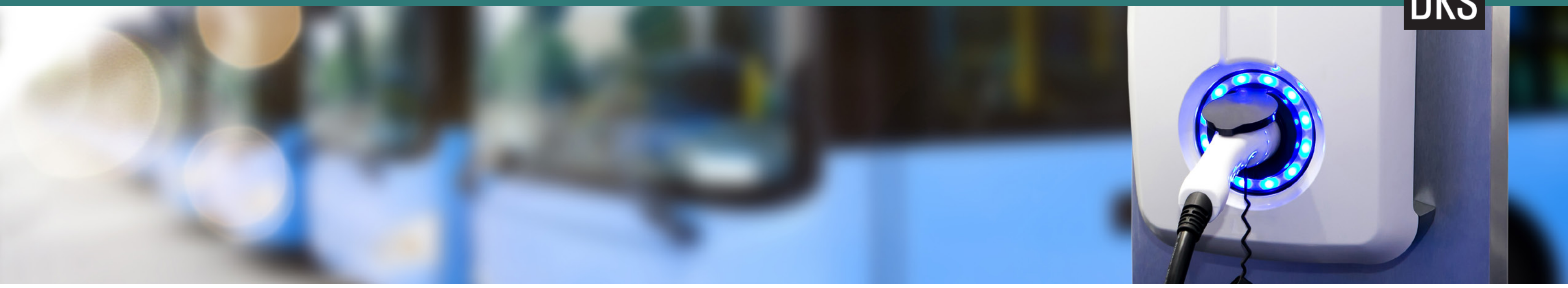
SHAPING A SUSTAINABLE FUTURE FOR PUBLIC TRANSIT

DKS LEADS RABA'S ZERO-EMISSION BUS IMPLEMENTATION PLAN

By Bincy Koshy, Steffen Coenen, and Mike Usen
DKS Associates

At DKS Associates, we believe in designing transportation systems that deliver cleaner air, smarter mobility, and a sustainable future for every community. That vision is at the heart of our current work with the Redding Area Bus Authority (RABA), a joint-powers transit agency providing urban and rural public transportation services in northern California's Shasta County. RABA is advancing its transition to a zero-emission fleet with the development of a comprehensive Zero-Emission Bus (ZEB) Implementation Plan, led by DKS Associates. This plan builds upon RABA's initial ZEB rollout plan and takes a deeper dive into the practicalities of fleet transition, offering the specificity and guidance needed to turn long-term goals into actionable investments.



Meeting the State's Mandate

California's Innovative Clean Transit (ICT) regulation requires small transit agencies like RABA to operate 100% zero-emission buses by 2040. It mandates that an increasing share of new bus purchases – including regular transit buses, over-the-road coaches, and cutaways – must be zero-emission, beginning in 2026 for small transit agencies. While RABA completed an initial ZEB Rollout Plan in 2023 (in compliance of ICT requirements), that plan stopped short of answering a critical question: How should RABA transition its fleet and infrastructure to zero-emissions in a way that is operationally sound, cost-effective, and tailored to the region's unique geography and constraints? ICT-mandated rollout plans were meant to commence each transit agency's initial steps toward electrification but did not typically include block- or site-specific recommendations to guide an agency's ZEB implementation actions and investments. That's where the current ZEB Implementation Plan comes in. This plan will provide detailed analysis of the technological options available – primarily battery-electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs) – and will evaluate them against the unique operational and geographic conditions of RABA's transit services in Redding and the surrounding region. We are currently exploring critical implementation details such as BEB charger types, FCEB fueling infrastructure, installation locations, design options, and cost estimates.

Why This Matters

This effort highlights an example of DKS's growing leadership in ZEB transition planning combining our expertise in transit operations, zero-emission vehicle modeling, infrastructure planning, and stakeholder engagement. Our work with RABA also demonstrates the importance of customized, data-driven solutions for smaller agencies that face unique constraints not captured in one-size-fits-all approaches.

As agencies across California begin to implement the ICT mandate, detailed, site-specific implementation plans like this one will prove critical to ensuring a cost-effective, reliable, and community-aligned transition to zero-emission fleets.

DKS's Comprehensive ZEB Implementation Approach

For the RABA ZEB Implementation Plan, transit planners and electromobility experts brought an intensive implementation-focused analysis across multiple critical dimensions:

