Strong Plug-in Hybrid EV
COALITION

January 16, 2024

California Air Resources Board staff
1001 I Street
P.O. Box 2815
Sacramento, CA 95812

Submitted via Advanced Clean Cars II workshop comment docket

Re: November 2023 workshop on Advanced Clean Cars II Regulations

Dear CARB staff:

The Strong Plug-in Hybrid Electric Vehicle (PHEV) Coalition's advocacy team appreciates this opportunity to comment on the Advanced Clean Cars workshop. Established in July 2019, the Strong PHEV Coalition represents an independent group of over 40 electric transportation experts with many years of collective professional experience. We possess expertise throughout the EV industry including research and academia, vehicle manufacturing and deployment, policymaking, utilities, NGO advocacy, consumer education, EV fleet management, and charging infrastructure development. We have provided information to CARB during the last 3 years as we have supported PHEVs with a minimum of 50 miles or greater all electric range. We continue to support CARB and its inclusion of SPHEVs with the comments that follow in this response. Please see www.sphev.org for our previous education and advocacy efforts including letters to CARB staff. We very much appreciate the access we have had to CARB staff on PHEV issues and our constructive dialogues we've had.

The following 11 recommendations highlight our specific CARB requests. Details supporting each request follow:

1. We support your proposal on workshop slides 43-45 regarding CARB doing conformance testing on EV-EVSE performance of communications using SAE 1772, ISO-15118-2, ISO-15118-20, and DIN 70121, but respectfully request that you also look into end-to-end conformance testing of communications for level 1, level 2 and DC fast charging from the EV to the grid and SAE 3400.

2. We request CARB also conduct conformance testing of bidirectional charging of DC fast charging and also AC charging to see if they meet communication protocols.

3. We request that CARB conduct conformance testing to determine if BEVs and PHEVs can charge as fast as claimed by the vehicle manufacturer for both level 2 and DCFC.

4. We support your proposal on workshop slides 46-47 regarding consumer-facing vehicle labels but request that GHG emissions from battery mining and battery manufacturing be included in the California environmental performance label using best available estimates

5. ZEV assurance measures are needed such as those on workshop slide 47 and others such as

- an additional window label for BEVs and PHEVs to help the consumer understand several basic facts
- a CARB website that has the same information as this new window label
- two displays on the screen or dashboard of PHEVs and BEVs to improve the consumer experience
- a sticker on the inside of charge port door for BEVs and PHEVs, and on the inside of the gasoline port door too.

6. We oppose EPA and CARB changing the fleet utility factor for PHEVs at this time, but support seeking new data sources, considering other sources of GHG and new ways to verify PHEV use.

7.We recommend that CARB (potentially with DOE and EPA) update the current studies on GHG emissions from battery mining and battery manufacturing.

8. We recommend that CARB (likely with EPA, the DOE or the national labs) conduct a comparative analysis on PHEV and BEV costs with a stakeholder input or working group.

9. We recommend that CARB should consider adding a small bonus credit for vehicles that have on-board AC bidirectional chargers or are integrated with multiple DC off-board chargers.

10. We recommend that CARB conduct an analysis and make recommendations on whether the new ACC II needs to be adjusted for class 1 or 2a PHEVs and ZEVs.

11. We recommend that CARB (potentially with EPA, the DOE or the national labs) conduct an analysis on the value of PHEVs as a platform for low-carbon alternative fuels including whether to allow PHEVs with 85% or more low carbon liquid biofuels blended with gasoline to be treated as zero-emission vehicles (ZEVs) in future CARB regulations.

Recommendation Detailed Response:

We support your proposal on workshop slides 43-45 regarding CARB doing conformance testing on EV-EVSE performance of communications using SAE 1772,ISO-15118-2, ISO-15118-20, and DIN 70121, but respectfully request that you also look into end-to-end conformance testing of communications for level 1, level 2 and DC fast charging from the EV to the grid. It is important to recognize that almost all light-duty OEMs will be transitioning to the Tesla connector formerly known as the Tesla Universal Mobile Connector (TUMC) and soon, the North American Charging Standard (NACS) or SAE 3400. The Tesla connectors have their own communications protocol, similar to ISO 15118.20. Conformance testing should also include the TUMC or NACS as well. These standards should be required to communicate with the grid in one-way charging and problems may occur in de-encryption, translation to another communications protocol and re-encryption in order to communicate with the grid. We also recommend CARB hold a workshop to see if other standards should be included for testing (e.g., safety standards, cybersecurity, etc.).

Further we respectfully request that CARB identify whether or not a vehicle is capable of bi-directional charging, and if so, conduct conformance testing of bi-directional charging for DC fast charging as well as AC charging and compliance with specific communication protocols. For AC charging, that means testing to SAE J3072 for EV to EVSE and other standards from the EVSE to grid.

As bi-directional charging emerges, assurance, and identification of the appropriate standard(s) involved will become increasingly important to the consumer.

In addition, we respectfully request that CARB conduct conformance testing to determine if BEVs and PHEVs can charge as fast as claimed by the vehicle manufacturer for both level 2 and DCFC. Not all cars can charge as fast as claimed by the vehicle manufacturer, and having an independent test would be valuable (e.g., charging speed is influenced by temperature, typically decreases over time, etc.). It has not been uncommon that vehicles capable of charging at higher rates (both L2 and DCFC) are unable to do so. This may be because software is throttling the power to the L2 or the DCFC, or there is/are other software issues between the device and the vehicle.

We support your proposal on workshop slides 46-47 regarding consumer-facing vehicle labels but request that GHG emissions from battery mining and battery manufacturing be included as part of well to wheels GHG emissions in the California environmental performance label using best available estimates. As shown in Appendix A to our letter, these emissions are very significant for a battery EV and can equal the GHG from gasoline miles in a Strong PHEV (e.g. with 0-30% of total miles on gasoline). Further, due to this reason, there is a big difference in GHG emissions a battery EV with 150 miles vs 600 miles of range, and consumers should know about this. Education is critical today and we urge CARB to assume this role.

Additional ZEV assurance measures are needed such as those on workshop slide 47. We are very pleased that you are considering more ZEV assurance measures and would like to recommend several more assurance measures to help accelerate adoption of BEVs and PHEVs.

1. **We recommend adding an additional window label for BEVs and PHEVs** to help the consumer understand:
    a. The type of battery (where CARB would come up with a shorthand names of each chemistry)
    b. The size of the battery (kWh)
    c. Improved driving range information (including gasoline miles) for both city and highway driving and other major factors that impact range (e.g. HVAC, payload)
    d. The type of charging the vehicle can do (e.g. level 1, level 2, DCFC) including range of kW levels
    e. How quickly the vehicle can charge at different charging levels that is more sophisticated than the current federal window label (e.g., level 1, low-power level 2, high power level 2, and different levels of DC fast charging).
    f. If the vehicle can do bidirectional charging: vehicle to load, vehicle to home, or vehicle to grid
    g. A QR code on window glass or window label, similar to the QR code found on the Federal window sticker, be provided so the consumer can obtain more detailed information on the above and potentially more detailed information on other subjects (e.g. the vehicle's connectors, battery warranty, results from conformance tests, details on potential savings by using electricity, vehicle range under different conditions etc).

2. **Further, we recommend CARB create a website that has the same information as above** because window stickers are not used enough and are temporary. *Justification:* Moving from

early adopters to mainstream and late adopters will require more education on basic information. In addition, media attention has resulted in consumers needing to be more informed about basic battery information. Ideally well-educated consumers can push the market for BEVs and PHEVs to batteries with less environmental impact.

3. **We recommend CARB require automakers to provide several reminders or displays on dashboard of PHEVs and BEVs** to improve the consumer experience.
    a. **CARB should require a graphic, voice, or word reminder from the dashboard to plug in the vehicle when they park** (especially for PHEVs). In other words, it would be similar to the seat belt reminder, but at the end of a journey. We support more education on the issue of plugging in from the vehicles – human-vehicle interface.
    b. **CARB should require diagnostic trouble codes on the vehicle's screen or dashboard.** The basic idea is to reduce the perceived and/or real risk of buying either a new or used BEVs and PHEVs, as well as reduce the hassle/cost of maintaining BEVs/PHEVs. ICE vehicles have an On-Board Diagnostics (OBD-2) port. The owner can obtain the code and look up the cause. Having trouble codes and battery condition available on the vehicle's screen or dashboard would build confidence, especially for those buying a used BEV or PHEV. In case the display is non-functional, it would be a good idea to also have the DTCs available through an OBD2 port or USB-C port for PHEVs or some other common port for BEVs. Over the years, there have been "Right to Repair" concerns with ever more sophisticated cars. The auto manufacturers have made it very difficult to diagnose the vehicle. Owners may feel forced to have their cars repaired only at the dealer or by the manufacturer. Enabling independent shops or vehicle owners to diagnose and repair EVs would real help consumers. If CARB requires this, more independent repair shops will be capable of repairing BEVs and PHEVs. This should reduce repair costs, increase convenience, reduce perceived "risk" of owning both new and used BEVs and PHEVs . Given that the used car market is about 2.5 times the size of new car market, our proposal would eventually help the millions of 2nd and 3rd owners and many low- and moderate-income buyers/owners.

