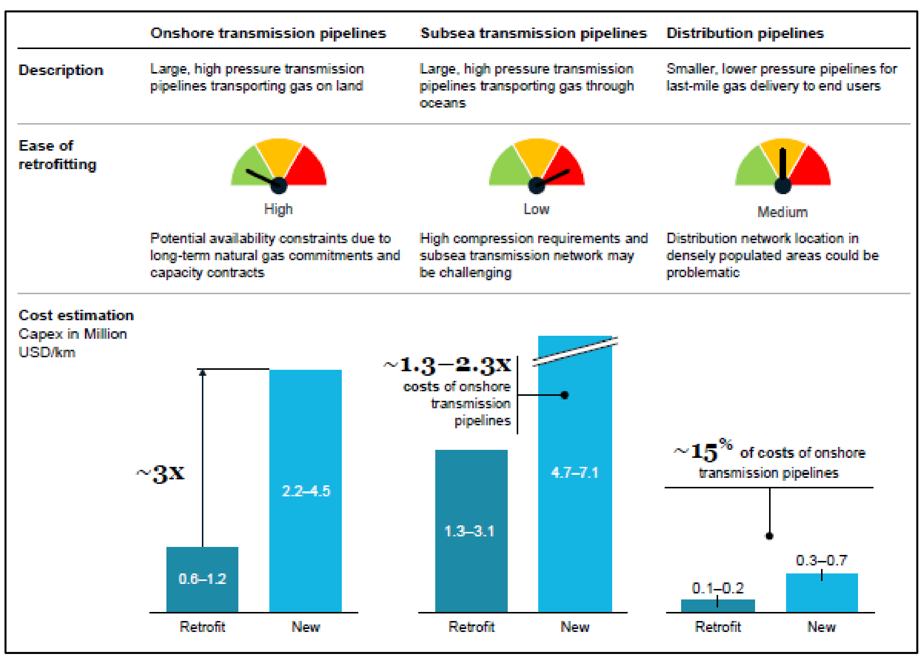


Figure 3. Energy storage capacity vs. discharge time for commercially available seasonal storage solutions

As batteries are not cost-effective in providing large-scale, long-duration energy storage, hydrogen becomes a necessity.

Maryland needs to identify areas conducive to geological hydrogen storage, similar to how natural gas is stored currently. While salt domes are present in West Virginia Western Maryland, and hard rock outcrops are present in Central Maryland**, Maryland would need to work with the USGS to study the viability of underground hydrogen storage in the region**.



As a gas resource in the state's energy sector, hydrogen is a decarbonization solution for Maryland's existing natural gas pipeline system when blended with natural gas, as found in California.[9] Hydrogen has the potential to completely replace natural gas through dedicated hydrogen pipelines[10] or retrofit existing pipelines, which can minimize costs[11].

[9] R. 13-02-008 Order Instituting Rulemaking to Adopt Biomethane Standards and Requirements, Pipeline Open Access Rules, and Related Enforcement Provisions. Decision 22-12-057 issued December 15, 2022.

[10] Office of Energy Efficiency and Renewable Energy. "Hydrogen Pipelines." https://www.energy.gov/eere/fuelcells/hydrogen-pipelines

[11] https://hydrogencouncil.com/wp-content/uploads/2021/02/Hydrogen-Insights-2021.pdf, p 21

It is recommended to include hydrogen as a major energy vector in the Plan and policy recommendations to enable utilities to invest/rate base in hydrogen infrastructure.

Hydrogen is already decarbonizing the transportation system in zero-emission fuel cell electric vehicles (FCEVs) like transit buses[12], light-duty vehicles[13], and heavy-duty vehicles[14]. Major OEMs[15] are bringing medium-duty vehicles to market, which can provide onsite energy to displace portable gasoline and diesel generators commonly used in the construction and utility sectors.

In California, the only state that has allocated funding towards hydrogen fueling infrastructure, over 50 hydrogen fueling stations have been deployed, and 113 are in development. Over 17,000 FCEVs have been sold or leased.[16] California's Air Resources Board also identified that "hydrogen fueling network self-sufficiency can likely be achieved within the decade with additional State support beyond AB 8."[17] AB 8 was passed in 2014 and allocated $20M per year to develop hydrogen stations in the state, an amount that is a fraction of the funding the State has invested in the buildout of charging infrastructure.

The 2023 UC Davis report: "California Hydrogen Analysis Project: The Future Role of Hydrogen in a Carbon-Neutral California - Final Synthesis Modeling Report"[18] found that "a hydrogen system development led by strong demand growth in transportation (especially light-duty and medium/heavy-duty road vehicles) can support the development of a medium-scale supply and distribution system by 2030." The report also found that "**Strong early investment is needed.** In the early years of developing hydrogen systems for transportation, many refueling stations are needed to ensure adequate coverage so drivers can reliably find fuel as they make journeys. This can mean generally low utilization of stations and challenging station economics. This in turn may require policies to ensure that profitability can be achieved." Furthermore, "**Small light-duty vehicle (LDV) market shares can yield big demands.** As we show in our Base scenario, even at a relatively small percentage of sales (e.g., 5% by 2030), LDV FCEVs would require a large number of fueling stations and hydrogen supply (on the order of 200 stations, several hundred tons/day of hydrogen). Trucks (particularly medium and long-haul heavy-duty) at a somewhat higher market share could trigger the same kind of hydrogen demand. Transit buses can also help as they are among the earlier adopters and could achieve much higher market shares (approaching 50% by 2030)." Based on these findings, the **Maryland Pathways report should incorporate policy recommendations that support near-term, strong investment support for hydrogen transportation to seed and foster the growth of hydrogen in the transportation market, in turn creating clean hydrogen production demand that the IRA and other federal policy tools support.**

---

[12] https://www.nrel.gov/state-local-tribal/blog/posts/fuel-cell-electric-buses-in-the-usa.html
[13] Office of Energy Efficiency and Renewable Energy. "Fuel Cell Electric Vehicles." https://afdc.energy.gov/vehicles/fuel_cell.html
[14] Hydrogen Fuel Cell Partnership. "California Fuel Cell Partnership Envisions 70,000 Heavy-Duty Fuel Cell Electric Trucks Supported by 200 Hydrogen Stations in-State by 2035." https://h2fcp.org/blog/california-fuel-cellpartnership-envisions-70000-heavy-duty-fuel-cell-electric-trucks-supported
[15] GM Authority, "Future GM Medium-Duty Trucks To Combine Battery And Hydrogen Tech," https://gmauthority.com/blog/2022/12/future-gm-medium-duty-trucks-to-combine-battery-and-hydrogen-tech/
[16] https://h2fcp.org/by_the_numbers
[17] https://ww2.arb.ca.gov/resources/documents/hydrogen-station-self-sufficiency-report
[18] https://escholarship.org/uc/item/27m7g841

Hydrogen and fuel cells are piloted in marine[19], rail[20], and aviation[21] end uses. Early learnings from bus electrification, where new electric school buses are losing up to 80% of range in the winter[22], need to be considered. **Policies should support all zero-emission technology solutions, not just battery technology.**

The report does model some hydrogen demand in later years but does not indicate the assumed cost or price of hydrogen. DOE's 1/1/1 goal ($1/1kg of hydrogen in 1 decade) would bring the cost of hydrogen produced low enough to compete or outcompete traditional fossil fuels in the transportation sector and beyond. The 2021 Hydrogen Council Report "Hydrogen Insights" identifies numerous areas where hydrogen would be competitive in terms of the total cost of ownership in 2030 over traditional fuels, including forklifts, medium & heavy-duty trucks, large passenger SUVs, regional trains, buses/coaches, delivery vans, fertilizers, steel, and refining.[23]

The report should further analyze and allocate investment in bringing these hydrogen solutions to commercial scale in these sectors.

