WHITE PAPER

# The future of transportation is electric

The case for electrification in North America is compelling, and it goes far beyond EVs

## The transition to electric vehicles (EVs) is just beginning but electrification of transportation (e-mobility) goes well beyond passenger vehicles to include fleet vehicles (cars and trucks), mass transit buses, light rail, ships and even non-road vehicles like forklifts.



The rationale is simple: electric vehicles have lower cost of ownership than their conventionally powered peers, they emit less pollution, and they enable emerging mobility business models.

This paper outlines the benefits of transportation electrification, explains why EVs are likely to overtake internal combustion engine vehicles, and identifies targeted actions that governments can take to support the e-mobility transition.

**E-mobility is already here**
Transportation electrification is well underway. From its origins with light rail and subway systems, electrification is expanding to incorporate more vehicle types and applications.

- **Subways and light rail –** New technologies like wayside energy storage systems (WESS) that capture braking energy and store it for use in powering other trains as they accelerate will make passenger rail systems more efficient and economical.

- **Buses –** Overhead power lines will likely be replaced with onboard batteries charged in bus depots and with on-route "flash chargers." ABB demonstrated flash charging technology with TOSA, an electric bus line in Geneva, Switzerland that entered commercial operation in December 2017.

- **Electric fleets –** EVs are appealing to fleet operators because their lower lifetime maintenance and fuel costs deliver a payback that offsets the initial higher purchase price of the vehicle, though those prices are falling as well. Cost advantages will increase as the energy density of batteries increases and battery management technologies advance.

- **Ships and ports -** Diesel-electric hybrid ships have been operating since the 1990s thanks to electric propulsion's improved fuel economy, superior maneuverability, reduced noise and vibration, and added flexibility in hull design. In 2000, ABB introduced the world's first shore-to-ship power connection that allows docked vessels to draw power from the local power grid rather than running their engines.

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The e-mobility transformation is being driven by three primary forces: cost, environmental benefits, and a view toward enabling future technologies.

**1. Cost**
**Light-duty vehicles**
There are two main cost categories where electric vehicles have significant benefits: maintenance and fuel. Unlike internal combustion engines, electric drivetrains have few moving parts—about 20 compared to the typical car's 1,500 to 2,000 [1]—and can last for decades. Their durability, reliability and relatively low maintenance costs have been well-proven over a century in rail transit and the toughest of industrial applications.

Fuel costs for EVs are also markedly lower. The Electric Power Research Institute (EPRI) estimates that the cost of electricity, per mile of driving, is less than one-third that of gasoline [10]. And electricity rates are much less volatile than gasoline prices. The combination of lower fuel and maintenance costs brings the total cost of ownership (TCO) of EVs below that of comparable ICE vehicles, despite a higher purchase price. [1][5] Meanwhile, the cost of electric drive continues to decline as battery energy density increases and cost-per-kWh falls.

**Transit buses**
Several municipal transit operators have conducted trials of electric buses, providing a growing body of

data to support the business case for going electric. A 2016 study by New York's Metropolitan Transit Authority and Columbia University found that, while electric buses presently cost about $300,000 more than the diesel alternative, "annual [operating cost] savings are estimated at $39,000 per year over the 12-year lifetime of the bus." [5] The result is a reduction in total lifecycle cost of more than $150,000 per bus.

**Fleet vehicles**
Reduced maintenance and fuel costs make EVs particularly attractive to fleet owners who have very high vehicle utilization rates. Autonomous vehicles (AVs) in rideshare applications, for example, are projected to be on the road 40% of the time [6], racking up as many as 70,000 miles per year. Whether it's local delivery, field service vehicles, ridesharing or other businesses, all fleets face cost pressures, making EVs particularly attractive.

Underscoring these cost benefits, electricity prices have been historically stable, while gasoline prices have often demonstrated high volatility. Electrification of fleets represents more predictable business model with lower risk where profitability is not subject to the whims of highly uncertain fuel costs.

**2. Environmental impact**
**Air quality**
Air pollution is a global but also highly localized concern. For example, in the areas around ports there are higher concentrations of harmful emissions from marine diesel engines, and people who live nearby suffer higher rates of respiratory problems and other illnesses related to poor air quality. [3] Ships that plug into the local grid while in port virtually eliminate those harmful emissions by using grid power instead of running their engines.