4. **We recommend CARB require a sticker on the inside of charge port door for BEVs and PHEVs, and on the inside of the gasoline port door too**. As stated above, the reason for our recommendation is basic education of the consumer to explain that PHEVs are dual fuel vehicles which can run on either electricity or a second fuel (e.g., gasoline or hydrogen or perhaps another fuel). The sticker on the charge port door would identify the different charging levels / types the vehicle is capable of. This approach would further reinforce our similar recommendations for window labels and dashboard communications. CARB should hold a workshop on this and potentially other ZEV assurance measures.

We oppose EPA and CARB changing the fleet utility factor for PHEVs at this time, but support seeking new data sources, considering other sources of GHG and new ways to verify PHEV use. Regarding staff's proposal and questions on slide 21, we repeat our comments we provide in July 2023 to USEPA on this topic and make the same recommendations to CARB staff.

Regarding the Fleet Utility Factor (FUF or UF) and the issue of PHEVs plugging in we have many recommendations. We recognize this is an important and a complicated issue. We share CARB and

EPA's desire to have PHEVs plug-in frequently in order to achieve needed emission reductions and make the averaging, banking and trading system work. We believe that a combination of regulatory requirements, incentives and disincentives discussed below will address the issues that CARB and EPA have raised and improve the FUF.

1. *We strongly recommend against using the California Bureau of Automotive Repair (BAR) data and [Fuelly.com]() data as the basis for a new FUF for PHEVs at this time. The Technical Committee of the Strong PHEV Coalition includes researchers who have been engaged with development and evaluation of UF calculations for more than 20 years. We are very familiar with the set of datasets that are available in the public and private domain for UF evaluation and have researched the datasets and authored many of the studies referenced in the Draft Regulatory Impact Analysis (DRIA). Our assessment and recommendations in response to the request for input on UF data in the DRIA is that the proposed changes to UF are based on a very poor dataset, poor analysis, and statistically indefensible methods. These datasets and methods are inadequate to inform policy of the importance and impact of CARB and EPA's emissions standards. See Appendix B for our critique of the BAR and Fuelly.com data sets.*
2. *We strongly recommend keeping the SAE J2841 FUF curve for PHEVs in the final EPA rule and not change ACC II at this time because the SAE standard FUF is an accepted, standardized, and well-understood model. The analyses that are presented by EPA and ICCT as evidence of the unrepresentativeness of J2841 are based on very poor data sources and analysis that is not statistically relevant or predictive. We agree that FUF and PHEV credits should be derived from operational data, but the proposed data sources and analyses are inadequate and reflect poorly on EPA's knowhow. CARB and EPA should engage with experts to derive a data-driven FUF using more representative datasets and methods including those of the CARB-funded UC Davis data logger study, or the EV Project analysis . See Appendix B for more explanation. Another factor that we respectfully request CARB and EPA informally consider is that PHEV batteries typically use five times or less lithium per all-electric mile than battery EVs, and as a result save substantial amounts of GHG from battery manufacturing. (See Appendix C below). Strong PHEVs have the same GHG footprint as a 300-mile range BEV and Strong PHEVs have much higher all-electric range than PHEVs with a low all-electric range. (See Appendix A below.) We support CARB and EPA not considering battery manufacturing GHG emissions in this rulemaking, but request that CARB and EPA informally include this factor when developing the final FUF. While SAE J2841 is not perfect given the factors above it is more than adequate when combined with our package of recommendations below and considering the GHG emission benefits of having a smaller battery pack.*
3. *Further, we support EPA's desire to update the FUF in a future rulemaking when new data becomes available and recommend CARB also delay updating the FUF. We commit to helping CARB and EPA acquire this data as we are a very data driven coalition that includes five universities (or similar research centers). Over time data derivable from CA BAR and other state's smog check programs will improve as more on-board diagnostic data becomes available which should be used in a future rulemaking with appropriate data quality testing, and improved methods.*
4. *CARB and EPA should extend the FUF to 150 miles in order to encourage automakers. For example, Toyota has announced that it is planning a PHEV with over 124-mile all-electric range.[1] While we don't know which test cycle this range is based on, EPA should encourage*

[1] Toyota Planning Plug-In Hybrid Vehicles With Over 124 Miles Of Electric Range (motor1.com)

this long all electric range.[2] Another example is the BMW i3 REX which was designed to primarily drive all-electric miles but is now only sold as a used PHEV.

5. *CARB and the EPA, in a future rule, should include* ***a true-up system*** *for automaker's FUF where debits or credits are provided based on actual data from on-board diagnostics and reporting by automakers of a fairly large sample. In other words, under this proposal, an automaker would lose or gain credits after-the-fact based on actual data on how consumers drive both new and older PHEVs. If CARB and/or EPA opts not to do this, we request that CARB and EPA should, at minimum, require manufacturers in this rulemaking to share anonymized actual data from PHEVs so that in future years, CARB and EPA can make informed decisions about the FUF based upon real world data.*
6. *CARB and EPA should note that PHEVs with a long all-electric range offer much greater benefits to consumers and show much higher levels of plugging in. See Table 1 I Appendix B.*

In addition, several things have changed since our June 2023 letter to EPA that strengthen our request to keep J2841 as the basis for the FUF in CARB and EPA regulations and work to improve the FUF for a follow-on rulemaking using improved data sources.

- *Several studies are saying that light duty EVs are not driving as much as ICEVs: as low as 61% of annual miles from ICEVs.[3] This makes SAE J2841 a conservative approach to the FUF.*
- *The big sales increase in China of PHEVs (including EREVs) compared to BEVs which points to consumers having concerns about BEVs in a more mature market such as China.[4] This further points to the potential (likelihood) for this need for PHEVs to occur in US in a future more mature market especially given the increased polarization and realization of real-world drive cycle applications that may be problematic for BEVs among drivers. Obviously, the press is full of articles about concern about the BEV market adoption slowing. Also achieving 100% adoption of ZEVs and Strong PHEVs will be very challenging.*
- *The Dodge RamCharger pickup with anticipated 145-mile AER and 690 total miles.[5]*
- *Finally, there is the cost of fuel. When the cost of fuel rises, owners are far more likely to drive their BEV or plug-in their PHEV.*

We recommend that CARB (potentially with DOE and EPA) update the current studies on GHG emissions from battery mining and battery manufacturing. We discuss this need in more detail in Appendix A. We believe the current approach taken by agencies is too siloed, does not provide consumers with the information they need and results in policy makers not having enough information. This issue is not just about PHEVs with their smaller batteries, but also the trend of BEVs having larger and larger batteries (e.g. BEV 600s vs BEV 300s).

We recommend that CARB (likely with EPA, the DOE or the national labs) conduct a comparative analysis on PHEV and BEV costs with a stakeholder input or working group). PHEVs can be made in

[2] If this 124-mile range is based on the WLTP test (instead of EPA two cycle test) it is a very good all electric range for a PHEV. Also see footnote 5.
[3] For example, see https://www.scientificamerican.com/article/electric-vehicle-owners-are-not-driving-enough-and-thats-bad/
[4] https://www.reuters.com/business/autos-transportation/hybrid-vehicle-sales-surge-china-posing-fresh-threat-foreign-automakers-2023-11-21/
[5] https://www.ramtrucks.com/revolution/ram-1500-ramcharger.html

a less costly manner than shown in most analyses. Technical maturity, engineering advances, supply chain issues, changes in mineral prices, war and scale-up issues are impacting the costs of BEV and PHEV up-front and operating costs. Today, costs are rapidly changing, especially for batteries. In addition, Argonne National Lab's recent report[6] shows that PHEVs are less expensive than BEVs for cars. Technical experts at Strong PHEV coalition assert that several additionalmodifications can lower the cost of PHEVs that most analyses do not consider. We think this likely applies to plug-in hybrid cars and trucks but recognize that more analysis is needed.

A common mistake we find in reports is not understanding the difference between a strong PHEV and other PHEVs because a strong PHEV can use the same batteries as a BEV which results in significant cost savings. See Appendix D for a more detailed explanation.