Policy support for hydrogen blending in the natural gas grid is absent. However, providing an investment mechanism to create clean hydrogen and add it to the gas grid not only provides a slight initial reduction of natural gas emissions but also provides a financing mechanism to ramp up hydrogen generation facilities that, over time, can switch to offering hydrogen to other markets, including transportation, peak power, and Grid energy storage.

As the California Governor has recently done, the report should propose developing a hydrogen market development strategy to identify market tools and public policy tools that can further enable the development and deployment of hydrogen infrastructure in Maryland.[24] The strategy should focus on financing models, permitting, procurement, market needs, barriers to adoption, etc.

b) Modeling Outputs document:

The readme section shows the citation for the report as having 127 pages, whereas the actual report only has 118 pages.

Electricity Generation Portfolio:

- The expansion of solar PV from 2020 to 2025 shows a quintupling of solar generation, from 2.64 to 12.63 TWh, which indicates a 100% increase in the 2020 base year for every subsequent year. Has this occurred for 2021 and 2022? Furthermore, the next period of solar PV – the timeframe from 2025 to

[19] Ballard. "Fuel cell technology: The most practical, viable zero-emission solution." https://blog.ballard.com/fuelcells-marinevessels
[20] Cummins. "Hydrogen Fuel Cell Trains are on the Fast Track." https://www.cummins.com/news/2021/08/20/hydrogen-fuel-cell-trains-are-fast-track
[21] "Zero Avia Achieves High Temperature Breakthrough on the Path to Powering Narrowbody Jets with Hydrogen," https://simpleflying.com/zeroavia-technological-breakthrough-high-temperature-hydrogen-fuel-cell/
[22] https://vermontdailychronicle.com/new-electric-school-buses-lose-up-to-80-range-in-winter/
[23] https://hydrogencouncil.com/wp-content/uploads/2021/02/Hydrogen-Insights-2021.pdf, page 26
[24] https://www.publicpower.org/periodical/article/california-governor-directs-development-hydrogen-market-development-strategy

2030 shows no net increase after linear growth of 100% installation increase per year for the period before. This is true for both policy scenarios. How can this start and stop change be explained, especially as solar tax credits will continue into and after 2030? Furthermore, how will the current barriers to stronger solar deployment growth be addressed, e.g., permitting, interconnection issues, and local opposition? Such growth scenarios are entirely fictional without addressing the existing impediments to renewable generation deployment.

- Some inconsistencies between current policies vs. pathways model – the amount of offshore and onshore wind is lower under the climate pathways scenario than just pursuing current policies. Similar developments can be seen for biomass (with or without CCS). Considering the policies under the Pathways plan are more ambitious, the model should show an increased renewables buildout, not less.
- What policy is required to remove 15 TWh of natural gas generation in 5 years? The assumption is that the cap and invest program will do so, but what parameters are used to ensure cheap natural gas-fired electricity will not be used to meet cap and invest requirements over high-in-demand renewables?
- Under Maryland's Climate Pathways approach, the total amount of in-state electricity generated by 2030 is less than that of imported electricity. How are the economic losses quantified that result from importing clean energy vs. producing it in-state? The report should identify economic benefits/losses for each model year/timeframe.
- Most generation added under the pathways approach is provided by purchasing out-of-state electricity. However, there is no in-depth discussion in the report of how this generation will meet the low GHG emission generation requirements. Since other states have significant RPS increase requirements during the same timeframe, how does the report propose that these hourly RECs will be available within the PJM region, and what cost does the model assume? This discussion is vital to meeting Maryland's goals but is absent from the report.
- There are no metrics of storage requirements or seasonal variability of renewable generation. Between 2030 and 2050, 50-78% of the generation will be from intermittent renewables. Please quantify the estimated cost of storage, including long duration and seasonal storage needed to enable a reliable and clean grid, and address the prospect of "Dunkelflaute."
- Questions: why is new nuclear not an option that is considered when between 28 and 40 TWh of electricity annually will be imported between 2030 and 2050?

Electricity Consumption Portfolio:

- Despite a higher focus on transportation electrification under the climate pathways scenario, the amount of electricity consumed is around 15% lower. The report explains this by reducing VMT. Generally, this means increasing density, reducing car trips, adding transit options, and improving bike and multimodal access and infrastructure. However, as the passenger transportation section outlines, passenger miles for walking, bus, and cycling all decrease in the Pathways scenario from 2025 to 2050. What drives these decreases in passenger miles for non-vehicle transportation options when these are supposed to be the main benefactor from the shift away from vehicular travel?
- Both models show a significant increase in electricity demand from all sectors from 2020 to 2050. As much of the generation for the demand will be intermittent, and much of the consumption will be intermittent (e.g., transportation electrification will likely shift demand in the evening/nighttime for

overnight charging when there is little solar), what are the approaches to match generation with consumption? There's an increase in medium/heavy-duty trucking, which requires major fast-charging infrastructure upgrades to meet demand – how are these demand spikes accounted for?
Does the modeling account for increased transmission and distribution infrastructure to bring the new generation to the new demand centers?

