# REDUCE, REUSE, REPOWER: THE BENEFITS OF ELECTRIC SCHOOL BUS REPOWERS

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JUNE 2023


PRODUCED BY ADRIAN GOMEZ FOR EVS36
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*36th International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium (EVS36)*
*Sacramento, California, June 11-14, 2023*

# Reduce, Reuse, Repower: The Benefits of Electric School Bus Repowers

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## Summary

In the U.S. today, drivers have many electric options when choosing a vehicle, and school buses are no exception. The U.S. government is investing billions of dollars to electrify the nation's school buses. Many districts will likely turn to purchasing new buses. Fleets of diesel-powered buses would be retired, sometimes prematurely, and new buses would be purchased, which is costly and is likely to cause the production capacity of electric buses to skyrocket. An affordable solution to these barriers is to repower existing diesel buses with electric drive systems, making the transition to electric faster and cheaper. To date, the repower approach has not received much attention. Forth aims to bring awareness to this process with a hands-on school bus repower project in Oregon, which will demonstrate the crucial role of repowering, barriers to this approach, and recommendations for increasing the use of repowers.

*Keywords: EV (electric vehicle), bus, government, federal, ICE (internal combustion engine)*

## 1 Introduction

Drivers in the U.S. today have an increasing number of electric vehicle options to choose from (1), and school bus drivers and their districts are no different. The numerous benefits of electrifying school bus fleets are well-known. Electric school buses (ESB) emit less gas emissions compared to diesel school buses, require less maintenance and fuel costs, and operate quietly (5). Clean energy school buses are also safer and healthier for students, drivers, and surrounding communities who are exposed to significantly less harmful emissions, like diesel particulate matter (PM) and poisonous gas like nitrogen oxide (NOx). These gases have proven links to cancer, asthma, and cognitive impacts (4).

Electrifying school bus fleets makes education more accessible and equitable. The harmful gases emitted from an internal combustion engine (ICE) bus disproportionately affect communities of color and students with disabilities. Several studies have proven that students with disabilities, who come from low-income families and are students of color are more likely to ride the bus for longer distances to and from school, which causes longer exposures to ICE bus emissions (11). The health of these students would benefit tremendously from the electrification of school bus fleets. But the high cost of new ESBs could also deepen the inequalities faced by these communities (11).

Electrifying school bus fleets has the support of the U.S. government, which is distributing billions of dollars to school districts across the country for the purchase of clean energy buses (2). The Environmental Protection Agency's (EPA) Clean School Bus Program will grant $5 billion over five years to U.S. school districts for the electrification of school bus fleets. In 2022, nearly $1 billion was awarded to 389 school districts for the purchase of more than 2,400 electric school buses (2). But for districts not directly benefiting from this federal investment, going electric in this way is costly. Moreover, low-income communities and people of color are often left out of federally funded programs in the U.S., so it would make purchasing new electric buses nearly impossible for low-income communities (11).

When plans are made to convert a fleet of buses from diesel to electric, a district may look to replace existing buses, including individual vehicles that still have plenty of life left, for new ones. This kind of complete overhaul and replacement is expensive and wasteful. Additionally, if districts were to purchase new electric school buses, the demand for production would rise significantly, placing strain on related supply chains. There are more than 480,000 school buses on the road in the U.S., and they typically operate for well over a decade. While production is scaling up, the U.S. does not currently have the capacity to manufacture 480,000 new electric school buses within a decade (8) The World Resources Institute (WRI), a global research nonprofit, plans to electrify the entire fleet of U.S. school buses by 2030. However, WRI acknowledges, "overcoming the cost, infrastructure and policy barriers to mass adoption will require an expansive and inclusive approach" (6).

A more affordable and sustainable option for electrifying school buses is electric repower. Sometimes called electric conversion or retrofitting, electric repower removes a bus's internal combustion engine that runs on diesel and replaces it with an electric drive system, removing the tailpipe emissions and allowing it to run completely on battery power (4). The repower process is more affordable and is less wasteful, allowing districts to keep the buses currently in its fleet instead of buying new vehicles. It would also provide low-income communities and communities of color a cost-effective option for making buses safer and greener.

However, the repower approach has not received much attention and faces some barriers to adoption. Forth is currently working with the Beaverton School District to complete one of the first independent repowers in Oregon of an electric school bus. Through this work, Forth will identify key benefits of repower, barriers to its wider adoption, and recommendations for making the most of this approach.

# 2 Repowering

Repowering school buses isn't a new concept; the first models were completed in 2014. The Kings Canyon Unified School District in California's San Joaquin Valley in March 2014 created the first repowered, modern electric school bus approved to transport students by any state in the U.S. (12). Months later, other California school districts in Torrance and Napa Valley also rolled out repowered ESBs.

Given the rise in popularity of electric vehicles and their related technology, repowered school buses have rapidly moved from novel technology to the mainstream (4). The process for repowering school buses, depicted in Figure 1, works like this: First, a used, diesel-powered bus is sourced. The fleet operator can save even more money by choosing a bus that's already in its fleet. The bus is then examined for structural integrity and compatibility with electric parts. The internal combustion engine (ICE) parts, including the engine and fuel tank, are removed, and the bus is refurbished. Next, the electric drivetrain parts are installed, which includes the batteries and motor. Finally, the vehicle is inspected and commissioned for use (4).

