

2020 Hawaii Climate Conference
Lightening Talks
January 14, 2020
East-West Center

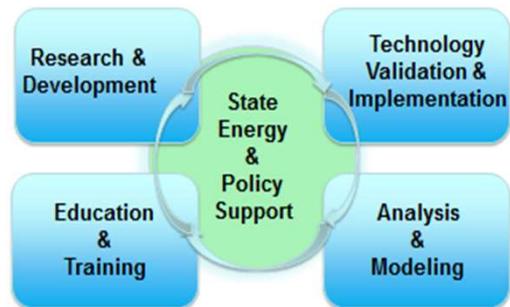
Katherine McKenzie, Hawaii Natural Energy
Institute, University of Hawaii
kamckenz@hawaii.edu

Hawaii Natural Energy Institute

- Organized Research Unit at the University of Hawaii
- Established by the Legislature in 2007
- HNEI leads significant public-private partnerships focused on the development, testing & evaluation of emerging energy technologies to reduce Hawaii's dependence on fossil fuels

Programs:

- **Alternate fuels**
- **Renewable generation**
- **Fuel cells & batteries**
- **Energy efficiency & Transportation**
- **Grid Integration**



Fact or Myth?



- Electric Vehicle (EV) cost?



- Electric power fuel and emissions in Hawaii?



- Manufacturing emissions?

- Battery second life?



To reduce petroleum imports to Hawaii and emissions from transportation, a shift is needed to energy efficient modes of travel – such as bicycling, walking and transit, and to reduce travel demand (e.g. reduce vehicle miles traveled, “smart” city planning, and remote work).

The focus of this presentation is on passenger vehicles, currently the largest source of petroleum use and emissions from ground transportation in Hawaii.

Fact or Myth?



- **Electric Vehicle (EV) cost?**



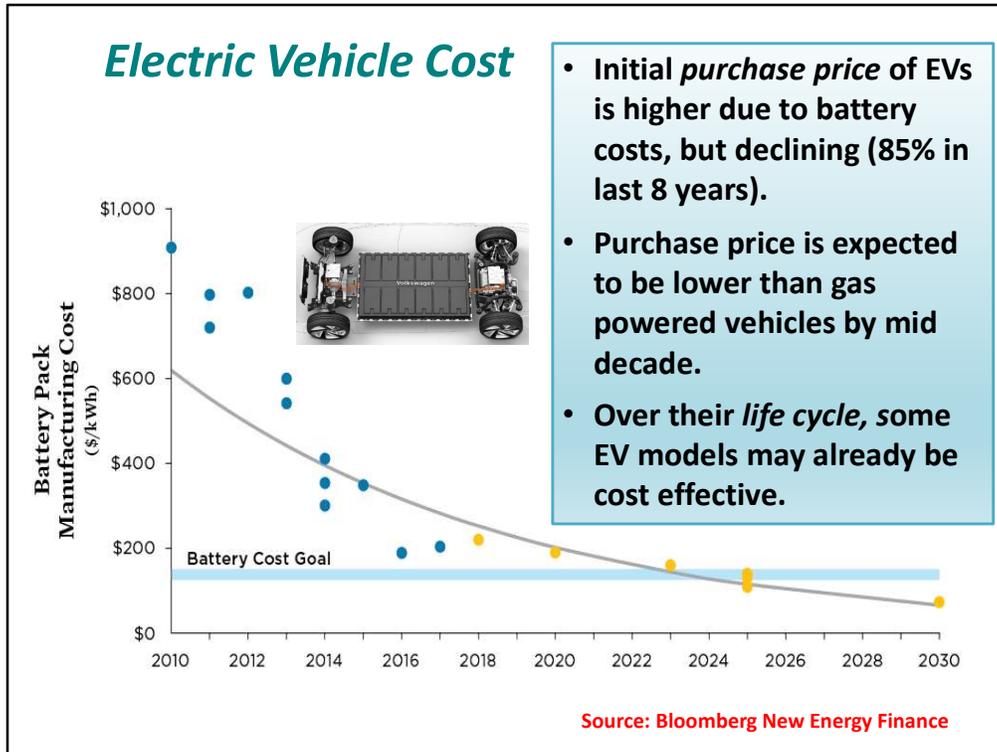
- **Electric power fuel and emissions in Hawaii?**



- **Manufacturing emissions?**

- **Battery second life?**





Purchase price of an EV comes down to the battery pack and is dropping rapidly – 85% in the past 8 years*. *Over the life* of the vehicle however it may be already more cost effective to own and operate an EV**, depending on the model and use, because of the low maintenance and fueling costs. In addition, low electricity rates are available from Hawaiian Electric Companies during daylight hours.