Transportation Energy Modeling:

- What's the qualitative differentiation between hydrogen retail dispensing and hydrogen wholesale dispensing?
- For trucking, a decrease of 33% in energy consumption is modeled for 2025 to 2035, during which very little consumption from electric trucks is shown. The total energy consumed for shipping will decrease by 50% by 2035 through 2050. Does the modeling assume a significant reduction in economic activity, which is usually what shipping and trucking is a proxy for? If not, how can this significant decrease be explained?
- Why is there an assumption that hydrogen in the transportation sector only becomes available by 2035, and then in very low numbers? California ARB's Mobile Source Strategy estimates "The relative ratio of combined BEV and FCEV sales start at 90 percent BEV/10 percent FCEV in 2030 scaling to 75 percent/25 percent by 2045. The rationale for this assumption reflects increasing FCEV adoption as hydrogen fueling infrastructure expands and a subset of the vehicle market that will still require frequent fast refueling, particularly in larger vehicle classes."[25] Pathways and current policies assume no more than 1-2% of light-duty transportation consumption for hydrogen compared to electricity consumption. What is the basis for these assumptions, and why do they differ significantly from reputable analysis sources like the California ARB?
- The DOE National Blueprint for Transportation Decarbonization[26] sees a strong role for hydrogen in long haul, rail, maritime, and sustainable liquid fuels in maritime and aviation. These significantly differ from the Current Policies and Climate Pathways projections. The authors should consider those reports in the modeling assumptions.
- The 2023 Clean Air Task Force report "Zero Emission Long-Haul Heavy-Duty Trucking"[27] highlights that "Unique to BEVs, the charging station electric power requirements are high enough to cause concern about the negative effects on the grid as well as the possibility of not being able to secure enough clean electricity." How are such concerns addressed in the modeling? In addition, the report states that "For long-haul heavy-duty operation, the hydrogen fuel cell vehicle (FCEV) outperforms the battery electric vehicle (BEV) in terms of number of stops required, total fueling time, and available room for cargo. Furthermore, switching a significant portion of heavy-duty trucks to a battery electric drivetrain requires a more robust infrastructure buildout, in terms of size or number of stations. In contrast, the buildout for hydrogen, while still challenging, is comparatively more similar to diesel." Why do the Pathways and current scenario have a far lower penetration of hydrogen trucking than eminent industry reports indicate?

[25] https://ww2.arb.ca.gov/sites/default/files/2021-04/Revised_Draft_2020_Mobile_Source_Strategy.pdf
[26] https://www.energy.gov/eere/us-national-blueprint-transportation-decarbonization-joint-strategy-transform-transportation
[27] https://cdn.catf.us/wp-content/uploads/2023/03/13145547/zero-emission-long-haul-heavy-duty-trucking-report.pdf

- A "Comparative Analysis of Infrastructures: Hydrogen Fueling and Electric Charging of Vehicles" from the Jülich Forschungszentrum identified that large-scale infrastructure expansion is cheaper when pursuing hydrogen FCEVs vs BEVs.[28] One factor is that "hydrogen permits the use of otherwise unusable renewable electricity by means of on-site electrolysis, the lower efficiency of the hydrogen pathway is offset by lower surplus electricity costs."

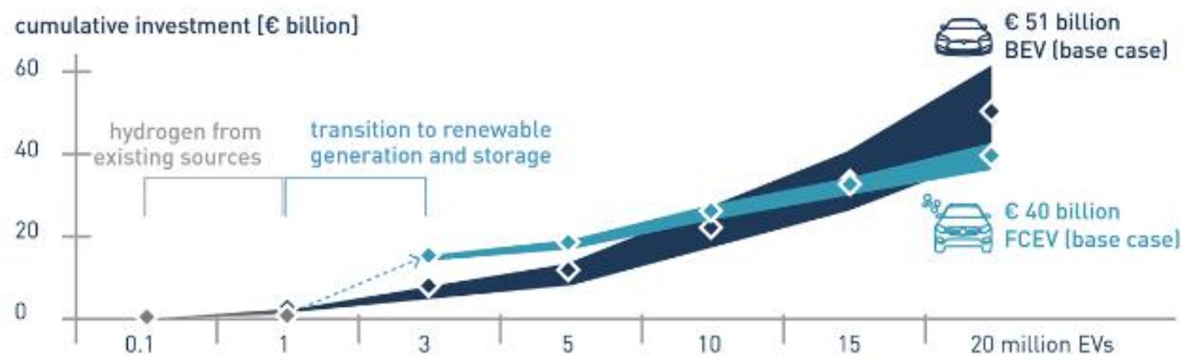
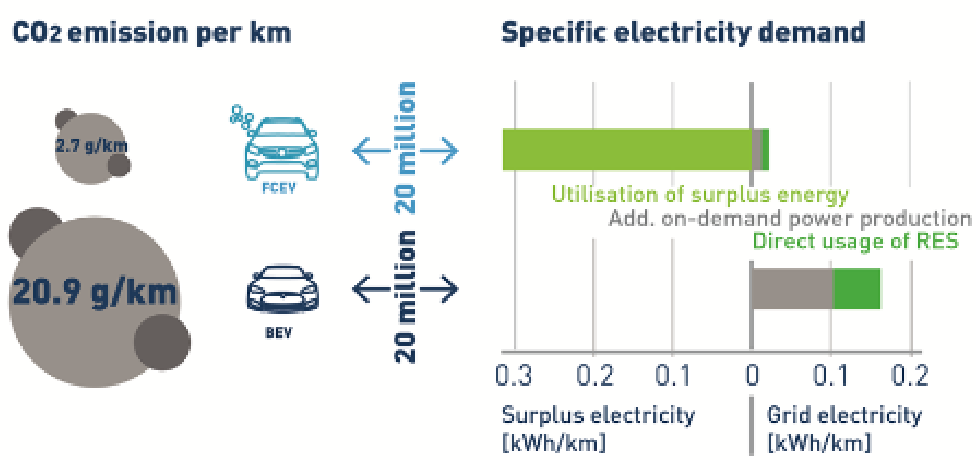


Figure 0-2: Comparison of the cumulative investment of supply infrastructures.

Furthermore, "available surplus energy in the assumed renewable dominated electricity scenario exceeds by factor of three to six the demand to supply 20 million electric vehicles. According to the use of surplus electricity, renewable and fossil electricity out of the grid, the corresponding CO2 balance for the high penetration scenario shows low specific emissions in comparison to the use of fossil fuels. The hydrogen infrastructure with the inherent seasonal storage option has lower CO2 emissions because of the high use of renewable surplus electricity."



For those reasons, the authors should reevaluate their assumptions for hydrogen transportation.

[28] https://juser.fz-juelich.de/record/842477/files/Energie_Umwelt_408_NEU.pdf

c) Detailed Report Feedback:

Page 11: "Key findings"

"All while realizing health and **economic benefits** for Marylanders, including improved air quality, new jobs, and **household cost savings**." – The report models GHG emission reduction policies and quantifies health and economic benefits but does not provide cost data to identify which policies fiscally sound and which are expensive. To better determine costs, an abatement cost figure is required that identifies the price per ton of CO2 reduced or avoided. This is a significant shortcoming of the report, as inexpensive and costly policies are not differentiated, giving the legislature and consumers no information about the fiscal impact. **The report needs to model these costs to clearly show to Maryland residents the cost of each policy and the GHG emission reductions they achieve.**

"The first step is fully implementing the policies already in place in Maryland. As of 2020, Maryland had already achieved half of the reductions needed—36.7 MMTCO2e of the 73.3 MMTCO2e to meet the 2031 target." – The report needs to identify how these reductions have been achieved, namely by replacing coal-fired power plants with natural gas-fired power plants. The share of renewable generation in Maryland is still very low.