Canada has funded projects to develop power from shore at seven of its ports. [13] The U.S. currently has 10 ports with high-voltage connections available for container ships and cruise vessels, and another six with low-voltage systems serving tugs and fishing boats. [14]

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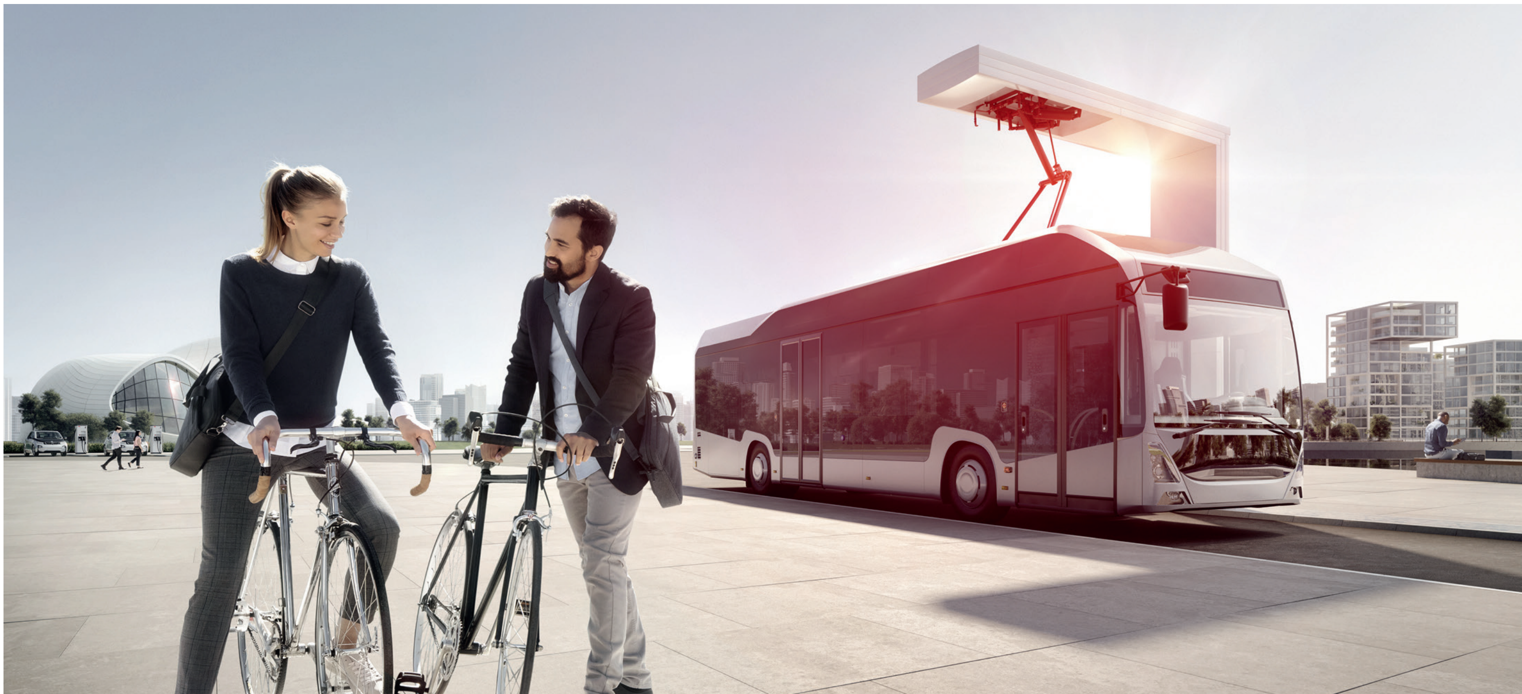
Road vehicles present an even bigger target. If the US light-duty vehicle fleet were to transition to electric drive, EPRI estimates that it could improve nationwide air quality and reduce petroleum consumption by 3 to 4 million barrels per day by 2050. [2]

Reducing greenhouse gas emissions
The transportation sector accounts for 27% of greenhouse gas emissions in the US [4] and 24% in Canada. [11] While fuel efficiency standards keep rising, ICE vehicles have inherent limitations. Further, the environmental performance of even the most fuel-efficient conventional vehicle today will decline over its lifetime, even with regular maintenance. EVs, on the other hand, get cleaner as



the power supply behind them becomes more sustainable and less carbon-intensive.

