DEUSA Fleet Success Stories: Knoxville Area Transit

Location: Knoxville, Tennessee
Fleet type: Heavy-duty All-electric Mass Transit Buses

Narrative: Knoxville Area Transit (KAT) is the operator of public transportation in Knoxville, Tennessee, and has been a member/partner of East TN Clean Fuels (ETCF) for two decades. KAT operates about 25 routes with a system ridership of well over 2 million per year, or almost 8,000 per weekday, and offers the Knoxville Trolley which is a free shuttle service which provides service to the University of TN, Knoxville campus and the downtown Knoxville area. KAT also provides a door-to-door paratransit service to Knoxvillians. They operate roughly 100 vehicles.

In the 2010s as fully electrified transit buses started coming to market, KAT staff including Chief Maintenance Officer Si McMurray began investigating and vetting the opportunity. They spoke with multiple OEMs, attended many conferences and virtual learning sessions, and held many discussions toward how these buses would operate and what kind of charging needs would be required to adequately recharge the buses. Of course, KAT would need to line up funding to bring electric buses and chargers into the fleet, too. Once they were further along the planning and decision-making curve, in 2018, KAT engaged Knoxville Utilities Board – the local electric utility – on the charging side, knowing that more than a handful of such DC fast chargers (DCFC) would be needed to charge the buses on a regular basis if their goals were to move well into the double digits in electric bus ownership and use.

One of KAT's new electric buses is shown above at its downtown Knoxville Transit Center.

Over many years, staff did the legwork to bring these to fruition, and in September 2021 once receiving two of twelve ordered new electric buses, held an unveiling and test rides for the media and interested community citizens. By early 2023, KAT had received all twelve buses, completed extensive employee training, and placed all 12 electric buses on Knoxville's streets. By the end of 2024 KAT plans to take the next step in expanding their battery-electric bus fleet by receiving an additional ten buses.

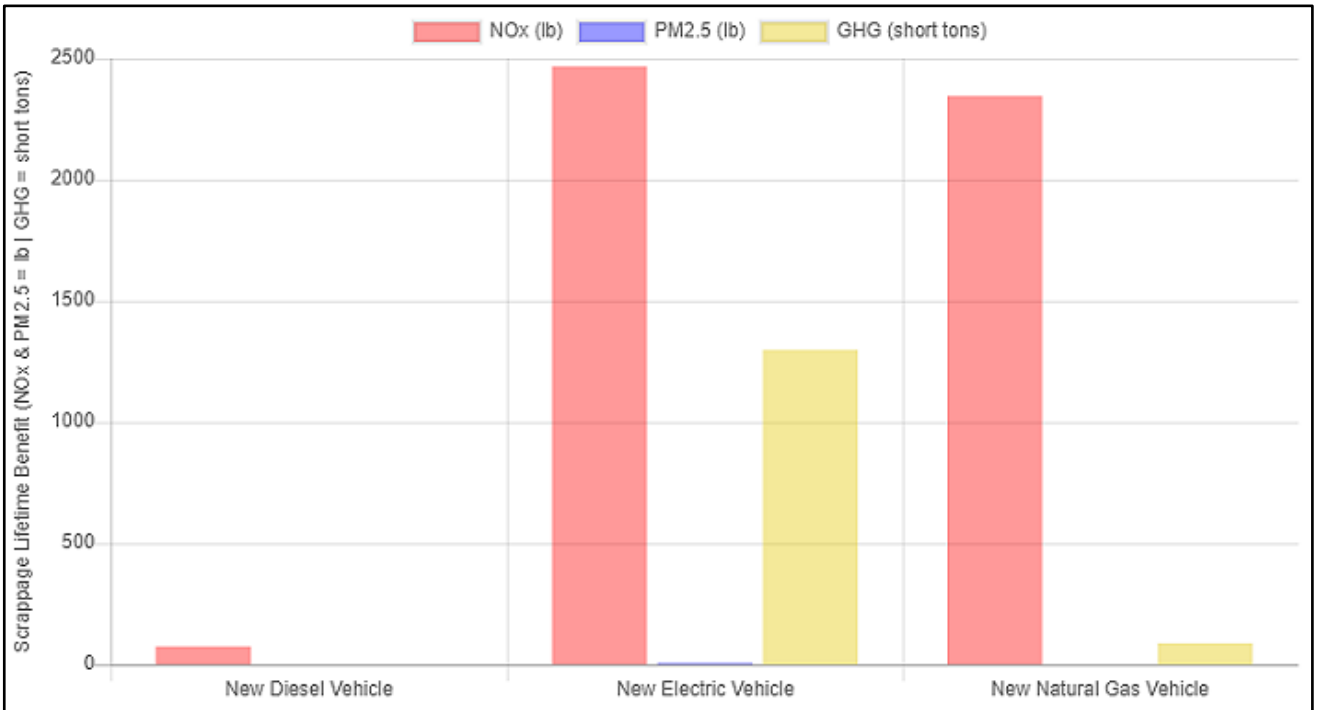
KAT's efforts fit and align with larger, local community efforts, including the City of Knoxville's plans. In 2011, Knoxville adopted its first Energy & Sustainability Work Plan as the guiding document to lowering emissions and combating climate change (this plan is part of what started KAT down its electric transit bus investigation path). Then in 2020 under Mayor Indya Kincannon, the City convened over 65 community leaders and technical experts through the Mayor's Climate Council; ETCF's Jonathan Overly is a member of the Transportation Working Group. The Council's all-inclusive efforts shone a light on the fact that while the City needs to take the leadership and implement actionable items across all facets of City operations, leaving out the larger community businesses and residents would render the effort ineffective since the City is responsible for a small portion of the entire community's emissions. Due to the KAT buses being such a visible piece of local transportation and being responsible for a significant portion of downtown and nearby diesel emissions (as the buses operate throughout most of the day and stay in largely the urban core), KAT took this to heart and produced tangible results that can now be seen on area roads every day. To learn more about KAT's plans, its Decarbonization Plan can be viewed here.