The Climate Pathways report doesn't evaluate scenarios that provide information on technology improvements, etc. For comparison, California's ARB 2022 Scoping Plan provided four scenarios to achieve an economy-wide decarbonization. Providing optionality will allow legislators to make informed decisions about the tradeoffs of pursuing one policy vs. another.

Page 16:

"Maryland can also leverage its involvement with the Regional Greenhouse Gas Initiative to set a cap for net-zero by 2040." There is insufficient consideration of which policies can be achieved from within Maryland vs. policies that require out-of-Maryland policy change.

The electricity sector analysis, as the comments below on the modeling outputs will show, needs to provide much more specificity on how a full phaseout of natural gas and reliance of up to 50% of all electricity consumption provided by out-of-state generation, which also needs to be clean, can be achieved. Considering that many states within the PJM territory are also increasing their state RPS requirements, there will unlikely be an abundance of available renewable generation for Maryland to access, especially if hourly RECs are required, as page 39 alludes to.[29] Since hourly matched RECs are a novel concept, assessing the viability of procuring up to 40TWh of those RECs should be undertaken to determine how realistic such an approach is.

Furthermore, the report needs to provide a distribution of renewable power generation per day and over the year. For daily generation, California can provide a telling example: with 40% renewable generation, California is experiencing phenomena such as the "Duck Canyon[30]," which is a function of strong solar production mid-day,

[29] "The use of time-matched RECs means that imported electricity would be uniquely matched with a renewable generation source that is producing electricity at the time of the import through the newly created PJM hourly tracking system."

[30] https://www.powermag.com/epri-head-duck-curve-now-looks-like-a-canyon/

followed by a rapid decrease in power in the evening hours which must be compensated by gas and other flexible generation assets. These phenomena also shift the peak power price for customers to these "canyon walls," requiring significant demand response and energy storage assets to be available to supplement the decline in solar output. Seasonally, renewable generation tends to be higher during the summer than during the winter and fluctuates in the seasons. However, during the wintertime, when lower renewable generation can be observed ("Dunkelflaute[31]"), the shift to electrification will create significant new demand, especially if gas home heating is replaced by heat pumps. Transportation demand will also likely be higher due to the lower efficiency of BEVs in cold weather. Modeling should account for these seasonal and hourly changes and determine the need for long-duration/seasonal energy storage to avoid blackouts during Winter months.

Page 17:

Proposed changes to be inclusive of hydrogen transportation: "Access to charging stations and hydrogen fueling stations, affordability of ZEVs."

Page 24:

The report mentions "Over 16,500 fewer days of restricted activity from pollution" as a result of the modeling. That needs to be explained. For example, is that for all the population in Maryland in 2031? If so, this would amount to less than 3 minutes per year of fewer restricted activity per capita.

Page 28:

"However, under Current Policies, emissions will stop declining by 2040 and resume growth through mid-century. This occurs because many existing policies at both the State and federal levels expire before 2040: many existing policies at both the State and federal levels expire before 2040: as policy support is withdrawn, emissions reductions slow or reverse in many sectors; and the demand for energy services continues to increase". The authors should explain why this should have such a significant impact and which policies this refers to. Mandates like the Clean Cars 2 Act or the Clean Truck Act do not expire, instead, it is federal funding that expires in the 2035 timeframe. However, the authors seem to assume that technologies like solar and wind will still require incentives at that time. Since further cost reductions are projected for these technologies, the authors need to identify their assumptions that GHG-emitting technologies will be competitive after the expiration of the IRA-related tax credits.

Page 29:

The plan proposes a new policy, the Cap-and-Invest program, to ensure emissions reductions. At the same time, cap-and-trade programs exist across states in the U.S., like California, where it generated $10.5B between 2012 and 2022 from obliged parties.[32] It is essential to account for what such a program will have on the industrial and commercial sectors, which would be included in shifting their production to other states with less burdensome programs. California, despite its significant regulatory environment, is a substantial market for any company to be engaged in. In comparison, Maryland faces stiff competition from its neighbors Virginia and Pennsylvania as alternative attractive places to do business. Maryland would also meet its GHG reduction

---

[31] https://qz.com/can-europe-survive-the-dreaded-dunkelflaute-1849886529
[32] https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/cci_annual_report_2022.pdf

targets if industries shifted their production from Maryland to other states, as the net effect would be a reduction in GHG emission sources. Policy measures that support in-state industries are essential to avoid encouraging a deindustrialization of the region. Also, note that the Cap-and-Trade program is merely one of several policy tools applied in California. Other programs are as follows: "the Low Carbon Fuel Standard (LCFS) allows for trading of LCFS credits and requires a reduction in carbon intensity across transportation fuels consumed in California. The Renewables Portfolio Standard (RPS) allows for trading renewable energy credits and applies an increasing renewable power standard for each utility's procurement of electricity consumed in California. In addition, the Zero-Emission Vehicle (ZEV) Program allows for trading ZEV credits and applies an increasing fleet-wide efficiency standard.[33] Of those, only the RPS exists in Maryland; the others are not proposed in the Maryland Climate Plan.

The report also does not clearly explain how this revenue will be allocated. The report should identify which entity would dispense the funds generated by a Cap-and-Invest program and which mechanism would best be used. The report should clearly identify the most effective and least burdensome approaches to distribute funds generated from the proceeds.

Page 31:

All emissions in this report should also be expressed in 100-year Global Warming Potential (GWP) from the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6), consistent with current international GHG inventory practices. Deviating from those creates an incompatibility with RGGI and other protocols critical to ensuring and comparing Maryland's GHG reduction efforts.[34] Unfortunately, the Climate Solutions Now Act erroneously states to "USE THE GLOBAL WARMING POTENTIAL FOR METHANE OVER A 20–YEAR TIME HORIZON, AS ACCEPTED IN THE MOST RECENT ASSESSMENT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IN ESTIMATING THE STATE'S GREENHOUSE GAS EMISSIONS REDUCTIONS".[35] There is no such statement in the sixth assessment of the IPCC, the IPCC states that "this Report does not recommend an emissions metric because the appropriateness of choice depends on the purposes for which gases or forcing agents are being compared."[36] Despite this requirement by the legislature, MEA should add the 100-year GWP to provide comparability.

Page 32:

It should be explained why adding new nuclear capacity is not modeled in the scenarios. New nuclear reactors have recently come online, and more are expected to go online soon.[37] As one reactor can have 1GW of generation and an average capacity factor of 92%, this can translate into producing 8tWh of baseload power per year, or between 7 and 12% of the annual electricity demand in Maryland.

---

[33] https://ww2.arb.ca.gov/resources/documents/faq-cap-and-trade-program

[34] https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf - "GHG emission metrics are used to express emissions of different greenhouse gases in a common unit. Aggregated GHG emissions in this report are stated in CO2- equivalents (CO2-eq) using the Global Warming Potential with a time horizon of 100 years (GWP100) with values based on the contribution of Working Group I to the AR6."

