Key Takeaways: RFI on Heavy-Duty Fuel Cell Electric Vehicle Market Development

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In November 2024, ARCHES released a Request for Information (RFI) to solicit feedback on its proposed strategic frameworks for supporting the adoption of 5,000 fuel cell electric trucks (FCET) and 1,000 fuel cell electric buses (FCEB) in California. The RFI included specific market development and cost reduction frameworks for FCETs and FCEBs.[1] Additionally, ARCHES posed a series of targeted questions for original equipment manufacturers (OEMs), truck fleet operators, transit agencies, and hydrogen station developers. The questions requested feedback on the effectiveness of the overall approach, structure of the proposed Request for Proposal (RFP), vehicle manufacturing volumes and purchase plans, incentive design, vehicle price parity, cost reductions, and more.

This RFI garnered over 50 written responses across six categories: FCET OEMs, FCEB OEMs, truck fleet operators, transit agencies, hydrogen station developers, and others. Respondents articulated their support for the core components of the proposed strategic frameworks for fuel cell trucks and buses. The responses were categorized by the number of organizations that responded to questions in six response categories. Since organizations often have expertise in multiple areas, several entities provided feedback in more than one category.

Response Category	Answers
Truck OEM	9
Bus OEM	5
Truck Fleet Operator	7
Transit Agencies	6
Station Developers	20
Other	3

RFI responses were overwhelmingly positive, indicating that approaching market development as a system can be highly effective. Respondents commented that the proposed ARCHES strategy could reduce fuel prices, improve the supply chain, reduce vehicle costs, accelerate the onshoring of fuel cell bus manufacturing, and increase the pace of fleet vehicle procurement. A basic premise is to increase competition to help drive down costs and provide incentives to jumpstart the scale of production at this early stage of commercialization. After an in-depth analysis of all stakeholder responses, the ARCHES team compiled the following summary of key

[1] The strategic frameworks for FCETs (Appendix A) and FCEBs (Appendix B) can be found in the RFI published in November 2024 at https://archesh2.org/wp-content/uploads/2024/11/RFI_HD_FCEV_Market_Development_Strategy.pdf.

takeaways. The takeaways are discussed by cross-cutting issues across both trucks and buses, and then by vehicle type.

Strategic Framework

The FCET and FCEB strategy frameworks are written on the foundational premise that moving from a year-to-year, first-come, first-served incentive system to one that provides long-term vehicle and hydrogen funding support for fleets and OEMs will create certainty and reduce complexity and costs for everyone. Respondents shared overwhelmingly positive feedback in support of developing a sustainable market that can achieve cost parity beyond an initial incentive period. Most agreed that the proposed framework would help them increase investment in truck and bus production. Respondents underscored the transformational impact that the funding certainty would establish, the role that partnerships would play in driving down costs, and the planned economies of scale that would help achieve increased production investments. Additionally, the positive feedback highlighted the importance of targeted incentives and instilling confidence in OEMs, which can increase production, resulting in reduced component costs and stable pricing. There was broad support for ARCHES to coordinate the deployment of FCETs and FCEBs across multiple fleets in the early stages.

Flexible Vehicle Incentive Partnerships

Incentive flexibility, simplicity, and having multiple options were key themes among respondents' preferences for how incentives are designed. Respondents were supportive of the fleet and OEM collaboration approach and a simple incentive process. Multiple truck and transit bus fleet respondents shared their preference to partner with multiple OEMs. One response emphasized the desire for warranties and service contracts to be included in partnership agreements. Others encouraged designs allowing hydrogen refueling infrastructure providers and sometimes even hydrogen suppliers to be included in application partnerships. While there was an overall preference for flexible partnerships with multiple partners, some preferred having more partnerships across the value chain than others.

Technology Standardization, Convergence, and Compatibility

A theme that emerged is the need to standardize parameters for vehicle and refueling station design. This standardization could reduce production costs and drive technology convergence. It is critical for reducing market fragmentation and accelerating the industry's ability to achieve economies of scale. While one respondent opposes overly detailed technical specifications, they see value in standardization through an RFP for more standardized vehicles, since it could drive competition. However, competition amongst manufacturers is the most effective way to decrease vehicle costs. Standardization would enable compatibility across vehicle and infrastructure platforms and improve the efficiency of hydrogen refueling infrastructure deployment.

