



Low-Carbon Transportation Analysis on University of Michigan Campus



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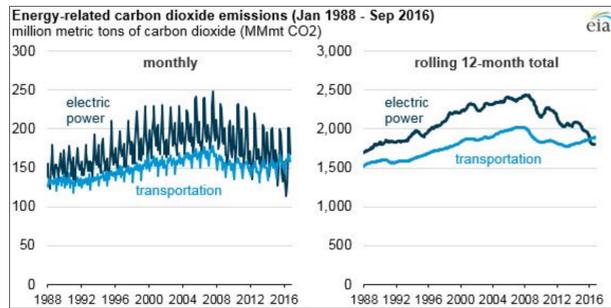
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1. Electrify U-M Transportation

In 2016, for the first time since the 1970's, US greenhouse gas emissions from the transportation sector were greater than those from the electricity sector. This speaks to the success of utility companies reducing the carbon intensity of their fuel mixes, as well as our failure to meaningfully reduce emissions from the ways we travel. Today, technology presents U-M with bold, tangible pathways it can take to create an electrified transportation system that helps U-M to meet its emissions targets, as well as improve the air quality on-campus in Ann Arbor. The focus of this research was to analyze these pathways to determine what the most feasible ways forward are for U-M from an economic and sustainability standpoint.

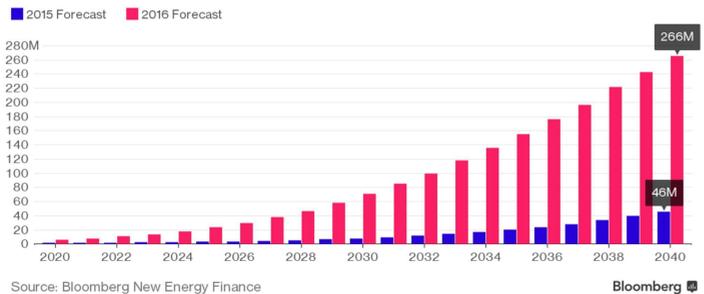


2. How will U-M plan ahead for electric vehicles (EV)?

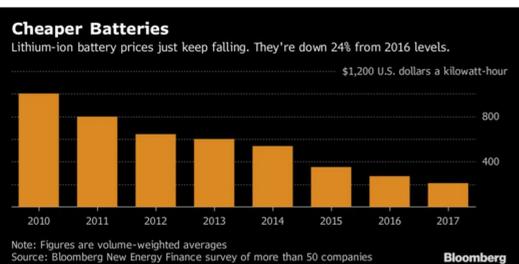
- OPEC boosted its EV sale forecast by 500% from 2015 to 2016 (70 million in 2030)
- Morgan Stanley 2017 predicted EV sales will outpace gasoline vehicles within two decades
- I.E.- U-M faculty and student cars will continue to become more electrified in the near future

Growing Expectations

OPEC's electric vehicle forecast grew by almost 500% last year



3. Main Driver: Decreasing Battery Storage Costs



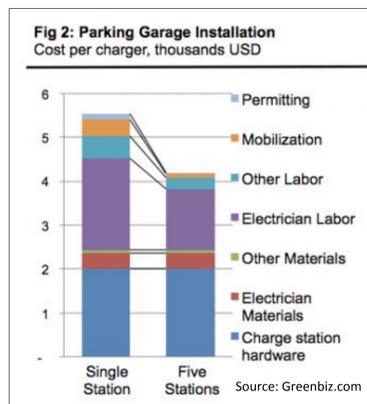
Every year, the price of batteries for electricity storage falls due to innovations in technology. Projected cost reductions look to make it economical by 2025, as the price of lithium-ion batteries falls below \$100/kWh.

- Batteries can help reduce costly peak load demand to save U-M money on its energy bills (peaking charges account for half of Ann Arbor's annual energy bill)
- Able to store energy from intermittent sources (solar and wind), allowing it to be utilized when there is the most demand
 - Zero emission energy drivers of electric vehicles
- Added energy security from batteries in case of blackouts, etc.

