



EXECUTIVE SUMMARY

Transforming Transit, Realizing Opportunity:

How battery-electric
buses can benefit
the environment,
the economy, and
public transit

JOBS TO MOVE
AMERICA



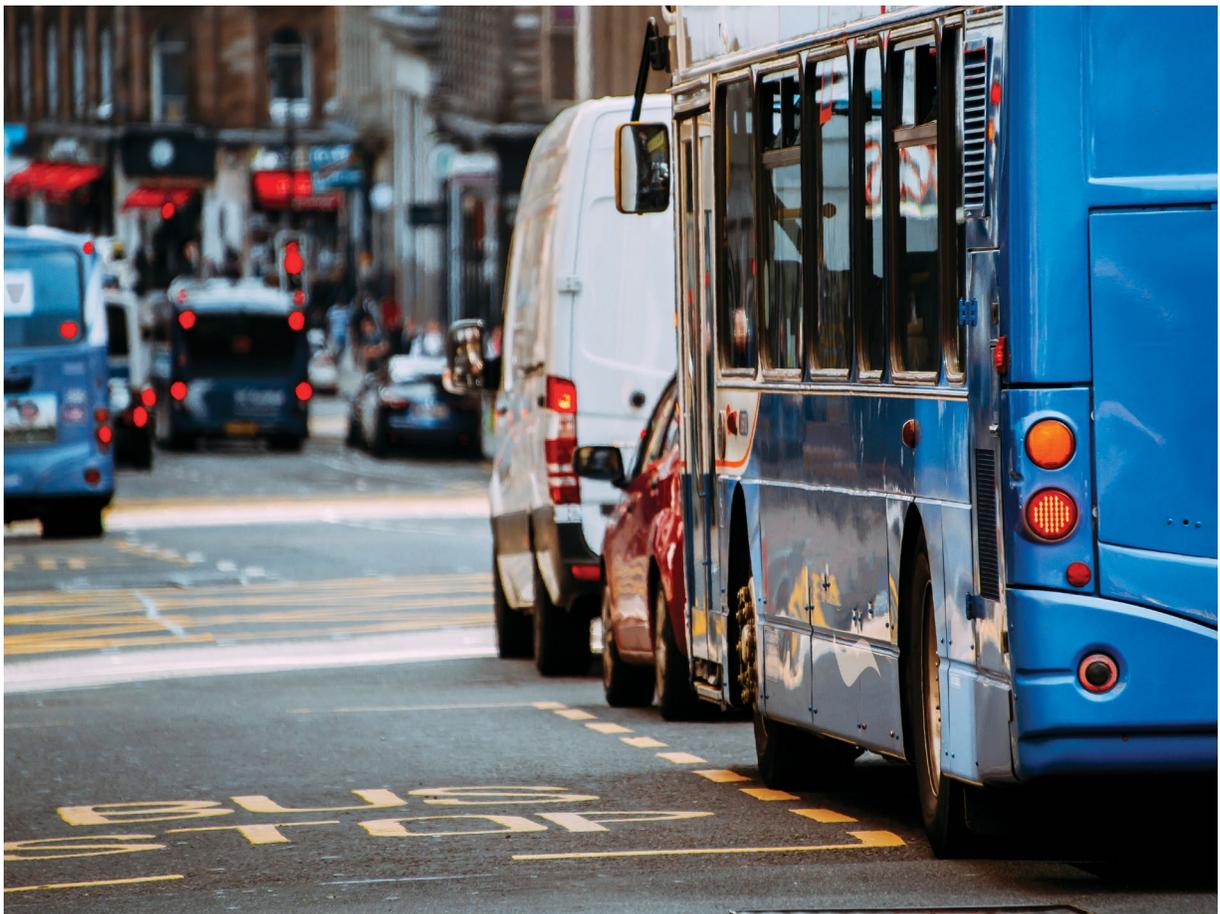
Executive Summary

Battery-Electric Buses: State of the Industry and Operational Considerations

Public transit agencies in the United States are in the early stages of what agency experts and industry professionals expect will be a large-scale transition from diesel and compressed natural gas (CNG) buses to zero-emission, battery-powered electric buses. Although the number of battery-electric buses (BEBs) in the US is less than one percent of all BEBs worldwide, the number of BEBs in use or on order domestically has multiplied dramatically over the past decade. While BEB technology and design are still developing, BEBs are expected to have lower total costs of ownership than conventionally fueled buses, and are seen as an important step that cities can take to improve urban air quality and reduce greenhouse gas emissions.

Despite these anticipated benefits, BEBs are still new and comprehensive data on their reliability, maintenance needs, and battery life spans are not yet available. A handful of transit agencies that have established themselves as early adopters of BEB technology are actively gathering operational and maintenance data. However, the costs of BEB ownership will remain challenging to forecast for some time to come. In addition to the current uncertainties around operating costs, BEBs have a higher upfront purchase price than diesel and CNG buses, and require agencies to buy and install battery-charging equipment. That said, a growing number of funding programs exist to support the purchase of electric buses; increasingly, state- and city-level policies and regulations (especially those designed to reduce greenhouse gas emissions) are also helping agencies start BEB pilot programs and make long-term plans for BEB fleet conversion.