1. Technology Assessment and Route Energy Modeling

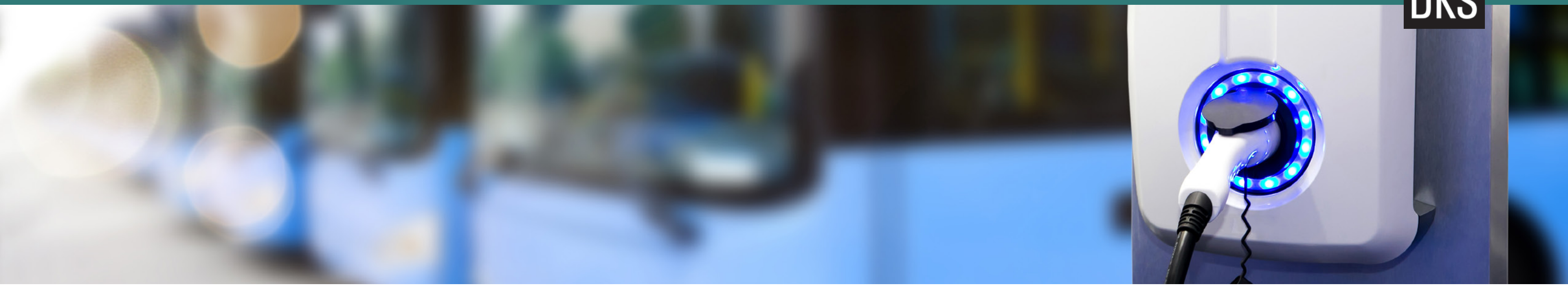
One of the central questions in any ZEB transition is which fuel type can meet the system's operational needs best: BEBs or FCEBs (or which combination thereof). For RABA, multiple unique aspects make this decision complex:

- **Battery-electric buses** have the potential to offer lower and more predictable fuel costs and are easier to integrate in urban areas but have range limitations—especially for longer routes in Shasta County's hilly terrain or during cold weather.
- **Fuel cell buses** have longer range and faster fueling, but hydrogen costs remain high and difficult to predict, especially in the long term. Also, there is currently no hydrogen supply infrastructure convenient to Redding.
- To inform this analysis, the DKS team is working with Microgrid Labs and their sophisticated EVopt software to conduct block-by-block route modeling and energy simulations. This level of detail allows RABA to explore feasible pathways under different assumptions and scenarios, considering factors such as terrain, layover times, and charging opportunities.

2. RABA's Unique Operational Challenges

Several characteristics make RABA's system distinct and particularly challenging for a ZEB transition:

- **Isolated system:** Unlike transit systems serving larger metropolitan areas, RABA operates as an isolated transit system without opportunities for resource sharing with neighboring agencies, requiring self-sufficient ZEB infrastructure solutions.
- **Geographic and operational constraints:** RABA's service area includes hilly terrain and very short layover times with long service blocks, requiring one vehicle per



route per day. Layover periods of many routes coincide to facilitate passenger transfer which would result in significant peak power demands at the Downtown Transit Center and how these constraints affect battery performance and charging strategies.

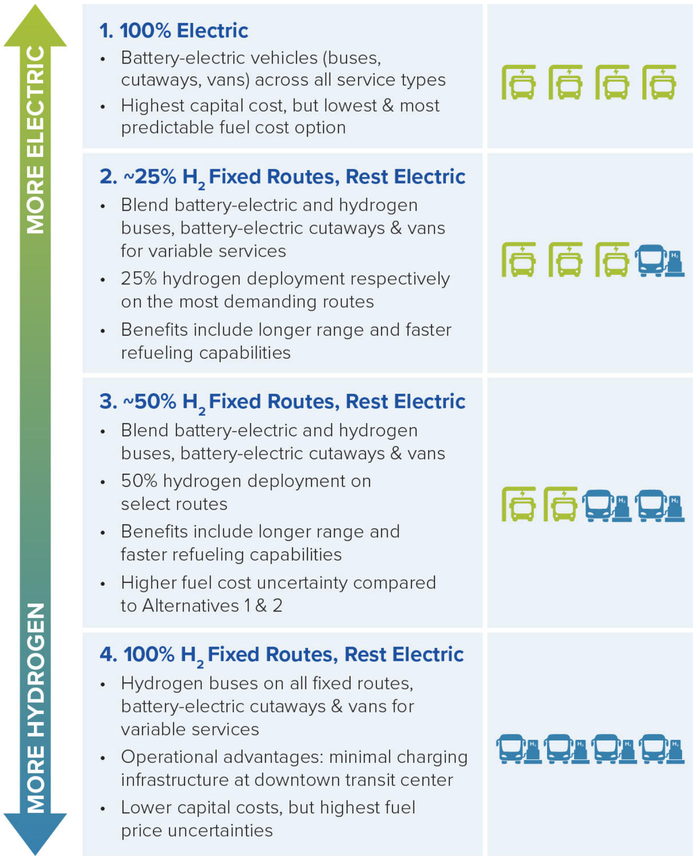
- **Hydrogen supply chain limitations:** Northern California currently lacks established hydrogen supply infrastructure, making fuel cell buses dependent on delivered hydrogen with uncertain pricing, potentially ranging from $5 up to $20 per kilogram and what the supply chain risks are.

These factors increase the importance of careful modeling and implementation planning to ensure reliability and long-term cost-effectiveness.

3. Operational and Financial Modeling for Alternative Implementation Pathways

To estimate potential costs, four distinct implementation alternatives were identified These range from 100% battery-electric to various combinations of battery-and hydrogen (H2) fuel cell electric options. Along with financial projections for each alternative, a detailed set of operational requirements, such as potential layover charging times and locations, as informed by Microgrid Labs' route-level modeling results was provided. This comprehensive financial modeling helps RABA understand the long-term implications of different technology choices, particularly in light of limited funding availability and reluctance against cost and service impacts.