References:

*"Where 3 Million Electric Vehicle Batteries Will Go When They Retire", Bloomberg Business Week, June 2018.

**"Electric Vehicle Lifecycle Cost Assessment for Hawaii", Makena Coffman, University of Hawaii Economic Research Organization, for Hawaii Natural Energy Institute, Electric Vehicle Transportation Center study, September 2015.

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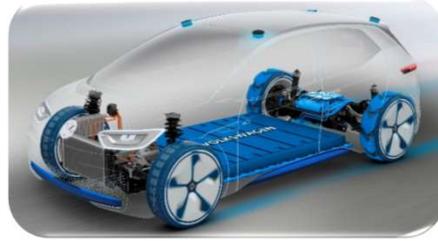
Fossil fuels are still used to generate electricity in Hawaii, so are electric vehicles any better than gasoline?

Energy Efficient

Gasoline vehicles only convert about 17%–21% of the energy stored in gasoline to power at the wheels.



EVs convert over 77% of the electrical energy from the grid to power at the wheels.



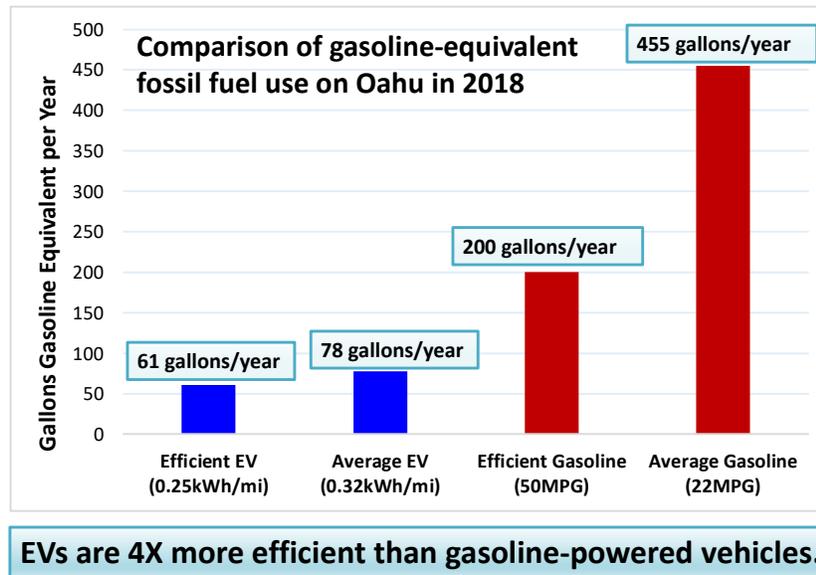
Source: US Department of Energy.

Only 17-21% of the energy in gasoline gets used to move the car down the road. Most of the energy is lost in the engine and drivetrain, mainly from thermal losses. EVs by contrast make use of over 77% of the energy from the power grid to move the vehicle down the road.

So EVs are 4 X more efficient.

Source: US Department of Energy, FuelEconomy.gov

Fossil Fuel Use on Oahu In 2018



This shows the amount of gasoline used for a year and the equivalent amount of fossil fuel used for EVs from the 2018 Oahu power grid*. We're looking at Oahu, because the neighbor islands have more renewables on their power grids – so even less fossil fuels are used by EVs powered on the neighbor islands (so the blue bars will be smaller yet). **Why is this so important in Hawaii especially?**

