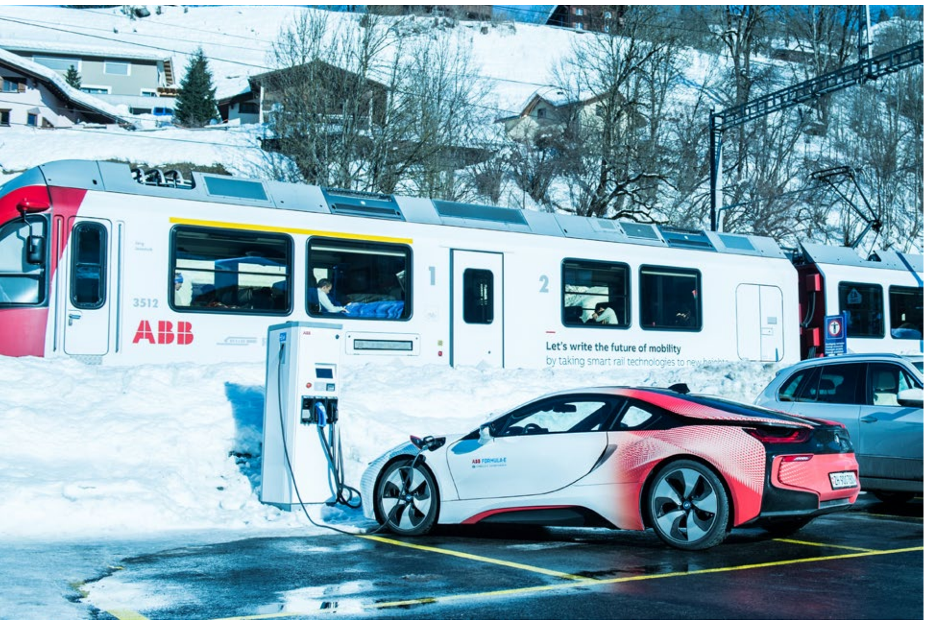
POLICY PERSPECTIVE

The future of transportation is electric

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



The transition to electric vehicles (EVs) is just beginning and with automakers and other countries making significant commitments to phase out conventional internal-combustion engine (ICE) vehicles, the future for EVs is bright. 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 technologies and 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 the federal government can take to support the e-mobility transition and itself realize its benefits.

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 transit types and applications.

Subways and light rail

Rail is one of the more prominent forms of electrified transport, as local rail and subway systems have used electric power for 100 years. Now electric rail is poised to become more economical, thanks to the development of supporting technologies.

One example is in energy storage. SEPTA, the Philadelphia-area transit operator, installed a wayside energy storage system (WESS) in 2012 that captures the energy from trains using their brakes as they enter a station and stores it for use in powering other trains as they depart. The system also allows SEPTA to provide power back to the local power grid, which creates a new revenue stream for the agency. The pilot program at a single station was a resounding success, leading to $16,000 in avoided energy costs and $250,000 in new grid-services revenue it its first year alone. SEPTA subsequently added more WESS facilities in 2015 and 2016 and is exploring more use cases and further expansion.

Transit buses

Electric powered buses are a familiar sight in US cities. The next step in their evolution is the replacement of overhead power lines with onboard batteries and bus charging in the depot overnight, at the end of routes during the day, and on-route “flash” charging at bus stops.

ABB demonstrated flash charging technology with TOSA, an electric bus line in Geneva, Switzerland that entered commercial operation in December 2017. Additional new electric-drive bus lines and charging system programs are cropping up around the world, and have been successful (see “Cost” in the next section). ABB has been involved in a number of them, from France to Singapore, Canada and the US.

Electric vehicles

While EVs are currently in the “early adopter” phase of the product lifecycle, they hold tremendous potential. A segment of the EV market with significant cost and pollution savings is fleets, whose operations place far greater demands on vehicles than the typical consumer. Fleets are also an important barometer of the evolving EV business case because their owners are focused almost exclusively on costs. Fleet operators in the public sector (US Navy, City of Seattle) and the private sector (UPS) are already using EVs as an integral part of their operations.

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. It’s also worth noting that the cost advantage EVs already enjoy will increase as batteries and supporting technologies advance, one reason why most autonomous vehicles are being built on EV platforms.

Ships and ports

Diesel-electric hybrid ships have been operating on the high seas since the 1990s, and the technology has now become the industry standard for cruise ships, LNG tankers, polar icebreakers, offshore support vessels and more. ABB’s Azipod™ electric propulsion system, for example, has become the propulsion system of choice for more than 100 cruise vessels, including the world’s largest cruise operators. This is 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 (in Gothenburg, Sweden) that allows docked vessels to draw power from the local power grid rather than running their expensive and polluting diesel engines to power onboard systems while in port. Cruise ships, for example, are like floating cities, and their power demands are correspondingly high. A typical vessel emits as much smog-producing nitrous oxides over an eight hour period as 10,000 cars driving round-trip from Silicon Valley to Los Angeles. Shore-to-ship power has the potential to dramatically improve air quality around major ports while also lowering vessel fuel and associated operating costs. The technology is already available at many of the world’s largest ports like Rotterdam (Netherlands), Geoje (South Korea) and Dalian (China).
So far, the only US port to use the technology is the Port of Long Beach (California), but more are likely to pursue it.

Port transportation does not stop when a ship is berthed: gantry cranes, tractors, forklifts, and more can all be electrified—reducing fuel costs, maintenance costs, noise, and pollution.

Why electrification is the future

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

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-tested in rail transit and the toughest of industrial applications for a century.

Fuel costs 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, which provides 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[5] 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.” The result is a reduction in total cost of ownership of more than $150,000.