**Corporations increasingly focused on emissions**
Regulation of CO2 emissions is only increasing. Corporations and the financial community are already pricing the costs of complying with CO2 regulations into their investments and businesses. Shell, for example, has used an internal carbon price of $40 to $80 per metric ton since 2000 to evaluate investment decisions, according to the Center for Climate and Energy Solutions. [8] Mining giant BHP uses a “shadow price” of $24 to $80 per metric ton of carbon dioxide equivalent to improve energy efficiency, reduce greenhouse gas emissions and diversify its portfolio for a carbon-constrained future.

Meanwhile more firms are shifting to electric-powered shipping. Walmart Canada, for example, has committed to convert 20% of its fleet to electric drive by 2020, and to using 100% alternatively powered vehicles by 2028. [12]

**3. Future technology enabler**
Autonomous vehicles have captured the public imagination as the technology for driverless cars continues to evolve. Nearly all of the manufacturers developing AVs have opted to use electric vehicles as the platform, and for good reason. First, EVs are mostly “drive-by-wire,” which are easier than mechanical linkages for computers to control. Their large batteries also make EVs capable of supporting the power-hungry sensors and control systems needed for autonomous driving.



Second, fuel economy and emissions requirements will only increase over time and EVs essentially take those issues off the table. Still, the bottom line is cost, and as noted earlier electric cars boast lower operating costs and lower TCO than their ICE equivalents. This is particularly important for fleet operators whose vehicles will spend every minute they can on the road. In the case of ridesharing, the evolution toward autonomous vehicles will create a use case that demands the lower cost profile and higher reliability that EVs offer.

According to some industry observers, like Navigant senior analyst Sam Abuelsamid, this fact alone might be enough to drive further development of the EV market even absent a significant jump in demand from consumers. [9]

**Challenges facing e-mobility, and their solutions**
The obstacles to wider adoption of electrified transport are challenging, but they are also addressable.

- **Technology & government leadership –** The world is converting to electric mobility, but while much of the technology is already here, the US and Canada lag other countries in deployment. North America must work harder to provide the private sector the certainty needed for investments in e-mobility solutions and also to encourage the deployment of e-mobility technologies, like electric transit buses and fleets, port electrification, and charging infrastructure. If we don’t, we will be left to import those technologies from nations that do (e.g., China).

- **Infrastructure deployment –** DC fast chargers already provide a full charge in 15-60 minutes and up to 125 miles of driving in as little as 8 minutes. However, support for further research, development, testing and deployment of fast charging technologies is needed and is an example of where government could make an impact. Canada has committed to building a nation-wide network of EV fast chargers and, like the U.S., is currently working with Volkswagen to expand its reach.

- **Standards –** Open charging connection standards for AC charging (J1772) and DC fast charging (CCS and CHAdeMO) have EVs covered. For other segments of the market such as electric buses and other medium or heavy duty vehicles, the charging systems currently available present a few solutions, some open and some proprietary. The industry is working to address this, with major EV standards bodies now solidifying open, interoperable high-power charging solutions.

- **Electric grid –** The North American power grid is already capable of handling millions of EVs. [5] These vehicles could also provide services back to the grid (e.g., absorbing excess solar generation during the day and easing the ramp-down of solar in the evening by delaying the start of their charging cycle). Southern California Edison is presently conducting a pilot study of vehicle-to-grid (V2G) applications with a fleet of cars at Los Angeles Air Force Base. [7]

**Policy prescriptions and opportunities**
Ensuring competitiveness in e-mobility will take competency and leadership. There are a number of things that governments can do to ensure they are not left behind in the global e-mobility transition. These include:

- Supporting EV markets via government procurement

- Directing funding for public transit to electrified transportation technologies
- Carving out tax incentives to encourage businesses and individuals to choose electric vehicles
- Tuning regulatory frameworks to support wider deployment of charging infrastructure, especially high-power facilities (e.g., by providing relief for demand charge tariffs for fast charging stations)

- Supporting R&D activities to advance e-mobility technologies in both passenger vehicles and in other applications

Ultimately, the shift to a transportation sector based on electric drive will be motivated by an economic imperative. We are seeing evidence of this now in public transit where lifecycle costs for electric buses are already lower than diesel-powered alternatives. In the passenger vehicle market, EVs still sell at a premium, but their cost of production, and critically their cost of ownership, are declining. The U.S. and Canada both enjoy abundant resources, talent and manufacturing resources. With the right governmental support, both nations will be well positioned to benefit from the switch to electrified transport.

**Endnotes**

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