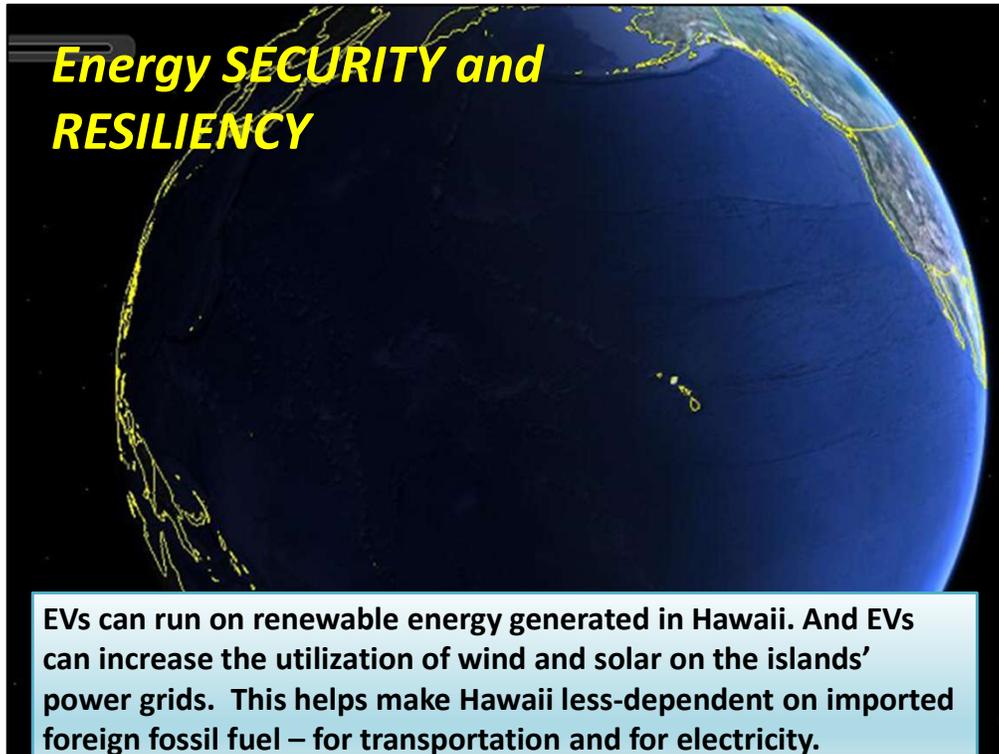
*References:

US Energy Information Administration,

EIA923_Schedules_2_3_4_5_M_12_2018_Early_Release.

Oahu total power generation in MWh in 2018, 81.4% coal and oil.

Gasoline 0.114 MMBtu/gallon.