Fleet vehicles.

Reduced maintenance and fuel costs make EVs particularly attractive to fleet owners who have very high vehicle utilization rates. For example, autonomous vehicles (AVs) in rideshare applications 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 flat for decades, while gasoline prices have been very volatile. Electrification of fleets represents a lower risk and more predictable business model where profitability is not subject to the whims of highly uncertain fuel costs.

Environmental impact

Air quality.

Air quality is a national but also highly localized concern. For example, locally in the areas around ports there are higher concentrations of harmful emissions from diesel 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 local harmful emissions from their diesel engines.

Nationally, if the 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 U.S. greenhouse gas emissions.

The transportation sector accounts for 27% of U.S. greenhouse gas emissions[4] and electrification is the key tool for de-carbonizing transportation. While federal fuel efficiency standards keep rising, ICE vehicles have inherent fuel-efficiency limitations. Further, the fuel efficiency and environmental performance of even the most fuel efficient conventional vehicle on the market will steadily decline over its lifetime, even with regular maintenance. EVs, on the other hand, get cleaner over time as the power supply behind them becomes more sustainable and less carbon-intensive, a pathway which is well-underway.

Corporations increasingly focused on emissions.
Meanwhile, 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-$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.

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. 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. Below we discuss three broad challenges that touch all modes of e-mobility and the solutions that are available to meet them.

Technology & government leadership

From both a policy and market standpoint, the world is already on its way to converting to electric mobility, but while much of the technology is already here, the US lags other countries in deployment. China is "all-in" on electrification to the point where that country has become the driving force in consumer EV sales. Sales of EVs in China are roughly equivalent to those in all other countries combined, and the majority of that demand is being met with domestic product.

The US 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 do not, we will be left to import those technologies from nations that do, and for the foreseeable future, that means China.

Infrastructure deployment

The primary infrastructure challenge for e-mobility lies in vehicle charging times and charging station availability. DC fast chargers already offer the ability to 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.

More deployed charging infrastructure is needed to allow consumers to "re-fuel" during long road trips, just like they can with gas-powered vehicles. The federal government is in a good position to assist and enable the deployment of sufficient EV charging infrastructure, particularly DC fast chargers. (See also "Procurement" below).

Standards

Open charging connection standards for consumer EVs have coalesced around one for AC charging (J1772) and two for DC fast charging (CCS and CHAdeMO). For other segments of the market such as electric buses and other medium or heavy duty vehicles, the charging systems currently on the market 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 power grid represents the foundation for a ubiquitous "refueling" infrastructure for e-mobility, and it is capable of supporting many more vehicles than it currently does. According to EPRI, putting 10 million (personal) electric vehicles on US roads will only increase nationwide demand on the grid by 0.5%, about one third of its annual growth rate. Even with a 60% market share, EVs would account for 7% to 8% of grid-supplied electricity by 2050.[5]

Importantly, EVs provide opportunities to lower the overall cost of operating the grid. For example, EVs could help ease the ramp-down of solar generation in the evening hours by delaying the start of their charging cycle or even sending power from its battery onto the local grid. This would allow grid operators to manage high penetrations of solar power without investing in new generation assets. EVs can also provide a range of other services to support the grid. In fact, when aggregated by a third party, EVs can play in any wholesale power market (energy, capacity or ancillary services) under FERC's Order 841.

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]. Nationally, the Department of Energy and National Laboratories have a key role to play in supporting research and development of technologies that enable the benefits of EVs.

Policy prescriptions and opportunities

Ensuring America's competitiveness in e-mobility will take competency and leadership. There are a number of things the federal government can do to ensure that the U.S. is not left behind in the global e-mobility transition.

Supporting e-mobility projects

The Federal Government allocates and spends significant funds on public transit projects, including buses, rail, and ports. In 2018, the Federal Transit Administration's (FTA) budget alone exceeds $13 billion for mass transit projects like rail and buses. Congress should keep the 2018 budget increase in the Low or No Emission Vehicle Program (5339c) and should encourage investments across FTA programs in electrified public transit because these projects deliver lower operating costs and longer asset life, making federal grant dollars go further. Similarly, department-wide, the Transportation Department should encourage electric transportation options in regional transit projects that receive federal funding, whether in its electric buses and associated chargers, port electrification, or light-rail energy storage systems.

Procurement

The federal government can use its exceptional buying power for its many fleet vehicles to drive growth in both electric vehicles and charging infrastructure. Increased government use of electric vehicles will save the taxpayer significant fleet maintenance and operations costs.

Tax incentives

Tax credits like the Section 30C credit for alternative fueling infrastructure, which incentivizes the deployment of EV charging infrastructure, and Section 30D credit for EVs (currently capped at 200,000 vehicles per manufacturer) should be continued and expanded. In particular, the 30C credit should be extended prospectively, not retroactively. The most recent extension of the credit provided a tax credit for infrastructure already deployed, instead of being extended into the future to incentivize further deployment. For 30D, the 200,000 cap should be lifted to encourage and enable expanded electric vehicle offerings. Given the diversity of applications described above, the government could also expand incentives for electrifying non-road vehicles like forklifts, tractors, and all-terrain vehicles.

Technology development
Despite its high visibility and growing deployments, e-mobility is still an emerging technology. The government should invest in early stage research and development to augment industry R&D programs in related technologies such as batteries, smart charging and vehicle-to-grid systems that aggregate EVs as a single resource. Additional work is needed to bring utilities, manufacturers and energy market participants together in order to remove technical barriers to commercialization. With the right level of leadership by government, the US can secure its position as a global leader in electric transportation technology and expertise.

Endnotes

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