The complexities of deployment are similarly expressed in the considerations around BEB fuel use and charging. Fuel economy for BEBs are typically about three times higher than those for diesel and CNG buses, with the added benefit that electricity prices tend to be significantly more stable than fossil fuel prices. However, variability in utility rates and added demand charges mean that the cost of fueling BEBs can be comparable to, or sometimes higher than, diesel or CNG fuel costs. The cost of an agency's electricity use will in turn depend on what types of BEB chargers the agency decides to use: on-route chargers that buses use during their duty cycles, and plug-in chargers that buses typically use overnight, draw electricity from the grid at different rates and will result in different costs to the agency. Whether an agency relies more heavily on plug-in chargers or on-route chargers often depends on what real estate is available for the agency's use, as well as what kinds of routes will work with the driving ranges of their BEBs. While it will take time for transit agencies to develop the best practices to address these and other operational challenges, many agencies have already demonstrated strong commitments to incorporating BEBs into their bus fleets and to full fleet conversion over the next twenty to thirty years.



Environmental and Public Health Considerations

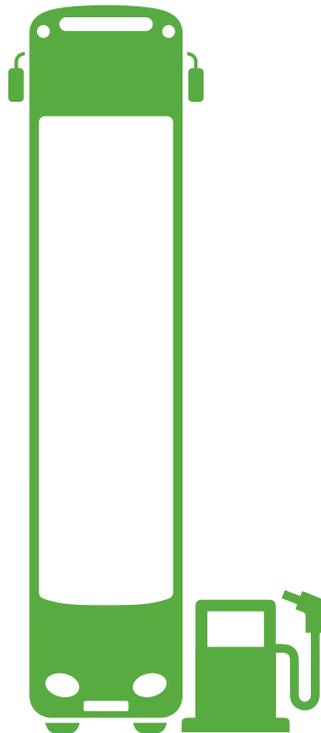
While deploying and operating BEB fleets requires complex preparation and planning, stakeholders at all levels have expressed widespread agreement about the substantial environmental and public health benefits that electric buses can provide. Agencies are clear on the value of achieving better air quality and reducing reliance on greenhouse gas-producing fossil fuels. Although BEBs are still a relatively small fraction of the global vehicle fleet, they are already significantly reducing demand for diesel fuel. The climate-related benefits of BEBs are also tied to the ongoing greening of the American electrical grid: over the course of their driving lifetimes, BEBs in the US currently have lower lifetime greenhouse gas (GHG) emissions than diesel or CNG buses. It is difficult to forecast the trajectory of renewable energy deployment, but it seems highly likely that GHG emissions for BEBs will diminish further as the prices of wind and solar power, which are already cost-competitive with fossil fuel-powered energy sources, continue to fall.