In order to show additional ways that costs can be reduced and that hard-to-reach markets are served, we respectfully request that CARB develop a scenario in the final rulemaking that reduces the total costs. Specifically, this new scenario should include a modest number of PHEV cars and trucks as that will impact the cost analysis by reducing the cost of charging infrastructure, the amount of critical minerals and by using BEV batteries in strong PHEVs. This scenario could reduce the number of BEVs and FCEVs by a small amount (say 20% collectively) and be instead served by a mix of Strong PHEV cars and trucks and other PHEV cars and trucks. The PHEV battery costs should be based on using BEV batteries as explained in Appendix D in this letter. The use of away-from-home DC fast chargers should be modestly reduced, and the cost of the PHEV including total cost of ownership should be based on work by Argonne national lab for light-duty PHEVs.[7] Finally, bidirectional charging using DC off-board chargers should be assumed in our recommended alternative cost analysis for a reasonable percentage of BEVs and PHEVs in order to further reduce the total cost of ownership.

We applaud EPA for commissioning a tear down analysis of BEV costs and request that EPA or CARB conduct a similar tear-down analysis be done for a Strong PHEV. Most importantly, In any cost analysis, scenario or tear-down study for PHEVs, special PHEV batteries should not be used, but rather medium and long-range PHEVs should use less expensive BEV batteries and the benefits of PHEVs not needing as strong of chassis as BEVs should be included in the cost. These are the two largest cost savings with mid- to long-range PHEVs compared to BEVs.

We recommend that CARB should consider adding a small bonus credit for vehicles that have on-board AC bidirectional chargers or are integrated with multiple DC off-board chargers. Alternatively, at minimum, CARB should conduct an analysis on how it can advance bi-directional charging in the future. *Justification:* The promise of bi-directional charging (AC or DC) to address air pollution, GHG and electric grid issues is very significant with BEVs and PHEVS in light-, medium- and heavy-duty vehicles, or off-road equipment. For example, a recent May 2022 presentation by the World Resources Institute using Bloomberg NEF and Energy Information Administration data

[6] https://www.anl.gov/argonne-scientific-publications/pub/167396

[7] Ibid

found the power capacity in 2030 for EVs to be 10 to 20 times more than the 2030 power capacity of stationary storage.[8] CARB can and should play a role in helping to unlock this potential.

- For example, the internal combustion engine in a PHEV has a much lower emission signature than a stand-alone, backup generator. A PHEV backup generator function can be extremely valuable in emergency response scenarios or with increasing grid failures.
- Bidirectional charging, like battery stationary energy storage, can reduce GHG and traditional pollutants from fossil fueled power plants by shifting electricity use to renewable energy in the cleanest hours of the day and reducing the need for high-emitting plants (such as traditional peaker power plants).
- Bidirectional charging can also provide many types of grid services including ancillary services, providing resource adequacy, and helping with the evening transition from renewables to other generation resources. Because the batteries are already paid for by the car and truck owners, utilities can gain a low-cost resource compared to battery stationary storage.
- The potential value is significant and can contribute to lower operating costs for BEVs and PHEVs.[9]

While we understand the desire by CARB to simplify the regulation and reduce the use of bonus multiplier credits, we believe a small bonus credit in the final regulation for a few years is justified and needed to unlock this technology because of the large emission reduction benefits and other benefits enabled by bidirectional charging.

We recommend that CARB conduct an analysis and make recommendations on whether the new ACC II needs to be adjusted for class 1 or 2a PHEVs and ZEVs. *Justification*: As mentioned above, several market drivers are changing fast which will likely impact willingness to pay and interest in ZEV and PHEV adoption. We believe the staff review should examine future adoption rates by the various market segments (e.g., type and mass of vehicles, type of consumer), consumer's willingness to pay and reasons why some market segments might be lagging in adopting ZEVs and PHEVs. Reaching 100 percent sales of ZEVs and PHEVs will be hard for late adopters and other challenging market segments. Some examples of difficult market segments that need to be better understood in a future technology and progress review:

- The needs of frontline and other priority communities need to be better understood.
- The needs of approximately eight million vehicles in class 2a vehicles (about 27 percent of all vehicles in California) to be ZEVs or PHEVs as this market often has the most difficult use cases such as 4WD and towing.
- Many of those surveyed recently were not interested in purchasing a ZEV according to JD Power[1] and those who bought a ZEV and then returned to a traditional gasoline vehicle for their next car.[10]

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[8] See slide 5 at https://www.slideshare.net/emmaline742/building-resiliency-with-v2g-in-residential-homes-by-camron-gorguinpour

[9] California Energy Commission, March 2019, Distribution System Constrained Vehicle-to-Grid Services for Improved Grid Stability and Reliability, Figure 42

[10] For example, see https://www.musclecarsandtrucks.com/50-of-ev-owners-are-switching-back-to-ice-vehicles-excluding-tesla/

We recommend that CARB (potentially with EPA, the DOE or the national labs) conduct an analysis on the value of PHEVs as a platform for low-carbon alternative fuels including whether to allow PHEVs with 85% or more low carbon liquid biofuels blended with gasoline to be treated as zero-emission vehicles (ZEVs) in future CARB regulations. The main issue to be studied is feedstock availability in the long run for both diesel and gasoline substitutes that could be used in PHEVs to make them have lower life cycle emissions. Related environmental issues could be studied. In addition, there are emerging technologies that can turn CO2 into gaseous or liquid fuels for engines and these also should be examined.[11]

Justification: Some biomass feedstocks used in gasoline can't or won't be used in diesel or jet fuel powered transportation. This should result in large amounts of unused feedstocks because biomass feedstocks for spark-ignited engines may not be needed in the long run (e.g.,2050) for transportation or industrial uses. However, using some of these existing feedstocks would make future PHEVs have even lower full fuel cycle GHG emissions than they have today. Strong plug-in hybrid cars and light trucks using gasoline already can have lower GHG than long range electric cars and light trucks due to the GHG emissions from battery manufacturing and the slightly poorer fuel economy of long-range BEVs. (See Appendix A in this letter).

Summary of why PHEV cars and trucks are needed. We believe that regulations and incentives have not tried hard enough to encourage Strong plug-in hybrid cars and trucks, especially those that can achieve 80% to nearly 100% of their annual miles using electricity. We believe that Strong PHEV in combination with battery electric vehicles (BEVs) and fuel cell EVs (FCEVs) are better in the near- and long-term than a scenario with FCEVs and BEVs with no Strong PHEVs or other PHEVs.

Advantages of including SPHEV (and other PHEVs) in the rule include:

- A combined strategy (SPHEVs + PHEVs +BEVs+ fuel cell EVs) is a faster path for the world to adopt vehicles with zero greenhouse gasses[12]
- Strong PHEV cars and trucks are a better solution (because they are dual fuel) to survive in long-term catastrophes and daily emergencies (e.g., wildfires, earthquakes, windstorms, hurricanes, tsunamis, power outages, riots, vandalism, tornadoes, and floods) and can provide power export using the engine
- Strong PHEV cars and trucks are a better solution for personal EV drivers and commercial fleets that are renters and change residences or business locations relatively often
- Strong PHEV cars and trucks are a better solution for owners of used cars and trucks who are often low-income residents or are low-income independent contractors
- Strong PHEV cars and trucks have much less cost impact to the grid and have a lower demand charge part of their electricity bill and help mitigate scale-up concerns of building a network of away-from-home heavy-duty vehicle DC fast chargers and heavy-duty hydrogen infrastructure in a timely manner
- Strong PHEV cars and trucks are a better option for the portion of the world that covers small and mid-size towns where trip distances (when needed) exceed urban megacity regions and in regions with extreme cold weather. Drivers in rural areas often drive longer distances than others and in areas with little access to charging

[11] For example, see https://www.thecooldown.com/green-tech/carbon-dioxide-propane/

[12] Long-range PHEV cars and trucks with 80-90% of annual miles electric and 10-20% existing miles on biofuels are likely a long-term solution.

- Strong PHEV cars and trucks are particularly useful in cold weather regions and for fleets that need to tow trailers, boats and campers for work
- Strong PHEVs are attractive to drivers who are skeptical of or opposed to battery EVs or fuel cell EVs
- Strong PHEVs can equal the GHG reduction benefits of a comparable long-range BEV when battery manufacturing emissions and other factors are considered (See Appendix B) and thus are a long-term solution
- Strong PHEV cars and trucks use substantially less critical minerals (due to their smaller batteries compared to battery EVs), and thus reduce pressure on the need to rapidly scale supply chains for these minerals and hedge against supply chain disruptions[13]
- Strong PHEV cars and trucks compared to BEV cars and trucks can weigh less resulting in fleets not having to purchase larger BEVs (e.g., Class 4 instead of Class 3) in order to have the same payload
- Strong PHEV cars and trucks will have important long-term adopters globally regardless of their cost and many car and/or truck makers will want to serve this market
- Strong PHEV cars and trucks offer air quality benefits.

