TO: SFMTA CAC Engineering, Maintenance, and Safety Committee
FROM: Alex Lantsberg, Andres Díez, Matthew Haugen
DATE: October 18, 2023
RE: SFMTA Staff Response to *San Francisco Muni Electrification Alternatives* Report

We are pleased to see SFMTA reconsider its earlier plans to abandon the trolley bus system, but reiterate our concern that staff appears to be fully committed to a wasteful Battery Electric Bus capital program that fails to take advantage of already existing electric transit infrastructure.

SFMTA staff's cursory response to our report is disappointing. While staff's memo raises several important issues, the main conclusion of our study that - all else equal - BEBs require greater investment in rolling stock, charging infrastructure, charging management, and yard capacity compared to IMC/trolleybuses remains undisputed.

SFMTA faces significant economic headwinds that have already resulted in service cuts and trimmed ambitions, making it even more important for capital investments to be cost effective, leverage improvements to existing infrastructure, and contain added operational costs. To that end, we urge the CAC to call on the SFTMA Board to direct staff to conduct a full system electrification alternatives analysis working experts in academia and at other agencies with successful IMC programs.

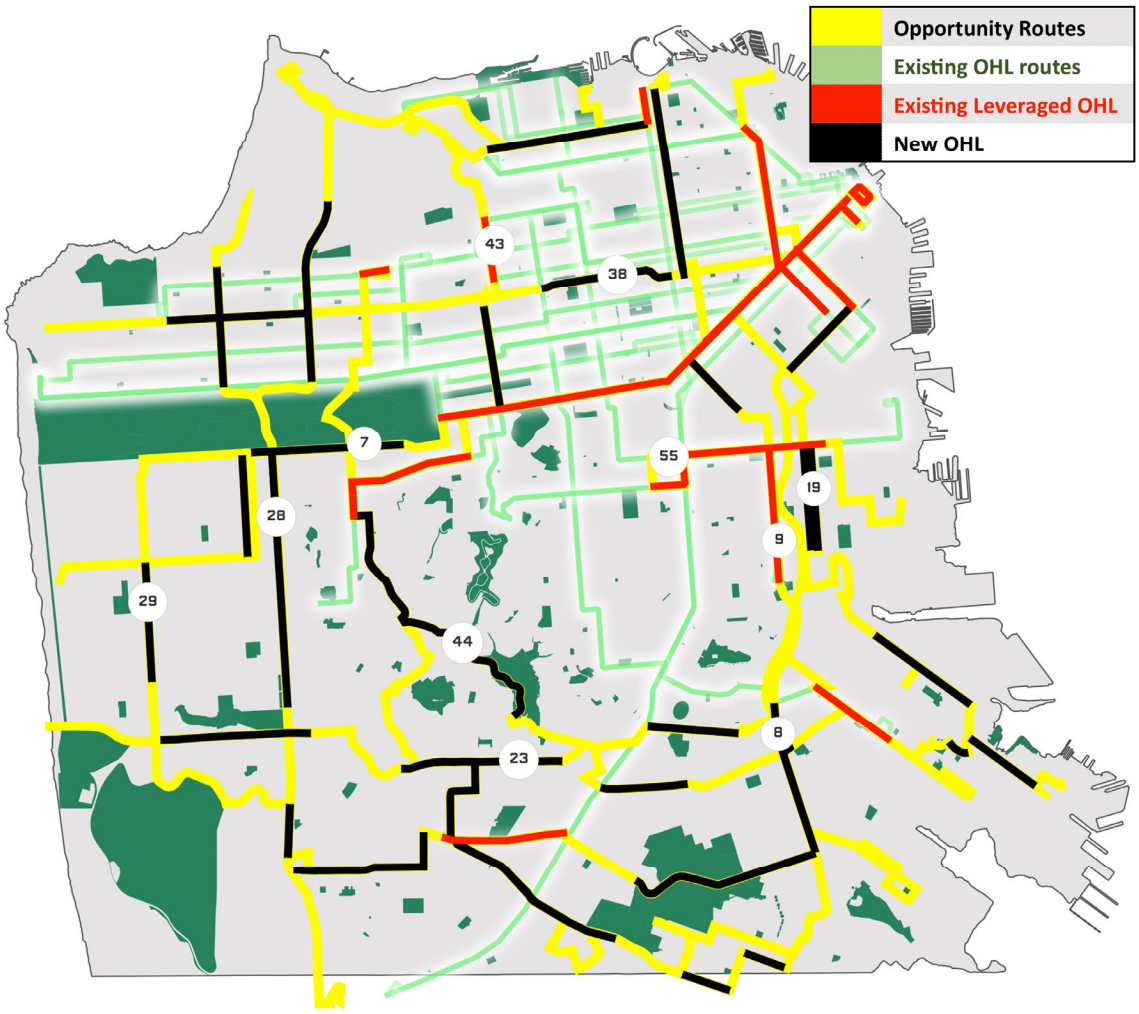
This will ensure:

- Planning for yard rehabilitation projects like Presidio does not proceed too far along an inefficient and economically wasteful path.
- Planning of yard projects does not bake in inaccurate assumptions around BEBs and IMC trolley buses.
- An efficient deployment of limited capital funds, including effective use of state and federal grants. Our report illustrates how going all in on BEBs will require more space and more buses.
- An operationally efficient public transportation system. BEBs will require more equipment changes during the day, meaning operators will be busy ferrying equipment to and from yards rather than serving riders.