[35] https://mgaleg.maryland.gov/2022RS/bills/sb/sb0528E.pdf

[36] https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf

[37] https://www.eia.gov/todayinenergy/detail.php?id=57280

Page 33:

How significant is the assumption of RGGI going to 100% zero GHG by 2040 to meet Maryland's electricity goals? Maryland is merely one of a dozen entities in RGGI, which means the success of RGGI in committing to 100% GHG reduction is highly questionable, at best, and should be identified as such. Numerous states within RGGI have weaker RPS/CES targets by 2040 than this plan proposes. RGGI also uses a GWP-100 metric, which is inconsistent with this report.

Page 34:

The report states, "All remaining natural gas plants are equipped with carbon capture and sequestration (CCS) technology by 2035, which would be supported by the recently proposed EPA rule on power plant emissions." According to the dataset, about 10% of current natural gas electricity generation will remain online with CCS. The report should clarify why CCS could not be applied to more gas power plants in the state, especially as those merely would require upgrades vs. entirely new builds for renewable generation that are space-constrained, and CCS receives incentives under the IRA.

Page 35:

This analysis excludes electricity production from hydrogen, which is unusual, as hydrogen is a dispatchable zero-carbon fuel that can ramp on demand. The report should model using hydrogen for power production.

NREL's reV model provides estimates for the Levelized Cost of Energy from different technologies based on spatial grid modeling estimates that onshore wind is the cheapest renewable generation asset in Maryland, with $20-30 per MWh in a few locations. Solar PV (not rooftop) follows with $50-58 per MWh, and offshore comes in at $55-$65 per MWh in areas closest to the coast. Cost significantly increases to $70 to $80+ per MWh, where floating wind turbines are required.[38] However, the grid mix proposed in the Climate Pathway is dominantly made up of solar and offshore wind, the technologies with the highest LCOE. The report should identify the assumptions used and results from any LCOE modeling. If this is not done, the report must develop an LCOE based on reV or similar analysis to determine the cost of generation and the assumed spatial distribution of those new generation assets.

Page 37:

The "considerations for policy implementation" section sidesteps the major hurdles renewable generation faces, such as local opposition. The authors should diligently work with renewable energy developers and utilities to understand the actual barriers to further expansion of renewable generation. Examples of resistance to using available land, such as the Agricultural Reserve in Montgomery County[39] exemplify the hurdles developers experience. State policymakers may step in to remove existing restrictions for a new generation.

Page 38:

The report states that "Recently, Maryland enacted the Maryland Energy Storage Program that established energy storage targets to accelerate deployment: 750 MW by year's end 2027; 1.5 GW through 2030; and 3 GW

[38] https://www.nrel.gov/gis/renewable-energy-potential.html
[39] https://moco360.media/2021/02/25/county-approves-limits-for-expansion-of-solar-farms-in-agricultural-reserve/

through 2033." The report should recommend that the duration of those targets also be defined as 3GW storage for 1 minute, 10 minutes, 1 hour, or 4 hours, or for several days or seasonal storage, which means very different things and achieves very different results. An emphasis on building our long-duration storage as baseload assets are retired is vital for continued reliable grid operations.

Page 39:

The report states, "Another recent report on the PJM grid outlined how the backlog and delays of the PJM interconnection queue could affect Maryland's ability to meet its renewable goals. It is important to note that PJM will be employing a new process for its interconnection queue going forward, which will evaluate many projects at once in a cluster-based approach. However, the extent to which the backlog is filled, and new projects are quickly studied and approved will be a deciding factor for renewables growth in Maryland." The report needs to identify what policies may help to reduce this backlog or if the new PJM process is sufficient.

"The use of time-matched RECs means that imported electricity would be uniquely matched with a renewable generation source that is producing electricity at the time of the import through the newly created PJM hourly tracking system." The report assumes that time-matched RECs will be available and affordable to meet the need for imported clean electricity as baseload power plants are retired. However, no details on the projected cost, especially when importing TWh of RECs, are provided. Also, note that compliance payments for not meeting REC requirements are only $30/MWh.[40] What do the authors propose to avoid companies merely using compliance payments in lieu of hourly REC acquisition?

Page 41:

The report states that "Maryland is adopting the ACC II rule this year, requiring manufacturers to continuously increase the share of zero-emission vehicles (ZEVs) they sell within the State until reaching 100% of passenger car and light truck sales by 2035." The Clean Cars Act mandates an increasing amount of ZEV sales over time. Crucially, zero-emission vehicles include plug-in hybrid electric vehicles (PHEVs), which can run on gasoline for much or all of their operational time. Real-world analysis has found that PHEVs have a real-world fuel consumption between 42%-67% higher than assumed within EPA's labeling program for light-duty vehicles.[41] Relatedly, as per Maryland's Open Data Portal, around 1/3 of all ZEVs in Maryland are PHEVs, and 2/3 are BEVs.[42] In 2020, 93 PJ of energy from fossil liquids was consumed for cars, whereas in 2030, only 40 PJ of energy is supposed to be consumed from fossil liquids. Since 1/3 of ZEVs are PHEVs, and a significant portion of vehicles are still traditional ICE at that time, this reduction in PJ seems highly unrealistic. The report should clarify its assumptions around PHEV adoption rates, which are permitted under Clean Cars 2, and how this will continue to drive fossil liquid (gasoline and diesel) demand.

The report points towards "MDOT's existing strategies include transitioning to cleaner and more efficient public transportation; expanding public transit systems and intercity systems; investing in bike and pedestrian infrastructure; and achieving the GGRA Smart Growth program's compact development goal." Furthermore, on

[40] https://www.pjm-eis.com/program-information/maryland
[41] https://theicct.org/publication/real-world-phev-us-dec22/
[42] https://opendata.maryland.gov/Transportation/MDOT-MVA-Electric-and-Plug-in-Hybrid-Vehicle-Regis/qtcv-n3tc

page 42, the report states: “Smart growth and transportation demand management policies reduce personal vehicle travel through ridesharing and mode switching to public transit, biking and walking.” Encouraging multimodal, car-light lifestyles will significantly improve the carbon intensity of the transportation sector. However, the report under the Climate Pathways scenario inexplicably sees a reduction of passenger miles not only for cars, aviation, SUVs, and trucks but also for modes that are encouraged by MDOT, such as walking, passenger rail, cycling, and bus. Unless the model assumes a major economic downturn or a deindustrialization of the state, these projections need clear explanations.

Page 43:

The report states, "In the near term, battery EVs dominate, and hydrogen-powered fuel-cell EVs play a minor role.” The rationale for the very low percentage of FCEVs needs to be provided, as this is contrary to California ARB’s Mobile Source Strategy[43] (“The relative ratio of combined BEV and FCEV sales start at 10 percent FCEV in 2030 scaling to 25 percent by 2045”), McKinsey[44] (25% for medium and large cars), and UC Davis[45] (5% by 2030). Since there is very little federal support to build out hydrogen fueling infrastructure via the IRA, the state would benefit from seed funding hydrogen infrastructure by developing programs such as tax credits or utility investments to build out the initial hydrogen fueling market until private investors are able to expand the network.