Reducing reliance on fossil fuel-powered buses also has the potential to substantially improve air quality and public health. The vehicle exhaust that is produced from burning diesel fuel contains nitrogen oxides (NO_x), ozone, and particulate matter (PM),

Lifetime global warming emissions for BEBs are about **75 percent less** than those for diesel and CNG buses



BEBs



Diesel & CNG Buses

and a large body of literature documents the extensive range of illnesses and diseases (including asthma, chronic obstructive pulmonary disease, cardiovascular disease, and multiple kinds of cancer) that are associated with these pollutants. In particular, a number of research articles describe the heightened health risks faced by bus operators, bus maintenance workers, and other people with occupational exposure to diesel exhaust.

Finding ways to improve air quality, especially in urban areas with high levels of heavy-duty vehicle traffic, is also an important factor in considering BEB deployment. The Environmental Protection Agency estimates that 15 percent of all Americans live near major traffic areas where exposure to vehicle exhaust is most pronounced; in urban areas, the estimate increases to 30 to 45 percent. Numerous studies discuss the high association between air pollution in low-income communities, communities of color, and the pollution-related health impacts suffered by those living there. These air quality findings echo the documentation on the disproportionate impact that extreme weather events associated with climate change have on disadvantaged communities that have the fewest resources available for response and adaptation. Several transit agencies, as well as public-private initiatives like the Zero-Emission Vehicle Challenge, are addressing these interconnected issues by developing BEB programs with an environmental justice focus and lowering the upfront costs of zero-emissions vehicle procurement by aggregating demand.

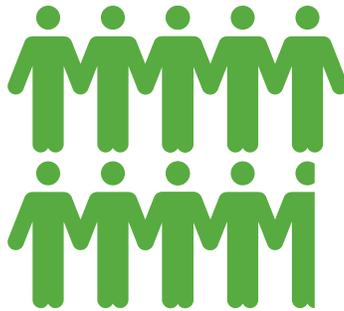
5.7 jobs supported
for every \$1 million
invested in BEBs



6.6 jobs supported
for every \$1 million
spent on manufacturing
and installation of
charging equipment



9.6 jobs supported
for every \$1 million
spent on bus facility
construction & upgrades



Economic and Workforce Considerations

In addition to examining the challenges that transit agencies must address with battery-electric buses, and the environmental and public health considerations that would result from a shift to BEBs, it is important to consider how a broad-scale BEB transition would affect the US economy and workforce. The largest impact that BEBs will have on job creation will be in the manufacturing sector—a part of the American economy that has been diminished for decades, but is now showing signs of post-recession improvement. Manufacturing contributes significantly to national gross domestic product, both in terms of gross output and value added. The manufacturing sector has also been consistently adding jobs since 2010, which is especially important because of the unique and valuable characteristics of manufacturing jobs. Careers in manufacturing can be accessible to workers with a wide range of abilities and educational backgrounds, and in particular to workers without college degrees. At the same time, manufacturing work requires notable levels of skill and in some cases pays better than other jobs that don't require advanced education. The historically higher rates of unionization in the manufacturing sector also contribute to the higher wages that manufacturing workers have earned. These are the kinds of jobs that could be created by a large-scale shift to BEBs that also includes a focus on ensuring the buses are manufactured in the US with good wages and benefits. Modeling studies by the Political Economy Research Institute at the University of Massachusetts Amherst



Photo courtesy Armando Aparicio

show that for every \$1 million invested in BEBs, about 5.7 US jobs would be created—a number that is comparable with the same amount of investment in diesel buses. When the jobs associated with the manufacture and installation of BEB charging stations and the necessary upgrades to bus depots are factored in, it becomes evident that a broad-scale transition to BEBs can have a positive impact on the job market if the transition is managed with good job creation in mind.