Note our May 31 2022 letter to CARB on Advanced Clean Cars II regulation goes into more detail on the above bullet points.

In this letter and our previous conversation with CARB and EPA staff, the Strong PHEV Coalition sought to share our data driven approach to understanding the future of PHEVs. We seek to be a resource to CARB and to EPA to connect policy making to the resources and expertise that we have available in our diverse team. We look forward to more dialogue with staff so that we might collectively improve the sustainability, justice, and economy of transportation for all stakeholders.

Sincerely,

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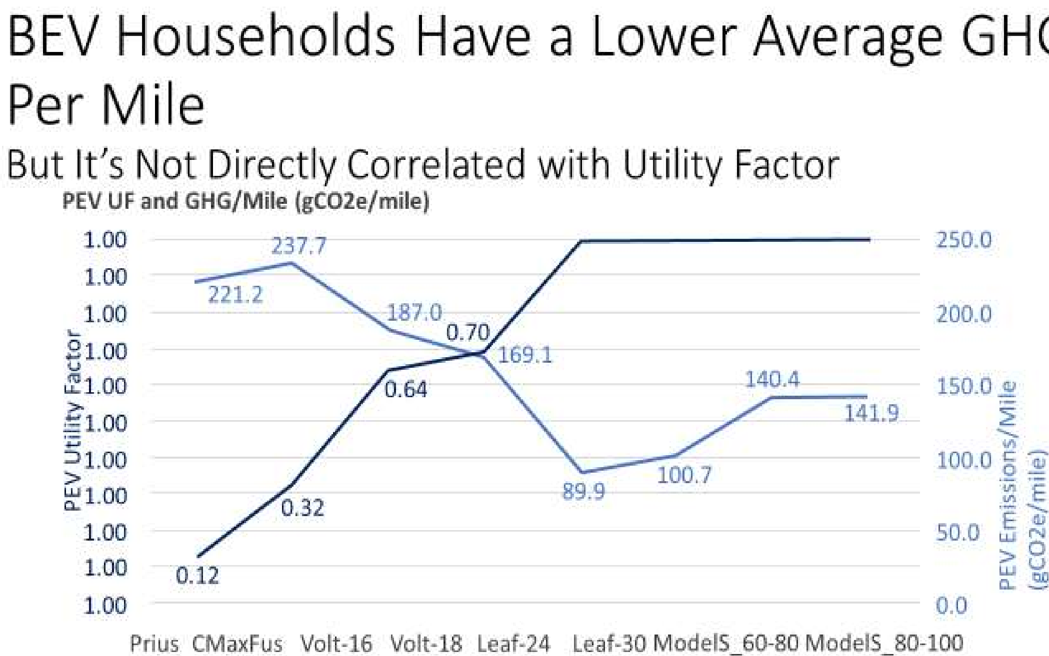
[13] For example, see https://insideevs.com/news/589228/stellantis-plans-combat-battery-shortage-recession/

Appendix A

Strong PHEV vs long-range BEV GHG emissions

CARB-funded research by UC Davis,[14] shows a PHEV 60 has the same life cycle GHG emissions as a Tesla model S because of the weight of the Tesla and it has fewer GHG life cycle emissions than a heavier BEV with 400- or 500-mile AER. See the first chart below. Toyota's publicly available tool also correctly shows this result.[15] Furthermore, the UC Davis analysis does not include battery manufacturing GHG emissions. Using data from the USDOE cradle to grave analysis,[16]we estimate that adding 350 miles more of AER adds about 10 grams per mile of GHG emissions to the above analysis for a light duty EV. See the next three charts below. Further, a flex fuel vehicle requirement to enable low carbon fuels for these stronger PHEVs would further lower their life cycle GHG.



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[14] https://ww2.arb.ca.gov/sites/default/files/2020-06/12-319.pdf Figure 82

[15] GitHub - khamza075/PVC: A software for assessing the efficacy of various vehicle powertrains at mitigation of greenhouse gas emissions . Also see https://app.carghg.org/

[16] See page 143 at https://greet.es.anl.gov/publication-c2g-2016-report. Extrapolate from 210 to 410-mile all electric range and divide by 150,000-mile vehicle life.

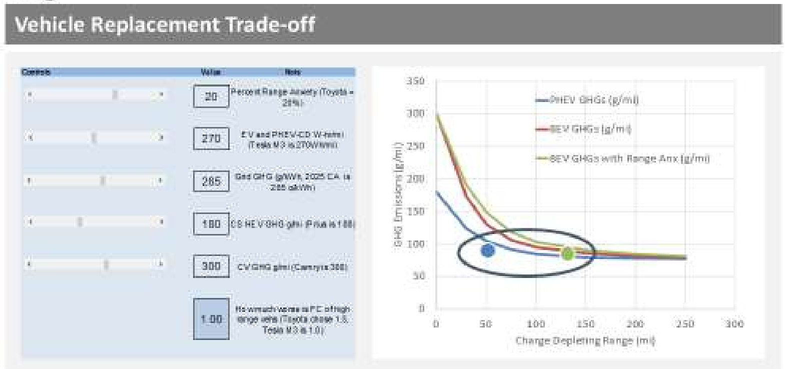
GHG Reductions of Strong PHEVs Compared to Large BEVs

Without Battery Manufacturing

Strong PHEV Coalition made a spreadsheet model to represent GHG emissions of BEVs and PHEVs, including considerations of:

- Drivers' use of replacement ICEVs for trips of max range or greater
- Varying vehicle efficiency, grid emissions, etc.
- Operable XLS and references (here)

Strong PHEVs at ~50mi of R_{CD} have similar GHG emissions as BEVs of ~150mi



T.H. Bradley, et. al, Colorado State University

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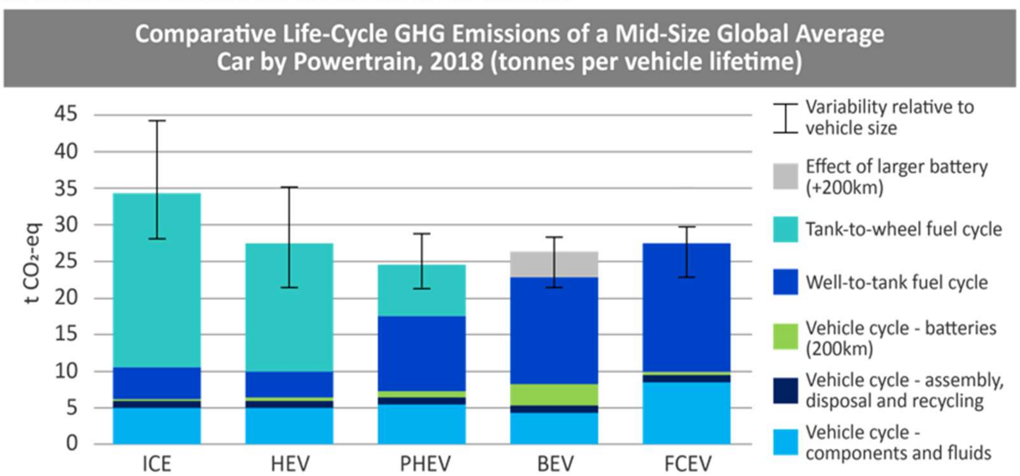
GHG Reductions of Strong PHEVs Compared to Large BEVs

With Battery Manufacturing

- **Strong PHEVs (PHEVs with 35 mi range) are indistinguishable from BEVs in lifecycle GHG emissions**
- Significant difference between BEV 100 and BEV 500 in GHG emissions