The report should recommend focusing on building out hydrogen refueling infrastructure in the same fashion as it has finances charging infrastructure buildout. The state should also direct gas and electric utilities to invest in hydrogen assets (e.g., production, distribution, and fueling), similar to the role of electric utilities in deploying charging infrastructure on the battery EV side.

Page 44:

The report states for Freight Trucks: “In the near term, battery EVs dominate, and hydrogen-powered fuel-cell EVs play a minor role.” This is contrary to DOE’s U.S. National Clean Hydrogen Strategy Roadmap, which says that “states with additional incentives such as a low carbon fuel standard (LCFS) can enable fuel cell trucks to be competitive before 2025.”[46]

[43] https://ww2.arb.ca.gov/sites/default/files/2021-04/Revised_Draft_2020_Mobile_Source_Strategy.pdf
[44] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/hydrogen-the-next-wave-for-electric-vehicles
[45] https://escholarship.org/uc/item/27m7g841
[46] https://www.hydrogen.energy.gov/pdfs/us-national-clean-hydrogen-strategy-roadmap.pdf

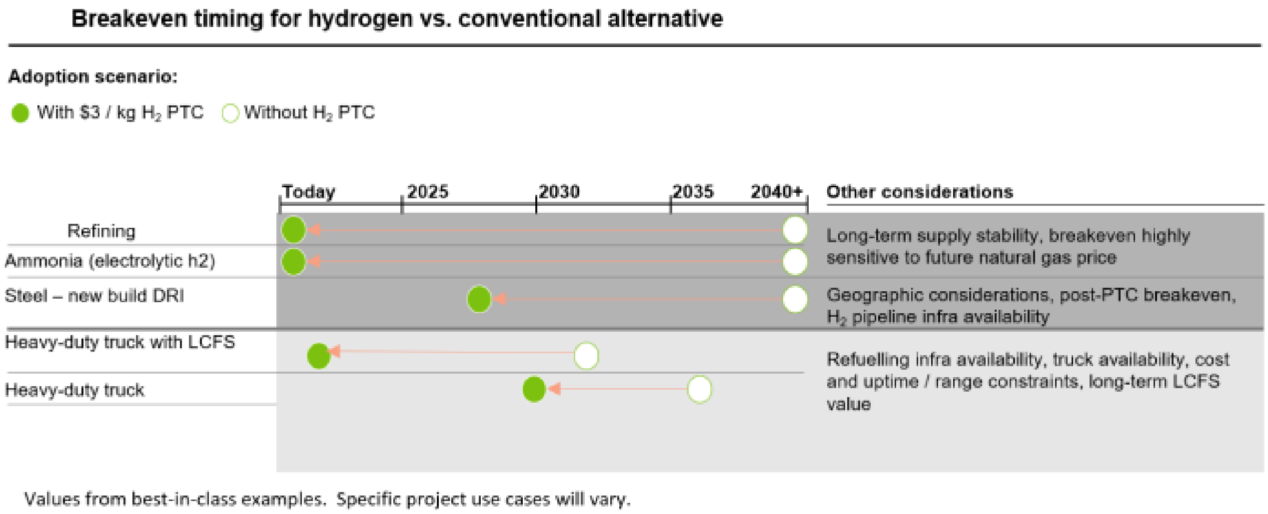


Figure 14: Breakeven timing for hydrogen with the clean hydrogen production tax credit vs. conventional alternative (Repurposed from DOE's report, Pathways to Commercial Liftoff: Clean Hydrogen[3])

The ICCT states that "specifically for long-haul heavy trucks – which consume 49% of all diesel fuel used by the freight trucking sector in the U.S. and accounts for roughly 13% of transportation GHG emissions, or 211 million tonnes of CO2e per year – the future probably includes a lot of hydrogen"[47], and many other assessments such as NACFE: "Hydrogen and battery electric are not an 'either/or' but an 'and' for the zero-emission freight future. Battery electric vehicles will inherently be the most economical and efficient choice for shorter distance zero-emission duty cycles, and hydrogen will be the only viable economic choice for long-haul zero-emission duty cycles."[48]

The report should identify policy support to provide dedicated funding for hydrogen fueling infrastructure in the near term to build out refueling assets in time for the commercial availability of fuel cell vehicles in the state. Since hydrogen fueling infrastructure takes between 1.5-2.5 years from permit submission to open retail[49], the earliest date for stations to be operational would be 2026 if funding is awarded in late 2024. On a graph like Figure 2.8 (and 2.9), the terminology for electric should be battery, for hydrogen, it should be fuel cell, which is used in the narrative text under the figure, but not actually in the figure.

Page 46:

The report, in general, needs to change the nomenclature from EV to ZEV, as EV in this context is confusing. Hydrogen fuel cell electric vehicles are EVs. Wherever the terminology EV is used to mean Battery Electric Vehicle, it should say battery EV or BEV. If the goal is to talk about all electric vehicles (including FCEVs and BEVs), the term to be used should be ZEV (zero-emission vehicle). In recommendations that highlight the need for charging infrastructure expansion, hydrogen fueling infrastructure should also be included, or generally, a technology-neutral term like zero-emission transportation infrastructure could be used. The report needs to

[47] https://www.catf.us/2023/03/why-the-future-of-long-haul-heavy-trucking-probably-includes-a-lot-of-hydrogen/
[48] https://nacfe.org/research/electric-trucks/hydrogen/#
[49] https://www.energy.ca.gov/sites/default/files/2022-12/CEC-600-2022-064.pdf, pp. 34-36

provide zero-emission technology-neutral terminology to allow for consumer choice rather than dictating which specific technology consumers need to choose.

"Increasing Maryland's rebates and the amount of funding for the program would align the State with others pursuing similar goals and prevent sales from flowing to neighboring states with less stringent targets. This is a key risk for Maryland's ACC II regulation, as the purchase of non-EVs in surrounding states that have less stringent targets (aka "sales leakage") could lead to lower numbers of EVs than if all sales were covered by the in-state targets. It is critical to track where EVs are sold and the total number of EVs on the road, as California does, to ensure Maryland's transportation sector is truly decarbonizing and meeting its targets." This refers to comments like the one on Page 44, where the report states that "Freight truck ZEV sales reach 30-50% by 2030, and 40-75% by 2035, depending on truck type, achieving Maryland's ACT target."