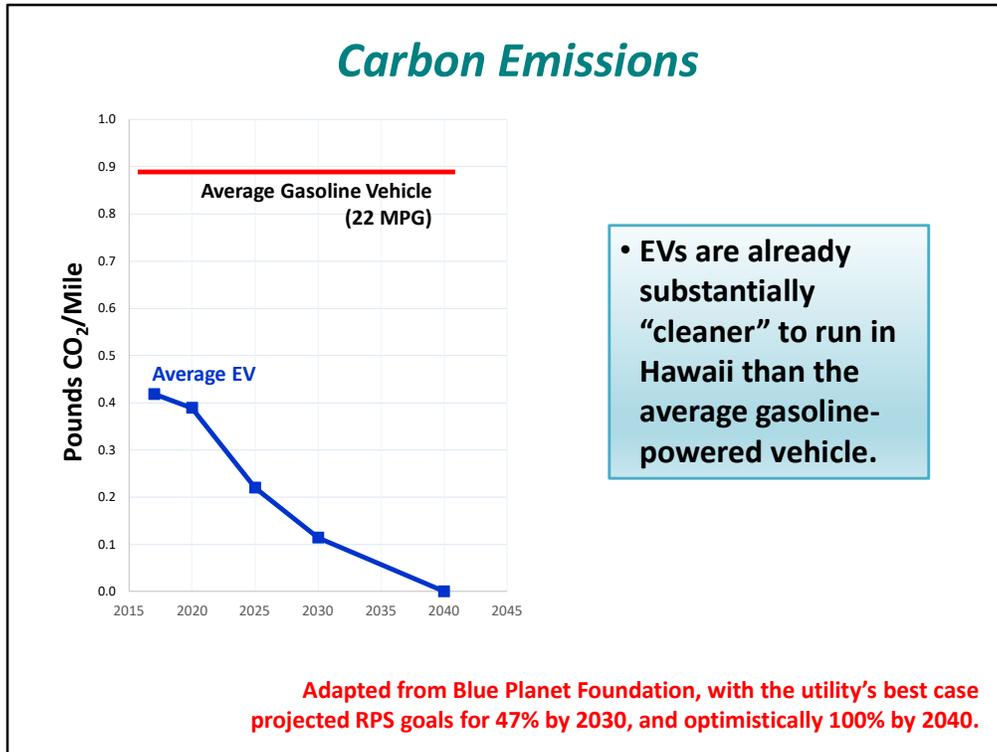


To reduce imported fossil fuel for transportation *and* for electricity, since EVs can be powered by renewables and can help increase the amount of wind and solar on the power grid*.

*References:

“Strategic Use of Electric Vehicle Charging To Reduce Renewable Energy Curtailment on Oahu”, Katherine McKenzie, Hawaii Natural Energy Institute, for State of Hawai‘i, Department of Business, Economic Development and Tourism , 2013,
<https://www.hnei.hawaii.edu/sites/www.hnei.hawaii.edu/files/Strategic%20Use%20of%20EV%20Charging%20to%20Reduce%20Curtailment.pdf>

“Oahu Electric Vehicle Charging Study: Mitigating Curtailed Renewable Energy on Oahu” GE Energy Consulting, for Hawaii Natural Energy Institute, 2013,
<https://www.hnei.hawaii.edu/sites/www.hnei.hawaii.edu/files/Oahu%20EV%20Charging%20Study.pdf>



Looking at CO₂ emissions from combustion in Hawaii – either burning fuel at the power plant or in the vehicle. Comparing an average gasoline* vehicle and an average EV** in Hawaii, an EV produces half as much CO₂ emissions, and emissions are decreasing. This is just one scenario looking forward, adapted from Blue Planet Foundation, with the projected RPS goals from Hawaiian Electric going to 47% by 2030, and 100% renewables by 2040.

This is a rich area for future work, such as extending this to encompass life cycle emissions. For example, biodiesel, which is produced in Hawaii, has 74% less GHG emission from its life cycle compared with petroleum diesel***.

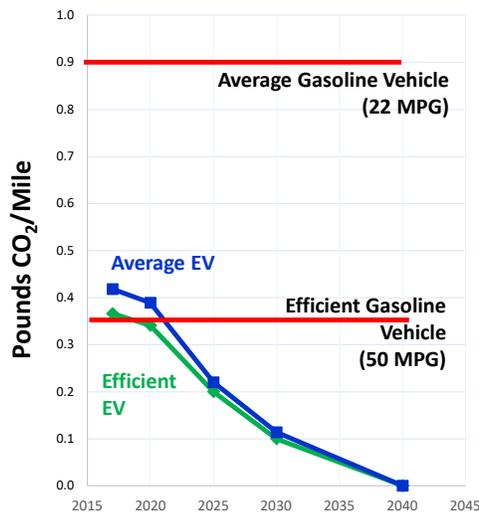
References/data:

*US Department of Transportation, average light duty (passenger) vehicle 22MPG (most recent data, 2016).

** Hawaii Auto Dealers Association, summer 2019 newsletter, vehicle sales.

*** Argonne National Laboratory, life cycle analysis found that emissions for 100% biodiesel (B100) are 74% lower than those from petroleum diesel. The California Air Resources Board has reported similar values for its life cycle analysis of biodiesel from various sources. (Sourced from: https://afdc.energy.gov/vehicles/diesels_emissions.html)

Carbon Emissions



- As the electric grids become cleaner ... so do the EVs powered by those electric grids.
- In 2018, even on Oahu, efficient EVs surpassed efficient (50 MPG) gas-powered vehicles.

Adapted from Blue Planet Foundation, with the utility's best case projected RPS goals for 47% by 2030, and optimistically 100% by 2040

Adding to this graph, (adapted from Blue Planet Foundation, with the projected RPS goals from Hawaiian Electric), an efficient gasoline-powered vehicle (50MPG) and an efficient EV in Hawaii, shows even better reduction of CO₂ emissions.