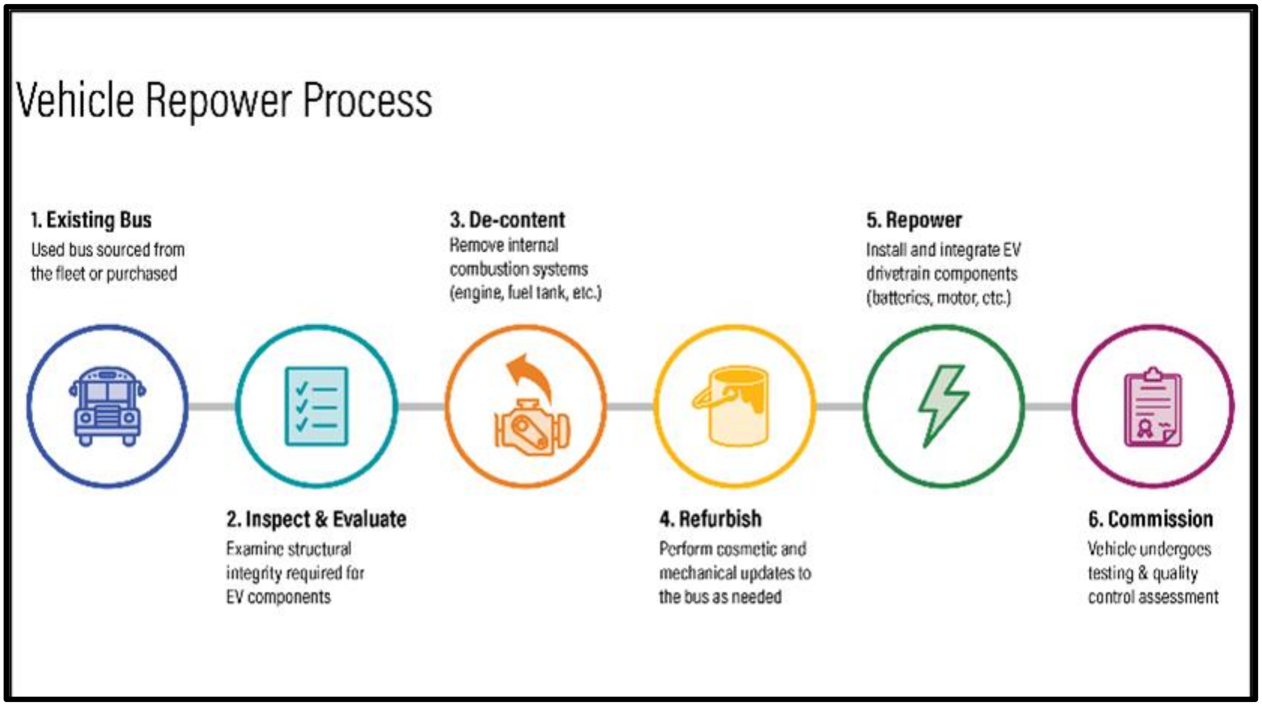


Figure 1: The engine repowering process (Image source: Emmett Werthmann/World Resources Institute)

The benefits of repowering a school bus are numerous and focus largely on cost savings, sustainability, and production speed.

## 2.1 Cost Savings

Upgrading a fleet of school buses from diesel to electric is costly, and choosing to completely replace a bus instead of repower it with an electric drive system has a much higher price tag. For the larger school buses most commonly seen ferrying students, referred to as Type C or Type D buses, new electric model can cost up to $440,000. These buses typically transport between 50 and 90 students. A new diesel-powered bus of the same size costs $100,000 (3). Comparatively, repowering a diesel-powered bus into electric can cost between $110,000 to $180,000, less than half the cost of buying new (4). The cost-savings of repower also extends to Type A buses, which are smaller and usually carry between 10 and 16 passengers. New electric Type A buses cost about $250,000 while new diesel versions run up to $65,000 (3). Repowering a Type A bus is within the same cost range as that of a Type C or D bus. The cost comparisons are reflected in Table 1.

| Type of Bus | Associated Cost |
|---|---|
| Repowered electric Type A, C or D bus | $110,000 - $180,000 |
| New electric Type A, C or D bus | $250,000 - $440,000 |
| New diesel-powered Type A, C or D bus | $60,000 - $100,000 |

Table 1: Cost comparisons of purchasing a new ICE bus, a new ESB, and repowering an ESB (3, 4)

The low maintenance costs associated with all electric vehicles is well documented, and that savings is the same for both new and repowered ESBs (7). ESBs need less maintenance simply because they have fewer moving parts. Additionally, ESBs do not require oil, do not have the aftertreatment systems that clean exhaust, and require less use of brakes, which reduces speed of wear (15). The lower maintenance and fuel savings an ESB provides, depending on labor costs, local electric utility rates, and the price of diesel fuels, can be between $4,000 and $11,000 per school bus every year (14).