We would also like to address the issues staff raise in their 9/25/2023 memo to clarify any misstatements or misunderstandings:

1. **We agree that a full conversion of the rubber tire fleet to IMC is not practical and are instead recommending strategic expansion of the trolley system to appropriate lines**

   Alex Lantsberg met with Julie Kirshbaum and Bhavin Katri in mid-August to discuss the study and the mistaken impression that we suggested a 100% IMC conversion was among the initial concerns raised in the conversation. Lantsberg clarified that our report presented a **High Opportunity Electrification Plan** to rapidly add more than 200 miles of electric service on 11 lines, with only 68 miles of new catenary and did not advocate for the full "trolleyfication" of the rubber tire network. We also include a simplified version of the map illustrating how existing infrastructure can be leveraged to achieve this goal.



Mr. Lantsberg also directed both Ms. Kirshbaum & Mr. Khatri to the section of the report evaluating the frequency and ridership criteria to determine which routes were better suited for IMC vs. battery via a Route Demand Factor (RDF) and the maximum density of buses (bus/mi) measure. As noted in Section 10.4 of the report:

> *when the RDF of a route is greater than 0.7—which is the availability factor of the BEB—and the density of buses per mile is greater than 1, depot-charging buses are not the most advisable option. For routes with low daily demand and low peak intensity, depot-charge buses can be considered as a complementary measure to the electrification of more intensive routes.*

2. Both 100% Battery Electric and IMC Buses face procurement challenges

The recent bankruptcy of Proterra, pending closure of Novabus in 2025, and reliability of BYD raise significant questions about adequacy of North American manufacturing capacity. That said, the entrance of Solaris into the North American marketplace is adding an additional manufacturer for both trolleybuses and BEBs. SFMTA's efforts to

assemble a trolleybus procurement consortium are admirable and we look forward to assisting with that initiative.

Additionally, Kiepe Electric is committed to the North American market and is likely to become more proactive under new independent ownership. Kiepe has been quite willing to take the lead where necessary as illustrated with the supply of trolleybuses to Dayton using bus bodies manufactured by the Bay Area's own Gillig. Furthermore, because the replacement of diesel-hybrid and battery drives with IMC requires only modest retooling, it can be accomplished by traditional bus manufacturers in the case of a substantial order. SFMTA's work to assemble a trolleybus procurement consortium is admirable and We also note that while our study focused on San Francisco, urban transit systems across the US will face the same logistic and technical issues regarding BEB operations and may find the IMC alternative to be superior in their cases as well.

3. **Improvements to the OHL system are complementary to OHL expansion and more cost effective than a new charging platform**

A principal goal of the **High Opportunity Electrification Plan** is to leverage existing infrastructure and strategically undertake improvements for the entire system. Expanding the OHL network would be a complementary and cost-effective way to bring existing infrastructure to a State of Good Repair while increasing electric service and making use of the more than 100 trolleybuses planned for long-term storage due to planned service cuts and the Potrero Yard rebuild.

An accurate economic alternatives analysis looks at the marginal costs of each alternative compared to the current baseline and staff's response raises concerns around how SFMTA is assessing the comparative costs of electrification alternatives. Our study conducted route-level capital and operational financial analysis for electrifying the 44 line, which showed that building new catenary, upgrading shared equipment, and acquiring new IMC buses is more cost-effective than a battery-forward approach that would require new charging infrastructure in multiple yards, extra buses, and additional land to store/charge above and beyond current conditions, and extensive front-of-the meter grid capacity improvements. Similar analysis would be required for other lines to accurately compare the costs of IMC trolley buses to BEBs.

4. **Trolley bus operational concerns should be compared to industry benchmarks and actual BEB performance**

Operational peculiarities exist with every fuel choice, making appropriate comparisons vital. While staff comment that the reconnecting to the catenary is less than smooth in Muni's network, this is a far less significant problem with other systems across the world, suggesting that the issue may be specific to Muni and could be rectified with sufficient focus on simple explanations (such as incorrect pressure from the springs on the trolley poles, poor tensioning of the catenary, poor positioning or sizing of the rewiring pans, or inadequate operator training). Notwithstanding those issues, a robust design allows for failures without service interruptions and the low connection efficiency is a bigger problem for trolleybuses with small batteries than envisioned for IMC.

Finally, staff fail to note that BEBs have their own significant operational issues including extensive downtime, multiple catastrophic fire events, charge inadequacy, and reduced

passenger loads due to battery weight along with significant concerns by operators. In light of SFMTA's current testing of nine battery buses we encourage staff to provide meaningful information regarding their operations to date along in a format similar to the National Renewable Energy Lab's evaluation of Foothill Transit's BEB program.

These include:

- Availability
- Fuel economy (kWh/mile)
- Fuel cost ($/mile)
- Miles between roadcalls (MBRC)
- MBRC propulsion system only
- MBRC energy storage/transfer system
- Total Maintenance cost
- Maintenance cost - propulsion system only
- Maintenance cost - energy storage/transfer system

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