Source: IEA (2019), "Global EV Outlook 2019", IEA, Paris

T.H. Bradley, et. al, Colorado State University

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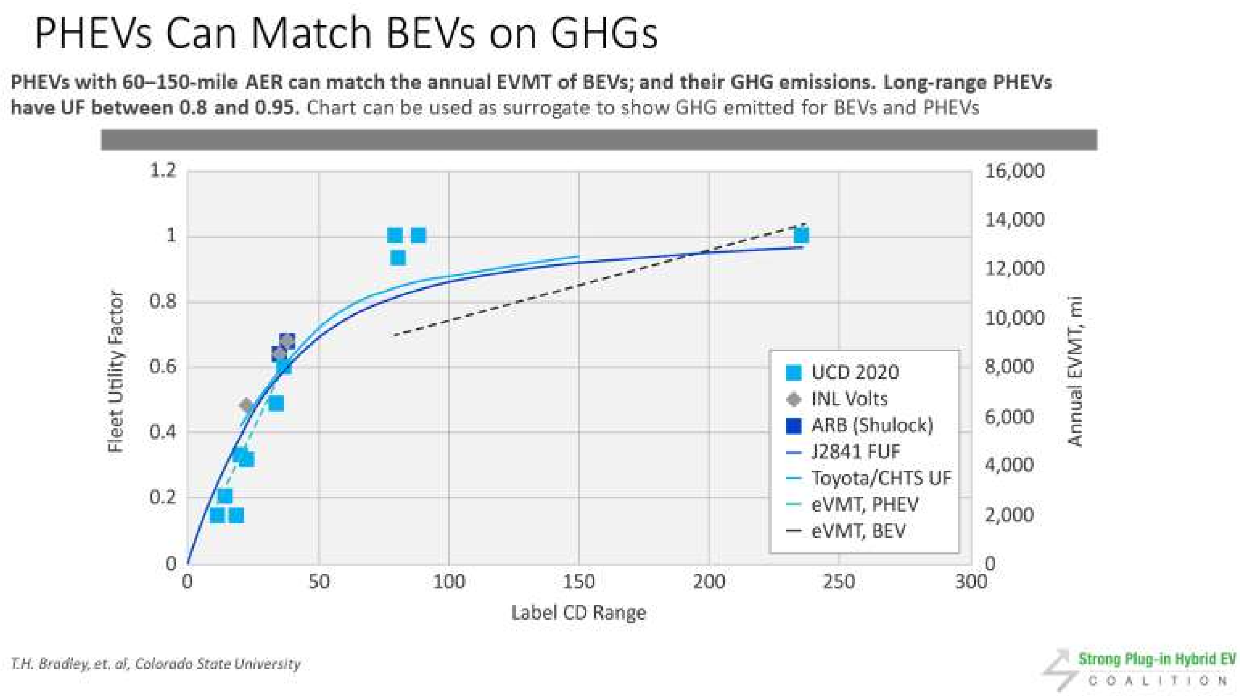

Appendix B

Fleet Utility Factors for PHEVs The Technical Committee of the Strong PHEV Coalition includes researchers who have been engaged with development and evaluation of UF calculations for more than 20 years. We are very familiar with the set of datasets that are available in the public and private domain for UF evaluation and have researched the datasets and authored many of the studies referenced in the DRIA by EPA. Our assessment and recommendations in response to the request for input on UF data in the DRIA is that the proposed changes to UF are based on a very poor dataset, poor analysis, and statistically indefensible methods. These datasets and methods are inadequate to inform policy of the importance and impact of CARB or EPA's emissions standards. See our recommendations section above for what should be done instead.

Critiques of the datasets that are input into the EPA UF calculations The BAR and Fuelly.com datasets that are referenced in the DRIA are both very poor datasets, methodologically and practically ill-suited to sample the population of PHEV owners.

> The Fuelly.com dataset is wholly inadequate to perform this function. It is a self-selected, self-reported online gasoline consumption log; Fuelly.com is not a survey, makes no claim to statistical representativeness, and does not have inputs or data to electric operation in any way. Methodologically, the means by which ICCT and EPA calculate UF from Fuelly.com data is to compare real-world fuel consumption to EPA rated CS fuel consumption, which is completely incoherent if one realizes that EPA rated fuel consumption and on-road fuel consumption are not the same thing. EPA researchers know better than any the many sources of variance between real-world fuel consumption and EPA -rated fuel consumption. In the ICCT calculation, the variance between these two fuel consumptions (which is strongly correlated with weather conditions, driving conditions, tire inflation, etc.) has entirely and

indefensibly been allocated to a lower UF. In both the data and analysis of Fuelly.com fuel logs, EPA and ICCT are using unrepresentative data and deeply inadequate analysis to make policy.

The BAR dataset is a relatively improved dataset, and we believe that in the future, a nationally representative dataset derived from many states who will be gathering this data will have value for measuring the real-world operation of PHEVs and will enable a data driven UF calculation in a future EPA rulemaking. At present, the BAR dataset has comprehensive data quality problems, and the naïve data filtering algorithms that ICCT and EPA used to wrangle and preprocess the data are inadequate to realize a coherent and representative analysis. A partial list of the sample and quality problems with the BAR dataset that are unacknowledged by ICCT and EPA include:

1. Because our coalition has been systematically studying the operation of PHEVs, we have also seen that the FUFs of vehicle models in the BAR dataset are changing as a function of time. We asked for and received from ICCT and CA BAR both the datasets that ICCT used for their analyses (from ICCT), and an updated dataset of the same fields of data up to the present date (May 2023).These datasets show comprehensively different results in calculating PHEV operation. For example, BMW X5 XDRIVE45E vehicles (MY 2019-2022) that meet the ICCT/EPA filtering criteria tested before 17 May 2022 have an average individual UF of 30%. X5 XDRIVE45E vehicles (MY 2021-2023) that meet the ICCT/EPA filtering criteria tested after 17 May 2022 have an average individual UF of 68%. These types of problems with the BAR dataset seem to be unrecognized and not validated by the research community, and further strengthen the case for not using the BAR dataset for research or policy making.

2. There is evidence of systematic importing of used PHEVs into California, a type of data pollution that is not affecting most of the conventional vehicles. For example, a set of vehicles included in the ICCT dataset are six 2019-2020 Toyota Prius Primes. These six Prius Primes are all tested on a single day, they each have > 3000 mi, and five of six of them are present in the ICCT analysis (one has a technician-recorded odometer inconsistency). Whatever the history of these vehicles, the fact that 6 of them are being tested back-to-back on the same day is evidence that these vehicles are not under the operation and ownership of the general public, and that their operational history is not representative of the general public. These clusters of similar vehicles undergoing back-to-back testing are common and easily identifiable in the BAR data used for ICCT and EPA analysis.

Prius Prime 1 tested on 02NOV2020:09:00:00.442000

Prius Prime 2 tested on 02NOV2020:10:34:51.141000

Prius Prime 3 tested on 02NOV2020:11:28:26.939000

Prius Prime 4 tested on 02NOV2020:12:14:16.189000

Prius Prime 5 tested on 02NOV2020:12:25:32.846000

Prius Prime 6 tested on 02NOV2020:13:36:16.952000

3. There is strong evidence that automakers (OEMs) are not implementing the data collection algorithms consistently. For example, all 2019 Chrysler Pacifica hybrid vehicles, transmitted the data required for these calculations from the HPCM-HybridPtCtrl control module, instead of from the ECM*-EngineControl control module which was used by all other OEMs. In reviewing and operating the ICCT's Data Import Algorithm (*BAR Data Import.R,* shared by A. Isenstadt 5/13/23), these vehicles are excluded from ICCT's analysis. Given that 2019 is the first year that on-board diagnostic technology allows data collection, and we anticipate better data reporting and processing in future years, but the handling of these types of inconsistencies is not in evidence in the ICCT/EPA data wrangling processes.

4. There is strong evidence of many significant inconsistencies between the technician and OEM-derived data that are present in the BAR data. For example, of the BMW 530e PHEVs in the ICCT dataset (ICCT_OBD_DATASET_MY2019, requested from BAR in April 2023), 585 (of a total 988) of them failed the odometer reading test (that the technician-entered odometer [in mi] is well-outside the OBD-reported odometer reading [converted to mi]). There is no reason why technicians are so comprehensively misreporting this very simple datum for a vehicle that is one of the most reported vehicles in this dataset (which has ~4000 PHEVs in total).

There are many more examples of these types of problems, none of which are identified or discussed in any of the ICCT/EPA literature or analyses. In summary, at this time, the BAR dataset is not a representative dataset to be able to assess the operation of PHEV in real world operation. In the future, as vehicles in CA (and in other states)[17] age into annual emissions testing, the BAR datasets will have a more comprehensive sample of privately owned and operated vehicles and may be evaluated at that time for its suitability for research and policy making.

Critiques of the methods that are used in the EPA UF calculations. We assert that the methods used to derive the proposed fleet utility factors (FUFs) from transportation datasets are not statistically defensible, and that the process of "averaging" FUF curves is inappropriate and does not improve predictive ability.

Apart from the inconsistencies described in the section above, policy makers and researchers must take caution in deriving findings from transportation data.

Figure 1 illustrates the set of individual vehicle-level UFs that are derived from an updated data pull from BAR. Of course, the data are extremely scattered and do not illustrate the validity of the UF curves for either the SAE J2841 FUF or the proposed FUF. When EPA or ICCT perform least-squares regression to derive a particular UF curve, they must calculate the confidence interval around the

[17] For example, in the state of Colorado, Colorado's Department of Public Health and the Environment will record and make available similar data when 2019 MY vehicles enter emissions inspections after they are 8 years old. This data will be available for researchers and policy makers.

parameter estimates. When we perform that regression with vehicle models' pooled averages, we find that this dataset provides no evidence that the EPA FUF model is more representative than the SAEJ2841 model. To illustrate this point more visually, Figure 2 provides additional statistical detail for some selected vehicle models. Figure 2 illustrates the wide dispersion of measured individual UFs and shows that the 95% confidence intervals on the mean value may or may not encompass any particular pre-derived response curve.