Even on Oahu it was a turning point in 2018 – an efficient EV produced less emission than an efficient gasoline-powered vehicle*. Since the source of the emissions is at the power plant, even old EVs become cleaner as the power grid becomes cleaner. Over the life of the vehicle, EVs will continue to produce less emissions. Clearly if EVs are run on solar energy, you're already at zero emissions – they're running on sunshine ☺

*References/data:

U.S. Energy Information Administration,
https://www.eia.gov/environment/emissions/co2_vol_mass.php.

US Energy Information Administration,
 EIA923_Schedules_2_3_4_5_M_12_2018_Early_Release.

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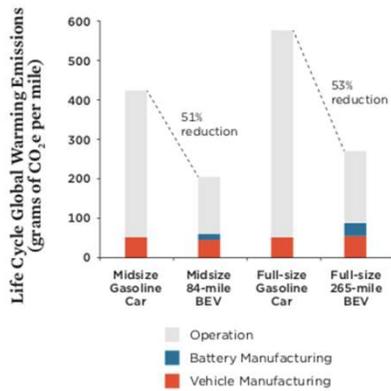
- **Manufacturing emissions?**

- Battery second life?



Manufacturing Emissions

FIGURE ES-2. Life Cycle Global Warming Emissions from the Manufacturing and Operation of Gasoline and Battery-Electric Vehicles



- Total life cycle GHG emissions by EVs are less than 50% that of gasoline vehicles.
- EV battery manufacturing GHG emissions are offset within 6 months to 2 years, depending on local electricity production.

Union of Concerned Scientists
Science for a Healthy Planet and Safer World

icct THE INTERNATIONAL COUNCIL ON
Clean Transportation

Numerous studies have now shown that over the life cycle of manufacturing and operation of the EV, they produce less than half the GHG emissions compared with gasoline vehicles*. In other words, the manufacturing emissions are offset within the first 6 months to 2 years of driving*.

*References:

UCS: "Cleaner Cars From Cradle to Grave", 2015.

ICCT: "Effects of Battery Manufacturing on Life-Cycle Greenhouse Gas Emissions", 2018.

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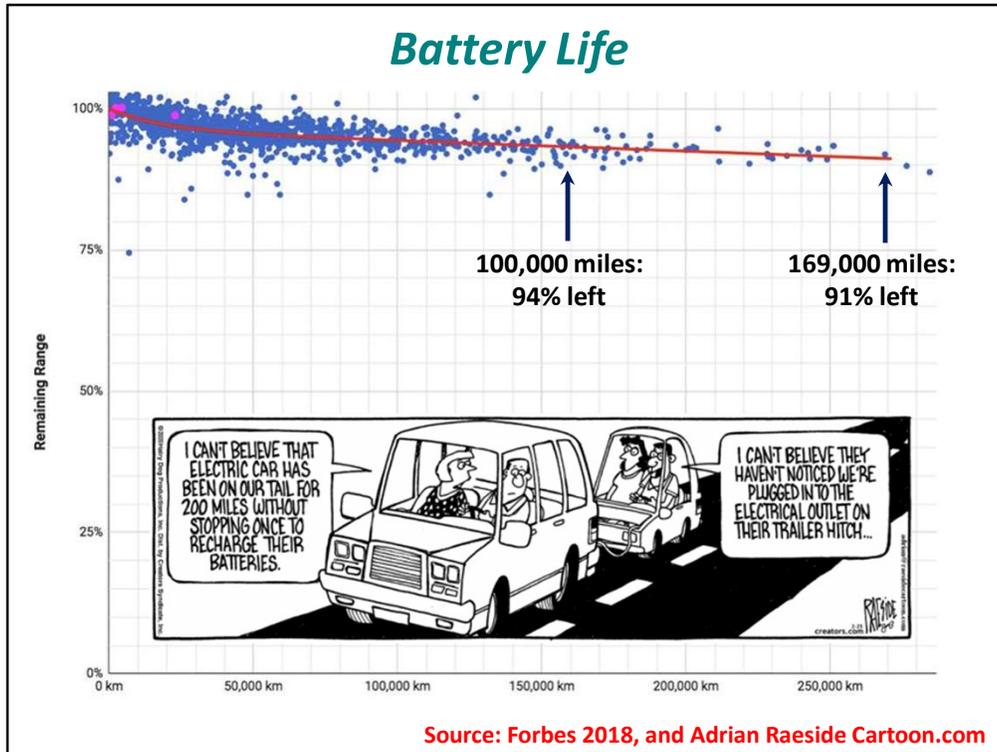


- Manufacturing emissions?