The four primary technology pathway alternatives evaluated in this project are listed in the graphic below:



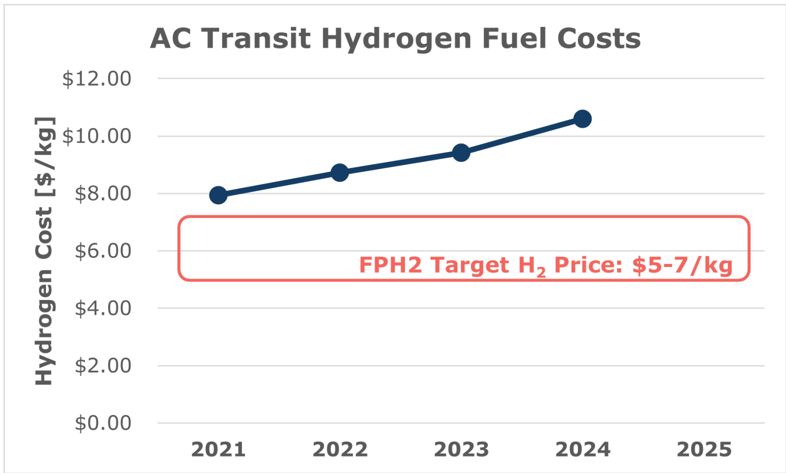
4. Infrastructure Planning and Utility Coordination

A comprehensive charging and fueling infrastructure plan was developed encompassing everything from depot modifications to downtown transit center enhancements, including evaluation of advanced charging technologies such as 300 kW inductive or overhead pantograph systems. The direct comparison of BEB charging with FCEB refueling cost to inform technology pathway selection requires an assessment of all electric rate components, including demand charges. As with many electric utilities, DKS collaborated with REU on previous municipal fleet electrification projects for the City of Redding and Shasta County. RABA benefits from both this broad and local experience by obtaining reliable fuel cost estimates and early coordination on anticipated electrical system upgrades.

OVERHEAD PANTOGRAPH CHARGING SYSTEM, PICTURED LEFT.

5. Economic Impact and Funding Strategy

A comprehensive economic analysis revealed the complex cost dynamics of ZEB transition. While initial capital costs are higher than conventional buses, the total cost of ownership analysis shows potential long-term savings through reduced fuel and maintenance costs. These cost dynamics vary greatly region by region and must be carefully evaluated before key technology decisions. However, hydrogen costs remain highly uncertain, with current costs for hydrogen fuel supply ranging greatly. For example, AC Transit in the San Francisco Bay Area has been procuring hydrogen for its FCEBs for multiple years, with hydrogen costs climbing from $8 to more than $10 per kilogram as illustrated by the chart below. The First Public Hydrogen Authority (FPH2), a newly founded public utility dedicated to providing renewable hydrogen at reliable price points across California, targets prices of $5-$7 per kilogram to support long-term economic viability. FPH2 is one potential hydrogen fuel supply mechanism for RABA.



6. Engaging Public and Stakeholders to Shape the Plan

The transition to zero-emission buses will provide significant air quality benefits, particularly important for transit-dependent populations. A successful transition to zero emissions must include the voices of local and regional stakeholders and the public. DKS and RABA kicked off the project with an initial public and stakeholder meeting earlier this year, gathering input about planning, utility coordination, environmental policy, and funding. Alternatives were presented to stakeholders in August 2025, including vehicle types, infrastructure strategies, and phasing recommendations. Stakeholder feedback will help fine-tune the plan to ensure regional alignment and community support.

What's Next?

The RABA ZEB Implementation Plan represents more than just compliance with regulatory requirements—it is pioneering solutions for smaller transit agencies facing similar challenges across California and beyond establishing best practices for:

- Comprehensive technology assessment that balances performance, cost, and operational requirements
- Infrastructure planning that maximizes efficiency while minimizing capital investment
- Stakeholder and public engagement that ensures equitable access to clean transportation
- Financial modeling that supports realistic implementation timelines and funding strategies

The final ZEB Implementation Plan will provide:

- An optimized vehicle procurement schedule
- Conceptual designs for charging and refueling infrastructure
- A vehicle replacement plan aligned with CARB's 2040 mandate
- Cost-benefit projections
- Workforce training and development recommendations

RABA is not just complying—but leading—with a zero-emission strategy rooted in local needs, smart engineering, and long-term sustainability.

Curious about how your transit system can go zero-emissions?

Partnering with agencies across the country to plan and deliver the clean mobility future your community deserves is the first step. As DKS continues to lead innovations in transportation planning and engineering, projects like the RABA ZEB Implementation Plan demonstrate our commitment to creating sustainable, accessible, and economically viable transportation solutions. Our expertise in complex systems integration, advanced modeling techniques, and stakeholder collaboration positions us as a trusted partner for transit agencies navigating the critical transition to zero-emission operations.

FOR ADDITIONAL INFO, PLEASE CONTACT:

Mike Usen, *National Director for Electromobility*
206.288.3174 • mike.usen@dksassociates.com