Technology convergence was mentioned numerous times regarding fueling station design, parts, and maintenance. Some respondents specifically identified hydrogen storage systems, dispensers, fuel cell stacks, and fueling protocols as areas that need convergence or increased compatibility with other systems. One response noted that OEMs need ARCHES' support in three key aspects: safety, regulatory requirements, and interoperability. Deployment of FCEBs may benefit from standardized designs and a hydrogen fueling protocol specific to buses. Additionally, HySTEP 2.0, a device for testing station performance to validate and commission hydrogen stations, does not support testing heavy-duty vehicle fueling stations. The network would benefit from having a heavy-duty HySTEP device specifically for testing public heavy-duty vehicle refueling stations.

Price Transparency

Responses suggested different strategies to ensure there is price transparency in the ARCHES incentive framework and hydrogen fuel pricing. This transparency is meant to prevent incentive-based price inflation on vehicles, which a couple of respondents cited as a concern. Yet, an OEM indicated that price gouging is unlikely when OEMs are aiming to reach economies of scale. Proposed transparency strategies include 1) oversight mechanisms like price reports and regular third-party audits to track price inflation trends, 2) clear price benchmarks based on past and current FCET, FCEB, and hydrogen fuel sales data, 3) establishing an independent advisory board dedicated to enabling price transparency and monitoring incentive impacts, and 4) implementing strict monitoring and guidelines for incentives. Several respondents brought up the critical need for increased transparency around hydrogen fuel pricing, as this is the most impactful component to achieving total cost of ownership (TCO) parity with diesel. One response suggested a guaranteed gate price for hydrogen fuel as a potential solution that can provide the needed certainty to prevent price spikes due to supply shortages.

Fuel Cell Electric Trucks

Scope of Incentive-Eligible Trucks

Several respondents suggested expanding the scope of heavy-duty FCET incentives to include medium-duty trucks, refuse trucks, and high power takeoff vehicles. One response called out the need to support Class 5 vocational trucks and motor coaches. Four submissions advocated for the inclusion of refuse trucks, highlighting their lower TCO compared to standard FCETs due to their higher fuel efficiency and refuse fleets' ability to absorb a $10-$15 per kg fuel price. There was also a suggestion to include utility trucks and cement mixers with a target of 100 of each type. However, other responses cited that the vocational market is "less significant" and the focus should remain on Class 8 heavy-duty vehicles.

Total Cost of Ownership

Respondents agreed that the vehicle funding structure should be built around TCO parity with similar conventional diesel vehicles. The TCO encompasses vehicle acquisition, insurance, maintenance, fuel, and operating costs. One response included calculations that a $5-$7 per kg price of hydrogen at the pump could potentially enable TCO-parity by the late 2020s. A different response shared that a hydrogen price between $4-$5 will make FCETs achieve parity with the TCO of a diesel truck. This is because the hydrogen fuel price is the most sensitive variable in the TCO of FCETs. An analysis shared that a $1/kg change in hydrogen price could result in a +/- $0.13 change in TCO per mile of an FCET, which can drive down costs through economies of scale. One hydrogen fuel provider shared that a cluster of 700+ FCETs in a region would enable it to reduce its per unit price of hydrogen fuel by 40 percent. Others mentioned the need for competitive insurance rates and a restructuring of the federal excise tax for zero-emission trucks.

Incentive Funding Structure

One respondent suggested funding incentives to be structured around meeting a minimum number of FCETs to justify investments in infrastructure. Tying incentives to minimum vehicle thresholds could ensure demand certainty. This certainty could then unlock private investment and other sources of funding. In the RFI, OEMs were asked to provide feedback on what appropriate incentive stepdown levels are needed to encourage systems-level cost reductions. ARCHES received four proposed incentive funding amounts with step-downs in funding amount at specific vehicle quantities. These proposed incentive starting amounts ranged from $50,000-$400,000 per vehicle, with two respondents proposing incentives starting at $240,000. Respondents proposed phasing out incentives at between 1,000 to 3,500 vehicles per OEM. Differing amounts of information were provided to justify the incentive phaseout amounts and schedule. ARCHES will conduct additional analyses to determine the optimal incentive structure.

Production Volumes

Standardizing vehicle parameters and technology will help reduce production costs and manage consumer expectations. Many respondents agreed that more standardization is needed to ensure compatibility across infrastructure and vehicle platforms. This ultimately can lead to higher production and technology deployment efficiencies. OEM respondents provided information about their potential annual production capabilities and at what order volume they can reap the benefits of economies of scale through manufacturing efficiency. However, ARCHES will need to verify how this information compares to the FCET industry-wide production curve to effectively address incentives.

Several respondents shared the usefulness of pre-orders and fleet purchase commitments to provide financial stability for scaling production. With fleet commitments, ARCHES' plan to aggregate demand across fleets within California's regions can help scale permanent refueling

stations. Additionally, vehicle production commitments are essential for planning and supply chain coordination to ensure the timely delivery of vehicle components and the delivery of the vehicle as a whole.