As many states around Maryland are not signatories to the Advanced Clean Truck MOU and have not adopted mandates, this sales leakage will be a major concern. However, the report identifies the problem but makes no recommendation on how to address the very likely shift from trucking companies to purchasing non-ZEV trucks out of state and registering them in-state, avoiding the mandate. Providing rebates for light-duty vehicles for the number of vehicles sold per year in Maryland may be financially viable. However, providing rebates for medium and heavy-duty trucks in the order of magnitude required to meet ACT needs to be calculated and considered. Specifically, since battery trucks and fuel cell electric trucks are not widely commercially available, and pre-commercial trucks tend to be 2x-3x the cost of their diesel equivalent, the rebate to provide price parity could easily reach $200,000 or more (which is what California's HVIP[50] provides in a limited fashion). Assuming 500 trucks were to be sold in the first year supported by a $200,000 rebate to provide parity with diesel, the cost would come to $100 million for one year of truck sales. This is to exemplify that **cost data is vital to ascertain if policy recommendations are feasible**. While vehicle costs will decrease over time, the financial support for such a program to provide cost parity will be significant and needs to be identified.

Page 47:

The section under "Realizing the Advanced Clean Truck Rule" in the report states: "As increasing adoption of EVs reduces fuel sales, alternative sources of funding will need to be found." This is not true for hydrogen FCEVs, as hydrogen, similar to gasoline and diesel vehicles, use public fueling networks, and thus, a gas tax can easily apply to hydrogen sales in later years to provide revenue for road maintenance.

Furthermore, the report comments, "Because EV charging infrastructure suitable for freight vehicles must also be built and expanded in Maryland and throughout the wider region to make this transition feasible, Maryland should partner with surrounding states to support interstate freight transportation. One caveat with Maryland's ACT regulation is its requirement of a thorough needs assessment prior to implementation, which could delay the realization of the rule. The assessment must analyze factors such as the number of charging stations needed, how utilities could fulfill new demands, economic feasibility, etc. Through this assessment, the bill also lays the groundwork for transitioning medium- and heavy-duty vehicles in the State fleet to ZEVs." Again, **the report should include hydrogen fueling infrastructure wherever charging infrastructure is mentioned.**

[50] https://californiahvip.org/

Page 48:

The report highlights the need to transition away from nonroad fuel use by highlighting electric technology and fast charging needs and gives examples like CORE. Notably, not mentioned in the section is that CORE incentivizes battery AND hydrogen fuel cell technology: https://e-missioncontrol.com/funding-opportunities/clean-off-road-equipment-core-voucher-incentive-program/. **The report needs to be revised to treat both technology options (fuel cell and battery) fairly and equitably.**

Page 49:

The case study provided incorrectly states that the CSNA requires all new school bus purchases and contracts to be electric by 2025. That is, in fact, erroneous, as the bill establishes "**zero–emission vehicle** requirements for the State vehicle fleet and local school buses," not **electric requirements**. This is the issue with using inconsistent terminology. Although generally speaking, electric vehicles include fuel cell electric vehicles, this report differentiates between electric and hydrogen. So, in this case study, when saying electric, not only does the reader believe battery electric is implied, but the language actually contradicts the climate bill it is referencing. **The entire report needs to refocus on ZEV terminology and only differentiate between battery and fuel cell EVs where appropriate**. For example, the case study could be amended as follows:

> "Climate change and concerns about student and community health are driving school bus electrification mandates around the country, including in Maryland. The CSNA requires all new school bus purchases and contracts to be ~~electric~~ zero-emission by 2025. Montgomery County Public Schools (MCPS) and Highland Electric Fleets (Highland) recently implemented the country's single largest deployment of battery electric school buses at Walter Johnson High School, upgrading 326 school buses to battery electric by 2025. On a business-as-usual day, MCPS diesel buses use approximately 17,000 gallons of diesel fuel, emitting GHGs and other harmful matter from tailpipes. Replacing the diesel bus fleet with ~~electric~~ zero-emission buses will help Montgomery County achieve its target of reducing GHG emissions 80% by 2027 and 100% by 2035.
>
> The partnership between Highland and MCPS will not only deliver cleaner, healthier transportation for students and local communities, but will also support electric grid reliability with vehicle-to-grid (V2G) services and the nation's first use of battery electric school buses to provide synchronized energy reserves. During the 2021-2022 school year, MCPS installed 25 battery electric buses. In the 2023 school year, another 61 buses will be delivered, and ~~electric~~ charging infrastructure will be installed at three more transportation depots."

Page 50 – 53:

Hydrogen is not at all discussed in the section on building decarbonization. Instead, the sole focus is on electrification and energy efficiency measures. However, as the report "Use of hydrogen in Buildings[51]" showcases, replacing gas furnaces and water heating will drive an increase in electricity peak load by 157% in Germany from today (79GW) to 2045 (203 GW). The Pathways report does not at all address these issues.

[51] https://hydrogeneurope.eu/wp-content/uploads/2022/12/Buildings-and-H2_Brochure_FINAL.pdf

Developing a hydrogen strategy to produce large-scale hydrogen, store it underground, and distribute it during peak demand times would help alleviate these grid challenges. Unlike electricity, hydrogen can also be transported overseas and via pipelines, providing flexibility similar to oil and natural gas and reducing our reliance on regional intermittent generation. **The report should include the recommendation for developing a hydrogen roadmap in Maryland.**

Furthermore, this section doesn't discuss renewable gas or biomass (cordwood/pellets) as solutions to meet GHG reduction goals. This is likely an option in rural Western Maryland, where many customers use heating oil or propane to heat their homes, making them resilient to power outages during the winter. Wood-based heating is also supported by BIL funding ($2,000 or 30% of project cost)[52] and incentives by the state of Maryland[53]. Considering that a switch from heating oil or propane to biomass eliminates all GHG emissions for that customer instantly rather than waiting decades for the grid to become cleaner, the authors should elaborate on why expanding wood heating is not recommended in this report.

The report also ignores the implications and increased risk to human life due to a lack of heating during power outages during winter storms in these more remote regions. **This should be included in the health benefits section on pages 90-93.**

Finally, the energy consumption stats for residential (as well as commercial buildings) need more explanation. "As zero-emission appliance standards and zero-emission construction standards kick in, the share of electricity increases to almost 60% of total residential energy consumption in 2031, while natural gas consumption falls to 31%. […] total residential building energy use falls by 15% from today's levels due to efficiency measures from EmPOWER and from electrification". While EmPOWER may reduce energy consumption overall due to insulation and weatherization programs, a strong focus on building electrification implies more electricity demand as non-electric appliances are replaced by electric ones. Generally, an electrified home requires more electricity than a non-electrified home. However, the total amount of electricity used in residential buildings will decrease from 2025 to 2030 and remain steady (7% increase from 2025 to 2050, or a 0.3% annual increase) according to this report. This needs to be explained, as such a low annual rate of increase, despite massive additions to grid demand (especially in the winter), would be expected with an all-electrification scenario.