- **Battery second life?**



At the end of the serviceable life for transportation, can the battery be reused before it's recycled?



EV battery life is much longer than expected.

Recent data published by Forbes* for one manufacturer’s batteries, show that even after 169,000 miles the battery has lost less than 10% of its capacity.

Reference:

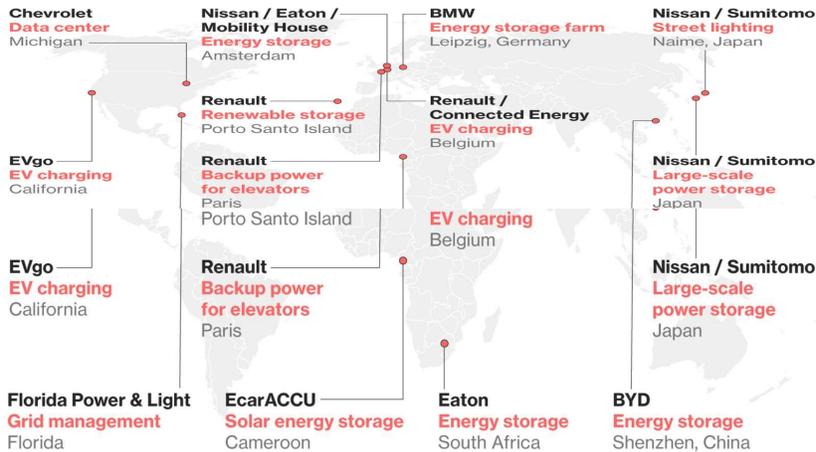
*Forbes, “Seven Reasons Why The Internal Combustion Engine Is A Dead Man Walking [Updated]”

Tom Raftery, Sep 6, 2018, <https://www.forbes.com/sites/sap/2018/09/06/seven-reasons-why-the-internal-combustion-engine-is-a-dead-man-walking-updated/#5ad523b4603f>

Battery Second-life projects

A New Lease on Life

Where electric-vehicle batteries are being used and tested for new roles



Source: Bloomberg New Energy Finance, 2018

When the battery gets down to 70 to 80% capacity, it can be used for other applications, such as stationary energy storage. Globally there are a host of new demonstration and commercial applications rapidly coming online*. This can provide an additional revenue stream. **Hawaii is a haven for renewable energy testing and demonstration, and into the future we'll need more energy storage as we add more wind and solar to the power grid.**

Reference:

*Bloomberg New Energy Finance, 2018

<https://www.bloomberg.com/news/features/2018-06-27/where-3-million-electric-vehicle-batteries-will-go-when-they-retire>

Fact or Myth?

Performance – acceleration, speed, handling, quiet, towing capacity...



EVs simply have better performance! Often what drives the purchase decision.

Speed and Acceleration

Qantas Boeing 737 vs. Tesla Model S



Source: <http://bit.ly/QantasvTesla>

To raise awareness and drive innovation and sustainability in the transport industry, Qantas partnered with Tesla and raced a Boeing 737 jet against a Model S. (“Qantas vs Tesla”, On You Tube.)

Towing Capacity

Tesla Model X towing Qantas 787



Source: <https://www.youtube.com/watch?v=rvk4fNxF0I4>

SUV towing a Qantas Dreamliner (Boeing 787-9). (“That time we towed a plane with a Tesla”, May 14, 2018, On You Tube.)



In summary, we need to consider the life-cycle cost when purchasing vehicles, we can expect the purchase price to be not only competitive in 2 or 3 years but to under-cut gasoline vehicles by mid-decade. In Hawaii, EVs use 4X less fossil fuel now, already produce less emissions, and with more renewables on the power grids into the future, EVs will continue to use less fossil fuels and produce less emissions.