As of summer 2023, KAT operates the largest all-electric, mass transit fleet in the state, beating out Nashville, Memphis, and Chattanooga's transit systems.

ETCF worked with KAT to offer a tour of their new charging area and buses at their Transit Depot in April 2022. McMurray led the tour and showed attendees all the new, current charging pieces of equipment… as well as the planned space to hold a total of 25 DCFC connections for the new buses (once they bring their electric bus count into the twenties).

Outputs & Outcomes: There are clearly huge outputs as impacts from KAT's leadership, and the emissions reductions portion are the largest of them. Utilizing Argonne National Laboratory's "Heavy Duty Vehicle Emissions Calculator," ETCF ran an analysis to derive some of the largest benefits from this transition. The analysis is for full life-cycle emissions reductions – "well to wheels." Utilizing a few assumptions (including bus

is driven 45,000 miles/year, and that we are comparing a 2015 non-hybrid diesel bus to a new electric bus) and using a recent-year grid mix from TVA, the below table shows the results in graphical and tabular ways. The data shows the *emissions reductions* as compared to a 2015 diesel bus. The new diesel option shows nearly no benefits for any pollutants, which is as expected considering diesel particulate filters and selective catalytic reduction systems (where urea, or "diesel exhaust fluid" is commonly used) have been in use since the late 2010s. And while a new compressed natural gas (CNG) powered transit bus gets near the electric nitrogen oxides (NOx) reductions as compared to a 2015 diesel, the GHG reductions are not even a shadow of those realized by using all-electric buses. (The electric bus also generates some versus zero PM reductions.)



New Vehicle Lifetime Emission Benefits

Pollutant	Diesel	Electric	Natural Gas
NO_x (lb)	73.79	2,463.98	2,344.47
$PM_{2.5}$ (lb)	0.20	4.17	0.20
GHG (short tons)	0.00	1,295.17	87.79

On top of these great results is the fact that an electric mass transit bus has *zero tailpipe emissions because the propulsion system has no tailpipe – there are no longer ANY propulsion combustion emissions at the ground, passenger, driver, and urban community level.* All other combustion propulsion systems still have emissions that are released in the community, that directly impact human health. The U.S. must reduce diesel use as much as is possible, as fast as is possible. The use of diesel has profound impacts on both climate change and

direct human well-being. As noted from the EPA, "(there is) staggering damage that diesel emissions from the transportation sector inflict on U.S. communities, charting the more than 8,800 deaths, 3,700 heart attacks, hundreds of thousands of respiratory illnesses, and approximately $100 billion in monetized health damages per year across the U.S." [1]

KAT is leading probably what was one of the most needed – in terms of impacts and outcomes – projects and efforts in central East Tennessee. And with KAT's partner KUB already started on providing more solar options like its 1-MW Community Solar program and its purchase of solar power through TVA's Green Invest Program on behalf of KUB customers with an expected 325 MWs online by 2026. Using more solar locally or securing more solar for Knoxville entities – like KAT – will only further reduce the life-cycle emissions, including GHGs. Hopefully ETCF, the City of Knoxville, and KAT can get other large, medium- and heavy-duty fleet diesel users in the region to make the move in the next few years as well.

Best Practices & Lessons Learned:

- ✓ If possible, speak with other transit fleets that use the same combination of certain-OEM buses and chargers before you commit to ordering.
- ✓ Review any documentation you can find on other transit fleets that have made the move to electric. Look for lessons they learned or suggestions they have on reducing your speed bumps to a smooth transition.
- ✓ Engage your local utility as early as possible in the process. The power needs to fuel these buses will be substantial and the utility may need lead time to be able to provide the needed power.

[1] *2022, January. Clean Air Task Force website, "New CATF tool maps the staggering U.S. health and economic damages caused by diesel emissions", https://www.catf.us/2022/01/new-catf-tool-maps-staggering-health-economic-damages-caused-diesel-emissions/.*