The charging infrastructure needed for a repowered electric bus costs the same as what is needed for a new electric bus (4). Charging stations for ESBs can range from $596 per port for the simplest station to as much as $140,000 for a stronger and faster charger (16). One ESB requires, on average, between $10,000 and $30,000 in charging infrastructure (17).

Like the purchase of new electric buses, repowering buses may also qualify for government-sponsored incentive programs at the federal and state levels. In California, districts can get up to $43,500 for eligible repowered school buses; in New York, the incentive is even higher at $120,000. Legislation passed recently in Colorado created a $65 million grant program specifically for electric repowers of existing buses. And New Jersey is supporting repowered school buses with a $45 million pilot program (4). One of the most important benefits of choosing to repower a bus is that even without such incentives, it will provide school districts with a more affordable option for clean transportation.

### 2.2 Sustainability

Repowering a bus fleet instead of purchasing new is sustainable and less wasteful. New electric buses often replace diesel-powered buses that have plenty of life left. (4). When an operator chooses to repower a bus instead of buying new, it is keeping that bus from being sold to another state or country where it would likely continue to cause harmful pollution (4). Repowering one of those buses extends the life of the bus's functional internal parts like the chassis and body.

Additionally, repowering a bus means a new bus does not need to be manufactured. The production of new buses creates its own emissions and demand for products like steel, which require significant emissions to create (4).

### 2.3 Production

Repowering school buses places less pressure on supply chains. When a new electric bus is purchased, its production must rely on supply chains that directly relate to the chassis and body of the bus, as well as the electric power components. Repowering a bus means that the chassis and body are already in existence and only the electric power components will need to be sourced (4).

Today, there are more than 480,000 school buses on the road in the U.S., and they typically operate for well over a decade. While production is scaling up, the U.S. does not currently have the capacity to manufacture 480,000 new electric school buses within a decade (8). Choosing to repower these vehicles instead of buying new will be a critical step in converting America's school bus fleets by 2023.

## 3 Repowering Project in Beaverton, Oregon

In early 2022, Forth, a Portland, Oregon nonprofit organization dedicated to increasing equitable access to electric transportation, launched a project that aims to increase the number of repowered electric school buses (ESBs) operating in the Pacific Northwest. The impetus to establish such a project began when Forth received a $300,000 grant from the federal American Rescue Plan Act (ARPA) to further the adoption of ESBs in Oregon. Through the project, Forth and its partnering organizations will repower an existing, mid-life diesel bus to electric power, which will demonstrate the process and benefits of repowering over purchasing new, with the goal of encouraging wider adoption.

### 3.1 Project Overview

Today, about 8,000 school buses navigate the streets of Oregon. All but six of them are powered by ICEs (9). The Beaverton School District (BSD) in Beaverton, Oregon, a major city within the Portland Metropolitan Area, transports

28,000 students daily with a fleet of 300 buses that travel 3 million miles annually (9). The district was chosen as a major stakeholder in Forth's repower project because it is one of the first school districts in the state to adopt electric school buses. Once the project is complete, the district will be the first in Oregon to use a repowered electric school bus. The district chose a 2008 Blue Bird Type-C bus to be repowered. It will have a range of at least 100 miles per charge, which is more than enough to meet the demands of BSD's bus routes. The repowered electric bus will also exclusively serve Title I schools, or schools that have been identified as serving low-income students.

Through a request for proposal (RFP) process, Schetky was chosen as the project contractor for mechanical repower work. Schetky is a Lakewood, Washington business that specializes in mechanical work for and sales of electric buses and vans (11). Schetky will subcontract electrical work for the bus repower to SEA Electric, based in Kent, Washington.

### 3.2 Project Goals

Through the project, Forth aims to further electrification of transportation in Oregon and to accelerate and make it more affordable for the state to adopt electric school buses.

Because BSD has electric buses currently in use, providing charging infrastructure will not be necessary. Once the repower process is completed, the bus will be charged using BSD's existing charging stations, which are Nuuve Level 2 Charging Stations, single phase. As the project progresses, Forth will review and analyze data related to the performance of the bus once it is repowered and on the road. The data are expected to provide insight into cost-savings, the reduction of greenhouse gas emissions, and other information that will help compare repowering to purchasing a new ESB.

Once the project is completed, Forth will provide technical assistance to school districts that are considering electrifying their bus fleets but have limited financial resources, as well as to spur future ESB subsidies that include repowered buses. While the repower space is still limited, Forth is also hopeful that some larger Original Equipment Manufacturer (OEMs) will enter the repower space to increase attention and prominence.

## 4 Conclusion

As interest in and attention on electrifying school buses increases across the U.S., the high cost of purchasing new ESBs may detract some school districts from adopting a greener bus fleet. By demonstrating the process of choosing repower over purchasing new through its project with BSD, Forth aims to prove there is a cheaper and more sustainable way that would also provide cleaner and healthier bus rides for students from low-income communities, those with disabilities and students of color. With the project's success, there is hope that a wider adoption of repowering would take place throughout the U.S.

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