Finally, EPA's method of "averaging" of Fuelly/BAR/J2841 UF curves does not have any statistical/theoretical/practical power in achieving UF prediction and is inappropriate given the varied and disperse nature of these data. A more data-driven approach that incorporates a number of driver and vehicle operating factors is needed to better characterize the real-world utility factors that are likely to arise over time. As the BAR database expands and becomes cleaner and more regularized, it can form the basis of a statistically relevant and more acceptable data-driven model.

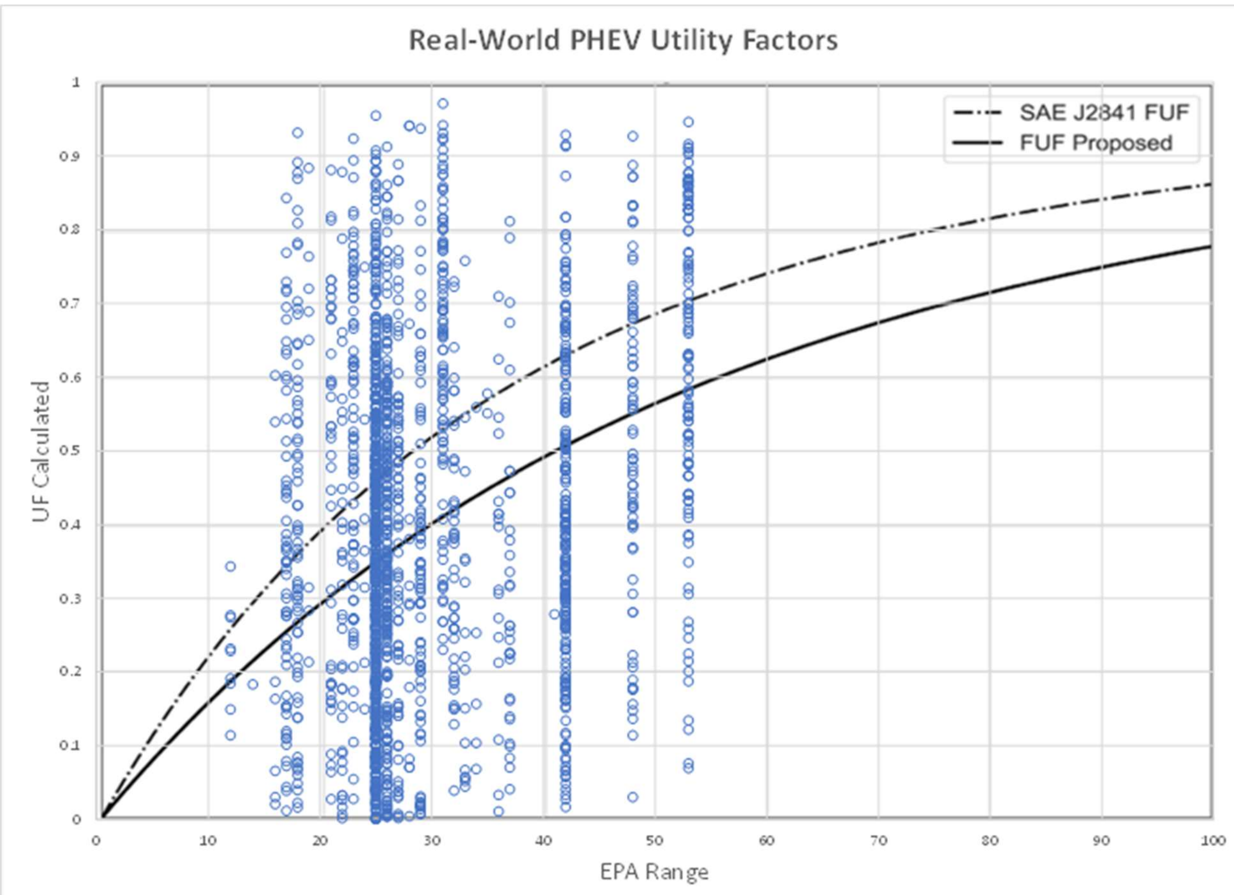

Figure 1. Calculated real-world PHEV utility factors for all vehicle models in the data set compared to the SAE J2841 FUF and the proposed FUF. Values are displayed as a function of EPA range irrespective of vehicle model and model year (e.g., EPA CD range of 31 encompasses two versions of the 2022 Hyundai Santa Fe and three model years of the BMW X5 XDrive45E). Note the wide variation in calculated utility factors compared to the two FUF curves for all EPA ranges.

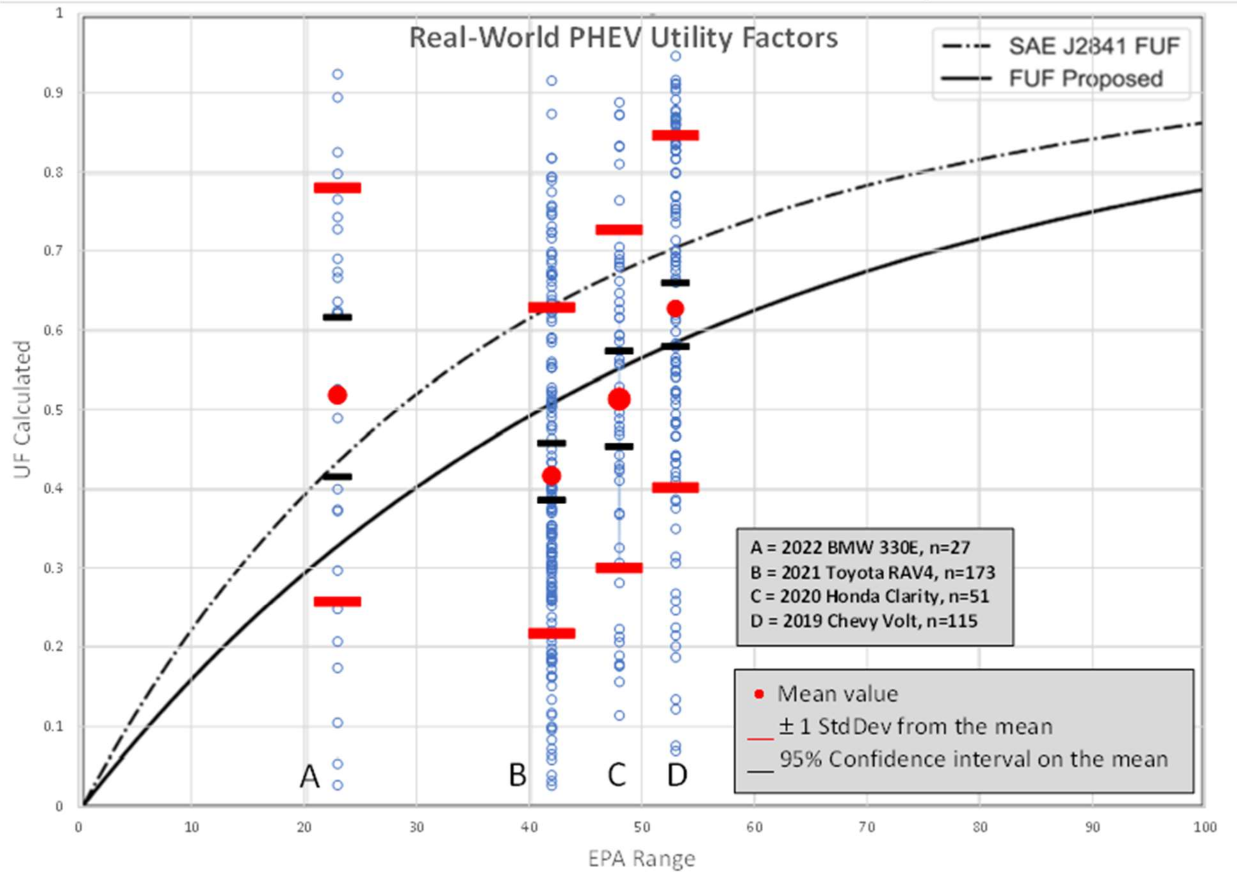

Figure 2. Statistics of calculated real-world utility factors for four selected PHEV models compared to SAE J2841 FUF and proposed FUF. Model variations (e.g., Volt and Volt Premier) do not exhibit significantly different utility factors, on average, and are combined in this figure. Model year is constant for each model to minimize potential year-to-year differences.