One OEM shared that large fleet orders of over 30 trucks can sufficiently justify the switch from mobile hydrogen refueling infrastructure to permanent refueling infrastructure based on TCO calculations. This is especially relevant for large fleets that are not planning on utilizing public fuel stations. However, not all fleets plan on utilizing solely private refueling infrastructure.

Desired Truck Fleet Performance Characteristics

Two responses listed specific range requirements for FCETs. One fleet operator shared their preference to use Class 8 day cabs with a minimum range of 300 miles. Another operator shared needing greater than 90% vehicle uptime, a payload capacity of 35,000 lbs, and 500 miles in range.

Refueling Station Development

Regional Clusters and Priority Corridors

Respondents were broadly supportive of focusing initial deployments in three regional clusters (as described in the RFI Appendices below), using the six priority freight corridors identified in SB 671 as the framework for public refueling station development.[2] Some mentioned the need to link the Southern California ports to the Inland Empire and the need to serve both inter- and intrastate commerce with infrastructure connectivity to neighboring states.

Coordination

Three priority areas emerged from the responses: 1) infrastructure mapping, 2) standardized protocols for station size, fueling rates, and technology compatibility, and 3) funding coordination by ARCHES. Many organizations agree that California's approach to hydrogen station development needs to be both scalable and modular. One respondent suggested setting an interim fueling station target (e.g., 10 stations by 2027).

One analysis revealed that hydrogen refueling station capacity may need to grow three to five times relative to today, which reflects a growth rate of 25%-30% per year. Respondents generally agreed that coordinating funding support through ARCHES will facilitate project implementation. Other major items that need coordination include permit streamlining and data and information sharing.

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[2] California Transportation Commission, Senate Bill 671 Top 6 Freight Corridors, https://catc.ca.gov/-/media/ctc-media/documents/programs/sb671/092023-sb-671-top-6-freight-corridors-a11y.pdf

Fuel Cell Electric Buses

Transit Agency RFP Input

Transit agencies are supportive of staggered FCEB procurements and increasing market certainty for OEMs. Generally, transit agencies would appreciate the opportunity to review and provide input on the ARCHES RFP to solicit bids from prospective bus OEMs and the option to review the bids. It is critical that agencies can verify the vehicle's reliability and if it works for their riders, funding, procurement process, and other operational and maintenance requirements. This approach should help standardize the bus formats to help drive costs down.

Limited FCEB Options

The United States currently has one Buy America-eligible FCEB OEM and limited vehicle model choices. One agency expressed the desire to see more FCEB types for purchase, such as cutaways. There was one overseas manufacturer that shared it could potentially establish U.S.-based production earlier if it were able to secure enough bus orders through the ARCHES RFP.

Incentive Funding and Transit Agency Price Sensitivity

One transit agency shared that it will procure four vehicles regardless of price, if there is available funding. Another agency revealed that the number of units it can procure is dependent on the available funding, but it plans on purchasing 37 FCEBs total in the next several years. This reflects the demand ceiling that some transit agencies might have. However, a third agency conveyed that it would potentially buy more FCEBs if there were sufficient increases in funding availability and/or price reductions. While a demand ceiling remains, this means some transit agencies could change their fleet transition plans to include more FCEB orders if market conditions change.

A respondent suggested that incentives be given directly to FCEB OEMs, with portions paid at specific milestones, such as acquiring fuel cell powertrain and other key components, installing components onto the bus, and others. Another response suggested providing a direct payment of the incentive funding to the manufacturer to aid with cash flow without risking transit agencies' finances if a vehicle is not accepted for delivery.

Conclusion

The responses to the ARCHES RFI reflect strong industry support for a structured, long-term approach to scaling fuel cell electric trucks and buses in California. Stakeholders broadly agree that market certainty, standardized technology, funding incentives, competition, and coordinated infrastructure development are essential to achieving cost parity and accelerating adoption. Furthermore, respondents affirmed that ARCHES' strategic frameworks will be effective for driving down costs and increasing market certainty. Key priorities named by respondents

include flexible incentive structures, price transparency, and the alignment of funding mechanisms with production and fleet deployment goals. While challenges remain, particularly in technology standardization, the feedback underscores the potential for ARCHES to play a pivotal role in coordinating statewide planning, fostering a clean, renewable hydrogen ecosystem. Continued collaboration between industry, government, and private sector stakeholders will be critical in refining and implementing these strategic frameworks.