4. EV Infrastructure Case Study: Five Largest U-M Parking Lots

There is great potential for U-M to build solar-battery systems in parking lots to provide drivers with zero-emission energy. We modeled the solar energy potential for the five largest U-M parking lots and determined that 7,400 MWh could be produced every year without any loss of parking space. This is enough clean energy to power EVs for 22,769,000 miles, or for U-M faculty to make 1,138,000 commutes to work every year.

- Fuel efficiency of the 2018 Tesla Model 3 was assumed for these calculations, as well as 20% efficiency losses with battery storage.



- Since first Ann Arbor EV charging stations were built in 2010, demand has increased three-fold
- Only five new charging stations have been added
- Half of the EVs in Michigan are in Ann Arbor today
- U-M could charge by kWh or institute a small fee of \$.30-.70 for EV spots to make a profit
 - Base parking fee more than covers cost of electricity for EV stations in Ann Arbor today
- DTE has expressed interest in getting more involved in EV charging
- Zero-emission energy for U-M electric vehicles
- Great potential for research on microgrid efficiencies, etc.

5. Electrifying U-M's Bus Fleet

Electric buses are the future of public transit, and will provide zero-emission transport that is more efficient and more reliable than traditional combustion engines. As battery prices continue to fall and technology advances further, electric buses will continue to become more economically viable. CALSTART, a California non-profit, predicts that 50-60% of all bus purchases will be electric by 2030.

In 2012, the first U-M hybrid buses were introduced on campus, marking an important moment in reducing carbon emissions from public transit. As these buses begin to reach the end of their lifetimes in the next 5-10 years however, it is important that U-M continues to build upon this momentum and electrifies its bus fleet.

- Ability to reduce on-campus exposure of students and faculty to toxic pollutants from buses, such as NOx and SOx
- Electric buses eliminate 10 tons of NOx, 350 lbs of diesel particulate matter, and 1690 tons of CO2 over their lifetime (USDOT)
- While there is a higher initial capital cost for electric buses (Approximately \$300,000 more), fuel and maintenance costs are 50% less than diesel buses
- Zero emission buses more fuel efficient than diesel (USDOT)
- Significant decrease in noise pollution



What Other Localities Today Are Doing:

- Tallahassee, Florida received a \$1 million federal grant in 2017 to add 15 new electric buses to its fleet
 - Has a fast charging station: \$1.1 million cost, 15 miles in 5 minutes
- In 2016, Pomona, California announced that its 300 buses would be all electric by 2030
- Los Angeles County purchased 100 electric buses for \$138 million in 2017
- IndyGo, which serves the greater Indianapolis area, recently purchased 31 electric buses from BYD, with an option to add dozens more

6. Opportunities for collaboration with the City of Ann Arbor

Increasing integration between the transportation systems of U-M and the city of Ann Arbor can make future developments more economical and efficient for students and all other residents of Ann Arbor. Collaborating on projects such as a central electric charging station for buses or battery storage for emissions-free electric vehicle energy in the near future would help both parties decrease their carbon emissions, while also making development more affordable and investment less risky.



- U-M pays Ann Arbor \$4 million every year to allow students to ride on AA buses for free (money could be reallocated for other projects if the two bus systems integrated)
- City officials have expressed interest in working with U-M on large battery storage project (financial incentive to decrease peak demand load)

7. Proposals

We recommend the following for U-M as it works towards electrifying its transportation systems and reducing its carbon emissions:

- Increase the number of Electric Vehicle Charging Stations throughout Ann Arbor (particularly in parking garages) to accommodate rising demand for charging stations.
- Utilize U-M's solar energy resources to provide electric vehicles zero emission energy, through the construction of solar-battery charging systems.
- Move U-M fleet and buses towards an all-electric fleet, replacing existing gasoline/hybrid vehicles as they need to be decommissioned.
- Build a central charging station for electric buses and increase focus on integrating transportation systems with Ann Arbor to reduce costs and unify the public transit experience for Ann Arbor residents.

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- <https://www.transportation.gov/r2ze/benefits-zero-emission-buses>
- <https://www.greentechmedia.com/articles/read/everyone-is-revising-electric-vehicle-forecasts-upward#gs.fKoeRlk>
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