Page 60-63:

"Non-cement industries within the State see a similar trend of lower growth in energy demand in Maryland's Climate Pathway compared to Current Policies, which would need to be achieved through efficiency measures or lower rates of demand growth. Further emissions reductions are achieved through greater electrification, increased use of biofuels, and phasing out the small amount of coal use that remains in the sector." Considering that this section specifically indicated difficulties with electrification, endorsing greater electrification seems counter-intuitive. What is missing is highlighting the role that hydrogen can play in ensuring deep decarbonization of industrial processes. The 2021 report "Hydrogen for Net-Zero A critical cost-competitive

---

[52] https://www.hpba.org/Advocacy/Biomass-Stove-Tax-Credit
[53] https://energy.maryland.gov/residential/Pages/incentives/woodstoves.aspx

energy vector" by McKinsey[54], as well as the "DOE Industrial Decarbonization Roadmap"[55] highlight the role of hydrogen. While the IRA and the hydrogen incentives are mentioned, surprisingly, the Maryland Climate Pathways scenario sees far less hydrogen utilized than under current policies, which is not explained, and sees much less energy consumption overall.

Hydrogen is widely seen as a major contributor to GHG reduction in the cement sector,[56] e.g., DOE: "cement can use clean hydrogen to decrease direct CO2 emissions where electrification is not an option due to high heat requirements", but the document referenced under the section: "A detailed analysis of decarbonization strategies for the cement sector can be found in Manufacturing Sector Decarbonization Strategies and Impacts in the State of Maryland" does not consider hydrogen at all.

Relatedly, the Case Study about Heidelberg Materials fails to mention its carbon-neutral cement production in the UK, where "A cement kiln at the Ribblesdale plant of HeidelbergCement's subsidiary Hanson UK has successfully been operated using a net zero fuel mix as part of a world-first demonstration using hydrogen technology. Led by the British Mineral Products Association (MPA), and funded by the British Department for Business, Energy and Industrial Strategy (BEIS), Hanson UK successfully implemented a mix of 100 per cent climate-neutral fuels including hydrogen for commercial scale cement manufacture for the very first time." [57]

Page 72-73:

This section doesn't discuss the capture of landfill gas and conversion to RNG. Currently, a significant portion of landfill gas is being flared instead of used to reduce fossil fuels. This needs to be considered, and a **recommendation to upgrade all landfill gas sites in Maryland to capture and convert LFG to RNG should be included.**

Pages 76-78:

To reduce methane emissions on farms, **a recommendation should include the incentivization for farms to convert manure in digesters to RNG.** Furthermore, using renewable-derived ammonia (e.g., using clean hydrogen) would also reduce emissions. **Programs to work with farmers and incentivize the use of renewable ammonia could be a recommendation.**

Page 79:

Policies that promote sustainable use of forests and incentives for using low-grade wood for heating in rural areas, e.g., via pellets stoves, would provide foresters with additional income and ease land-use change pressures from developers. **Creating a local economy for wood heating would reduce the amount of electricity to be imported from out of state and reduce winter peaks and should be included in the recommendations.**

Page 90-93 – Health Benefits

---

[54] https://hydrogencouncil.com/wp-content/uploads/2021/11/Hydrogen-for-Net-Zero.pdf

[55] https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf

[56] https://www.hydrogen.energy.gov/pdfs/us-national-clean-hydrogen-strategy-roadmap.pdf

[57] https://www.heidelbergmaterials.com/en/pr-01-10-2021

Health benefits seem to focus solely on combustion emissions. However, that is a narrow view, as trade-offs are to be expected. For example, as battery EVs are replacing traditional ICE vehicles, the vehicles themselves get heavier due to the increased size of batteries to meet range expectations. However, the heavier weight of BEVs increases safety risks for all traffic participants, but especially pedestrians and bicyclists.[58] The report needs to include those increased rates of injuries and fatalities.

In addition, BEVs suffer increased tire wear,[59] which is a little-understood cause of local air pollution and can create more emissions than what's coming from the tailpipe of a combustion vehicle[60]. As switching from ICE engines to BEVs eliminates tailpipe emissions but increases tire emissions, **this needs to be modeled in the emissions and health benefits section.** Battery EV tires also tend to wear out 20% faster compared to ICE vehicles due to higher vehicle weight and faster acceleration.[61]

Page 94 – Economic Impacts

The report uses REMI PI+ modeling and the creation of 6,000 new jobs, but it is unclear if those are net jobs or new jobs, which may not be accounting for lost jobs. It would also be vital to provide an analysis of the assumptions made to feed the REMI PI+ model. The report states, "To estimate the impact of Maryland's Climate Pathway, the difference between the Current Policies and Climate Pathway scenarios was calculated in terms of capital costs, electricity generation costs, and energy. These differences were entered into REMI PI+. Due to the broad industry scheme used in REMI PI+, the change in the cost of electricity generation was entered as a change in fuel costs under the Utilities sector." **Information about these costs and assumptions should be provided to provide transparency.**

Interestingly, California's ARB 2022 Scoping Plan includes economics and comes to a different conclusion. "While in 2035 there is a net decrease in personal income of $600 million, total income for households that make less than $100,000 per year is estimated to decline by $4.1 billion dollars, and the total income for households that make more than $100,000 per year will increase by $3.5 billion under the Scoping Plan Scenario. In 2045, although there is no net change in personal income across all California households, results vary by income level. Total income for households that make less than $100,000 per year is estimated to decline by $5.3 billion dollars, while the total income for households that make more than $100,000 per year will increase by $5.3 billion under the Scoping Plan Scenario."[62] **The Maryland Pathways Report needs to clearly delineate how it comes to the conclusion of economic benefits when other reports clearly indicate that household income, especially of poorer Americans, will suffer.**

Page 98

The table does not clearly delineate between existing and proposed policy approaches but should do so for transparency.

[58] https://www.axios.com/2023/04/28/evs-weight-safety-problems
[59] https://www.washingtonpost.com/climate-environment/2023/07/09/tire-brake-tailpipes-emissions-pollution-cars
[60] https://www.theguardian.com/environment/2022/jun/03/car-tyres-produce-more-particle-pollution-than-exhausts-tests-show
[61] https://cleanfleetreport.com/tech-why-dont-tires-last-as-long-on-an-ev/
[62] https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf, p. 125

Page 99

“To achieve the Pathway analyzed in this report, it will be essential for Maryland to pursue an all-of-society approach to climate action, with engagement and efforts by State and local governments, as well as community groups, businesses, and individuals. In one step toward building this broad-based effort, MDE and CGS will convene a series of public workshops and provide other methods for interested parties to comment on the proposed Pathway”. Unfortunately, no workshops have been held, merely listening sessions with Q&A from the authors. Unlike the work streams in California, where true, detailed feedback is gathered, open discussion of specific industry sectors is held, and impacted industries are invited, none of this has happened for this report.

Thank you for your consideration.

Best regards,

/s/ Emanuel Wagner
Emanuel Wagner
President
Palamedes Strategies