There are better data sets that support EPA using SAE J2741 for now. Regarding PHEVs not plugging in**,** there are many factors that impact plugging in and it is a complicated subject that needs more research.[18] This August 2020 paper from UC Davis is one of the best analyses and uses data loggers from actual drivers and shows that PHEVs with longer AERs do not have a substantial issue with not plugging in (e.g., about 3-5%).[19] See Table 1 below. Also, there are many factors that could see this

[18] Four studies 1) Bucher, J.D. and Bradley, T.H. (2018). Modeling operating modes, energy consumptions, and infrastructure requirements of fuel cell plug-in hybrid electric vehicles using longitudinal geographical transportation data. *International Journal of Hydrogen Energy* 43, 12420-12427. 2) Raghavan, S. S. and Tal, G. (2022). Plug-in hybrid electric vehicle observed utility factor: Why the observed electrification performance differs from expectations. *International Journal of Sustainable Transportation* 16, 105-136. 3) Mandev, A., Plötz, P., Sprei, F., and Tal, G. (2022). Empirical charging behavior of plug-in hybrid electric vehicles. Applied Energy 321, 119293, https://doi.org/10.1016/j.apenergy.2022.119293. 4) [1] Smart, J., Bradley, T., and Salisbury, S. (2014). Actual versus estimated utility factor of a large set of privately owned Chevrolet Volts. SAE International Journal of Alternative Powertrains 3, 30-35.

[19] https://iopscience.iop.org/article/10.1088/1748-9326/ab8ca5/meta

decrease in the future. We make the case above that better data in the future will allow a new rulemaking on the FUF issue.

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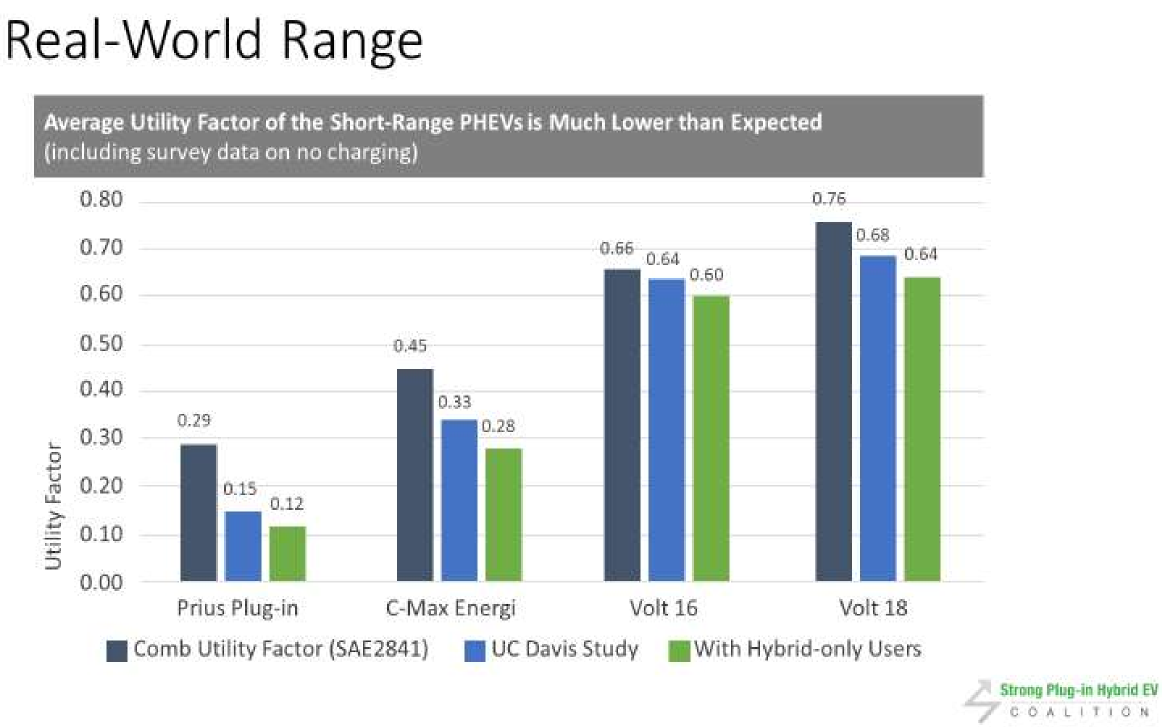
Table 1.

For short range PHEVs	AER EPA label	Percent not plugging in
Toyota Prius Gen 1	11 miles	17.6%
Ford Cmax and Ford Fusion	20 miles	12%
Audi e-tron	17 miles	9%
Toyota Prius Prime Gen 2	25 miles	9%
For longer-range PHEVs		
Chrysler Pacifica	33 miles	4%
Chevy Volt Gen 2-	53 miles	5%
Chevy Volt Gen 1-	38 miles	3%
Honda Clarity	48 miles	4%
For very long-range PHEVs		
BMW i3 rex	128 miles	no data
Karma Revero	60 miles	no data



Volt – E-Miles vs. Gasoline Miles[1]

PHEV Miles Driven in Charge-Sustaining Mode (Using Gasoline) or Charge-Depleting Mode (Using Battery)
Note: There was only one Ford C-MAX Energi and one Fusion Energi used in this analysis

Vehicle Model	Total Miles Driven	Charge Depleting Miles	% of Total Miles Charge Depleting	Charge Sustaining Miles	% of Total Miles Charge Sustaining	Fuel Consumed (Gallons)
C-MAX Energi	15,414.0	6,155.9	40%	9,258.2	60%	197.4
Fusion Energi	18,721.1	12,685.1	68%	6,036.4	32%	142.5
Volt	309,878.2	258,127.3	83%	51,751.5	17%	1,508.0

Electric Vehicle Driving, Charging, and Load Shape Analysis: A Deep Dive Into Where, When, and How Much Salt River Project (SRP) Electric Vehicle Customers Charge. EPRI, Palo Alto, CA: 2018. 3002013754.

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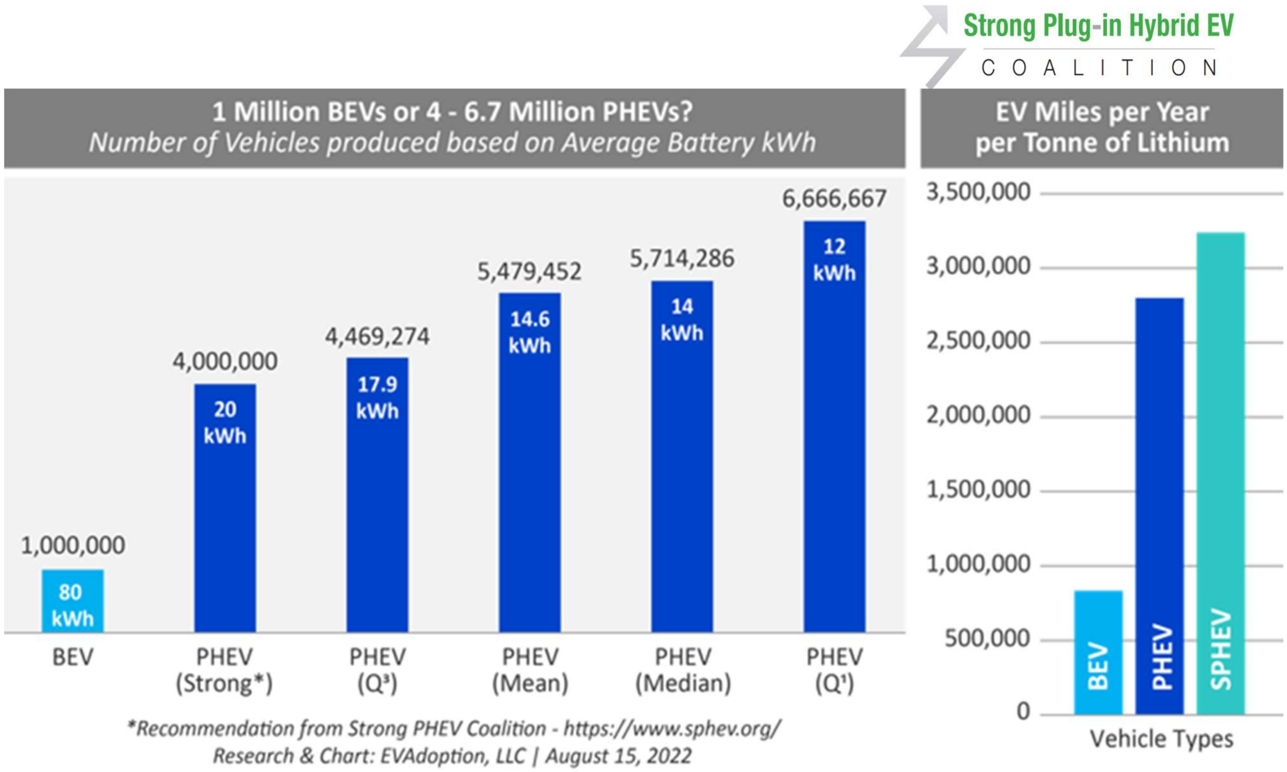
Appendix C