In considering this future job creation—especially in the tight labor market that currently exists in the US—it is important to understand the opportunities that exist for maximizing the economic impact of BEB deployment. For years, the American manufacturing workforce has been relatively homogeneous—roughly 70 percent male and 80 percent white. Given the high demand for workers, women and people of color are two of the most promising demographics for manufacturing sector recruitment. By focusing on these and other historically marginalized groups, manufacturing firms can realize their goals for workforce diversity and begin to correct for decades of hiring inequities. Because the lion's share of BEB purchases in future years will likely come from public transit agencies, these agencies can exercise their abilities as stewards of public resources not only to incentivize manufacturing firms to create good jobs with improved access for disadvantaged workers, but also to expand on-the-job training and access to pre-apprenticeships, which will be critical in growing the ranks of skilled job applicants. Agencies can also develop best practices around procurement that allow for training their in-house maintenance staff to keep BEB fleets in good repair. Underpinning these considerations is the critical role that transit agencies will play in creating predictable levels of demand for BEB original equipment manufacturers and supply chain companies: the stability of BEB-related manufacturing jobs will depend significantly on whether transit agencies have reliable access to the funds needed for future procurements.

Summary

The combined ways in which BEBs can improve public transit, public health, the environment, workforce, and economy present the kind of opportunity that only comes along once in several generations. The sum of BEBs' advantages is too great not to pursue, and a concerted effort to nurture the production of this new technology can result in strengthening an important part of America's emerging electric vehicles sector while improving air quality, transit services, and manufacturing jobs. Ultimately, capturing the combined upsides of BEBs can help America achieve an even more fundamental goal: expanding public transit availability across the country, so that people everywhere—especially those that need mobility most—can access transportation services that will expand their ability to connect with their jobs, schools, families, and communities, while improving the environment and creating better jobs for working Americans.

Policy Recommendations

The overall recommendation is for transit agencies to adopt comprehensive programs around transitioning to battery-electric bus fleets, with commitments to maximizing benefits to riders, taxpayers, workers, and communities:

Prepare for successful large-scale BEB deployment:

- Agencies should commit to ambitious targets for transitioning their bus fleets to BEBs over a specific period of time and create strategic transition plans for accomplishing these goals.
- In developing their transition plans, agencies should work closely with key stakeholders including their local government, current agency workers, and communities.
- All stakeholders should take whatever steps are necessary to create a constructive dialogue and a shared sense of mission between the transit agency and its utility.
- To increase the success of BEB deployment, policymakers and governing bodies that shape decisions at transit agencies should provide robust support for data gathering within the agency and sharing of best practices with peer agencies.
- Elected officials, agencies, and other groups should work together to create targeted funding streams and take any additional steps that are necessary to ensure that BEB procurements are funded and can progress on schedule.



A full conversion of the US transit bus fleet would enlarge the **global BEB count** by about **70,000 vehicles**, **reducing** the amount of **diesel fuel** needed by **35,000 barrels per day**



Create community health and climate solutions:

- As part of their transition plans, agencies should identify the neighborhoods in their areas that are most impacted by air pollution and prioritize the deployment of BEBs in those neighborhoods.
- Agencies should also engage in dialogue with their utilities about options for on-site renewable energy generation to maximize greenhouse gas reductions.

Prioritize good jobs with equity and career growth:

- Large agencies should develop sustainable good jobs policies to ensure that BEB manufacturers are incentivized to create permanent jobs with family-supporting wages, benefits, and training in transferable skills.
- Agencies and manufacturers should coordinate with economic development programs to support technical skills training for BEB manufacturing workers.
- Agencies should consult bus operators and maintenance workers, and their unions, to determine what skills training is needed to ensure that bus maintenance can be performed by current agency workers.

Commit to transparency and accountability for the entire program:

- Agencies should encourage and create opportunities for large-scale stakeholder participation.
- Agencies should build re-evaluation into their transition plans over time, and commit to regular and open review of their BEB programs.



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