Critical Mineral Use by BEVs and PHEVs

The chart below for light-duty PHEVs and BEVs show the benefit of PHEVs in reducing the use of critical minerals and accounts for the difference in electric miles between BEVs and different types of PHEVs. Strong PHEV battery utilization maximizes the value of battery manufacturing and materials capacities and helps address the need for fast scale up of battery manufacturing and mineral extraction by better utilizing resources. PHEV cars and trucks, especially, Strong PHEV cars and trucks, can electrify most daily commuting miles while occasionally using some gasoline, while BEVs have a lot of battery capacity that only gets "used" on very long trips. We assert that this could be considered wasted or underutilized lithium and other battery minerals. Thus, because PHEVs use their batteries more, the USA gets more EV miles per tonne of lithium by driving PHEVs and Strong PHEVs as shown in the chart below. PHEV's smaller batteries reduce the lifecycle environmental burdens associated with battery materials, production, and end-of-life.[20]

[20] Two studies. 1) Dunn, J.B., Gaines, L., Kelly, J.C., Gallagher, K.G. (2016). Life cycle analysis summary for automotive lithium-ion battery production and recycling. In: REWAS 2016: Towards Materials Resource Sustainability, R.E. Kirchain, B. Blanpain, C. Meskers, E. Olivetti, D. Apelian, J. Howarter, A. Kvithyld, B. Mishra, N.R. Neelameggham, and J. Spangenberger, eds. (Springer) pp. 73-79, https://doi.org/10.1007/978-3-319-48768-7_11 2) International Energy Agency (IEA) (2022). Global Electric Vehicle Outlook 2022, https://www.iea.org/reports/global-ev-outlook-2022



Appendix D

We have not been able to validate CARB staff's PHEV transmission costs and internal combustion engine vehicle "delete" costs in the 2022 ACC II and recommend further work in a technology and progress review by staff in two or three years.

CARB staff's cost modeling includes an assessment of transmission removal costs, which serve to represent the cost saving/increment that accrues to advanced technology vehicles (PHEVs, BEVs, and FCEVs) relative to conventional ICEVs. CARB's estimates are based on 2017 NHTSA CAFE[186,188] and 2018 NHTSA[187] (references refer to the References section of Appendix G). Notable is that the references 186 and 188 contains no transmission removal costs and are perhaps referenced in error or in lieu of other more authoritative sources. CARB assumes that PHEV transmission costs are the same as ICEV transmission costs, referencing primarily the NHTSA reference. [187] Islam (ANL) uses the same source for ICE transmission costs $2483 as CARB (Reference 187), but finds that PHEV transmissions are $793, ~$1600 less expensive than is in the CARB model. Because the ANL modeling is treated as an authoritative reference throughout the CARB cost modeling document, we recommend that CARB adopt Islam's (2021) same incremental cost of transmission removal for PHEVs. A plot from Islam, 2021 is included here for reference, highlights that PHEV transmissions (even for long range PHEVs) are lower cost than those of ICEVs.

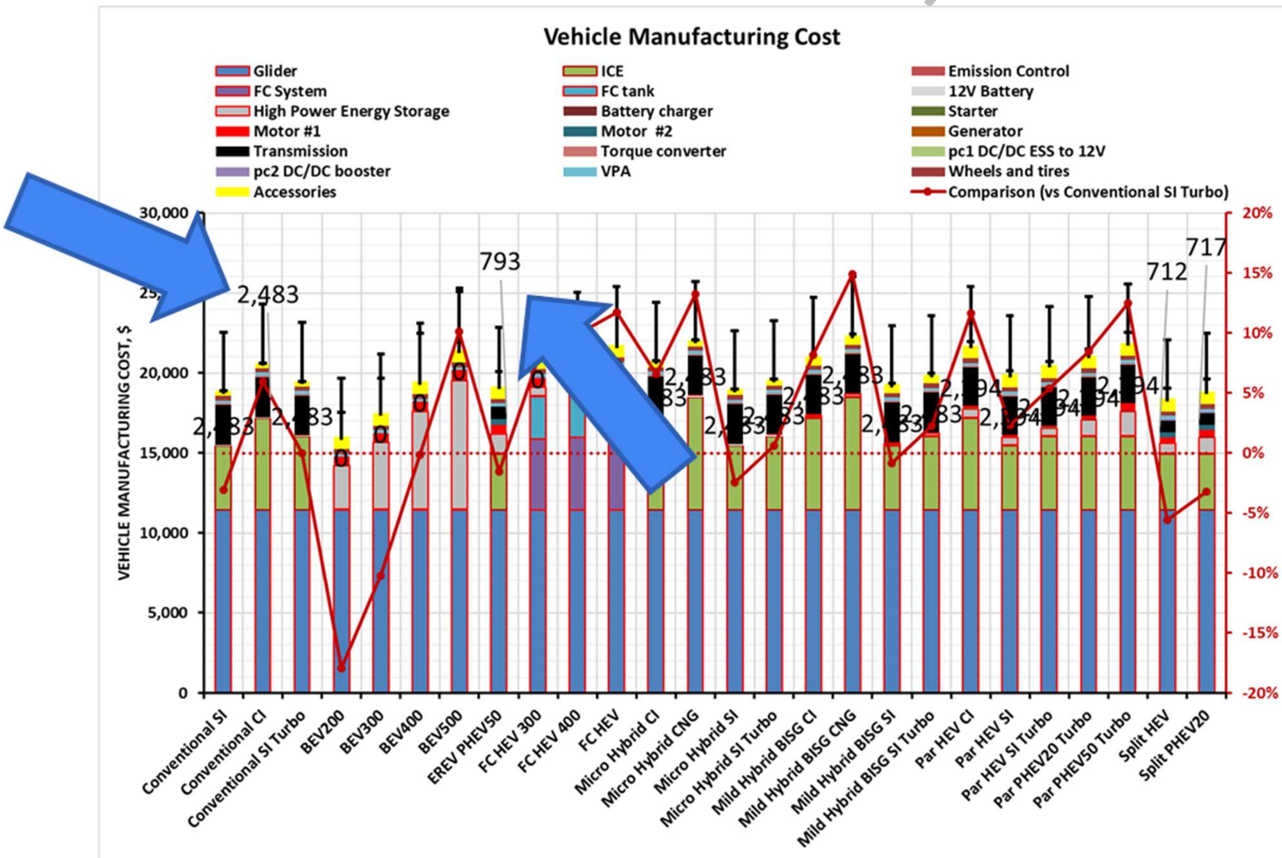


Figure 1. Transmission Manufacturing Costs modeling from Islam, et al., 2021

As transmission cost credits are the subject of considerable disagreement within the key references used by CARB, The Strong PHEV Coalition requests that a technology and progress review in two or three years that as part of its purview should seek to improve BEV and PHEV cost modeling.

CARB staff's cost modeling also includes a model of "assembly cost" for advanced vehicles. The result of this model of assembly cost as published is that BEVs are represented (in the costing worksheet) as having an assembly cost credit of $1600, due to "less complex assembly process." However, not many quantitative references for this benefit of EVs exist. McKinsey quantifies this benefit at $600, long-term (for native EV design), without any reference to primary sources, datasets or other literature.[2] ICCT is the primary reference for this assembly cost credit in the CARB Appendix, but the ICCT report referenced uses "vehicle assembly" to represent the entirety of components and process, scaled-up from a reference to the UBS report ***wherein this $1600 value and ICEV values are not present*** (UBS, 2017).[3] In our assessment, there is some confusion in interpretation of the ICCT publication in that ICCT uses the term "vehicle assembly" to mean what the experts in this field have traditionally called "glider cost". Further evidence is that the CARB cost model assumes that there is a $1600 cost savings available in vehicle assembly process costs, when the total vehicle assembly costs are asserted to be $2600 by the UBS report referenced. It is implausible that BEV's "less complex assembly process" reduces processing/labor costs by 62%. In our opinion, without a more definitive reference for this $1600 incremental benefit to BEVs (and FCEVs, which have even higher levels of advanced materials and precision assembled components), the Strong PHEV Coalition requests that a technology and progress review in two or three years seek to assess assembly cost credit issue we have identified along with other issues that we've identified above.

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[1] https://www.newsweek.com/most-americans-wont-consider-buying-electric-car-jd-power-study-finds-1710444 and https://www.thetruthaboutcars.com/2022/05/survey-suggests-americans-still-doubt-evs/

[2] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/making-electric-vehicles-profitable

[3] https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf