

Aloha! Welcome to our Class on Electric Vehicles on Kauai

## Introduction

My name is Sonja Kass, I am part of the KauaiEV group; we are convinced that electric vehicles are the personal transportation of the future. We want to provide information and solutions for electric vehicle drivers and for everyone who is considering purchasing an Electric Vehicle (or EV).

Recently, we are also trying to have a very open dialogue with owners of public charging stations, and convince properties to install them.

Lots of information about electric vehicles is available on the Internet, but this class is specific to Kaua'i - I'm trying to provide answers to questions such as "Where do I buy a new or used Electric Vehicle? Where do I charge? What are the benefits? What about our Utility KIUC, and the local grid?"

## Show and Tell

If we look at a Nissan Leaf, that's towards the low end EV. My favorite car IS the Tesla Model S towards the high end, they have a few things in common:

Both are quiet, fun and easy to drive, accelerate fast and have way fewer moving parts than an Internal Combustion Engine car (abbreviated ICE or ice). They are smooth and quiet, and their high torque, even at low speeds, provides instant accelerator response.

EVs have no transmission, no timing belt, no fuel injection system, no oil to change, no alternator,... The drivetrain in an ICE (Internal Combustion Engine) vehicle contains 1,000 to 2,000+ moving parts typically, and the drivetrain in an EV contains 20 to 100. This causes a lot less maintenance and less money spent, and the EVs are much more reliable.

The brakes last much longer because almost all braking (except emergency breaking) is regenerative, using the motor as a generator to pull rotational energy out of the wheels and store it back into the batteries.

## Types of EVs and Hybrids

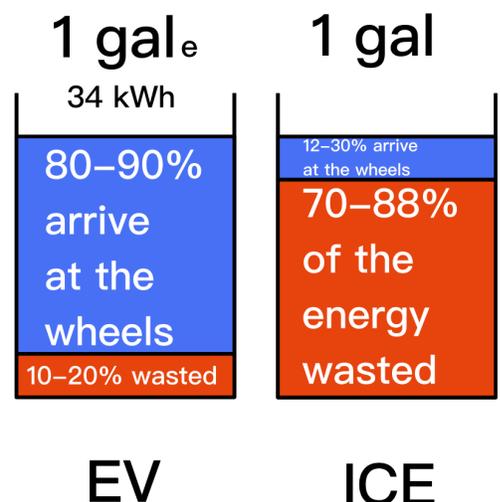
Electric vehicles get all or part of their power from electricity supplied by the electric grid. They are powered by electric motors and receive electricity by plugging into the grid and store it in batteries.

- Fully electric cars such as the Leaf, Tesla, Chevy Bolt have only batteries and electric motors. They consume no petroleum-based fuel and produce no tailpipe emissions. Sometimes called battery-electric vehicles (BEVs) or all-electric vehicles (AEVs).
- [Fuel Cell Electric Vehicles \(FCEVs\)](#) take hydrogen and generate electricity to run an electric motor. They do not have tailpipe emissions either, but these cannot be refueled on Kauai and won't be covered.
- EREVs or extended-range electric vehicles like the BMW i3 (150 electric miles) or the Chevy Volt (50 electric miles) also have an internal combustion engine, but only acting as a generator to recharge the battery when it is depleted. The electric motor always drives the wheels (although that is a bit oversimplified). Less maintenance than a regular plug-in hybrid for sure, their owners love them. Whenever I travel and need more than public transportation, I try to rent a Chevy Volt ([turo.com](http://turo.com)). Sadly Chevrolet stopped making the Volt, but is now starting to build other cars on the same principle. Wikipedia has a great page on EREVs.
- PHEVs or plug-in hybrids have medium-sized batteries to power an electric motor, plug into the electric grid to charge, and also have internal combustion engine (ICE) and its drive train/transmission. They go from 10-50 miles electric before driving on gas.
- Regular hybrids have batteries and electric motors, but you cannot charge them, only put gas in them. They use regenerative braking and the alternator to charge the battery, and they can go slow on electric, for example in a parking lot. They are now marketing these as "self-charging hybrid." Other brands are calling their cars "electrified" but they are the same as hybrids. Hybrids are more efficient gas cars, but they still produce tailpipe emissions.

In my opinion pure EVs are the best because there is a lot less maintenance. Internal combustion engines (ICE) and their drive trains traditionally need a lot of maintenance and some batteries don't age well, so you can get into double-trouble. Both systems add weight and need space, so often you end up with smaller parts and harder maintenance. Of course it also depends on other factors, like your daily commute, and ability to charge where you live.

## Efficiency

Most electric vehicles go 110 to 180 miles per gallon equivalent ( 3.2-5.3 miles/kWh) makes EV's cleaner, even if they are run on coal electricity (links below) - and KIUC's grid is 55% renewables on average. Because we have a climate better suited for EVs than places where it gets very hot (like Phoenix, AZ) or very cold (like Canada) we get much better range and battery life in Hawaii.



The measurement of “miles per gallon equivalent” (MPGe) is a solution federal agencies decided upon a few years ago to help shoppers compare energy costs for plug-in vehicles to fuel costs for conventional vehicles.

In brief, MPGe represents the number of miles a vehicle can travel using a quantity of “fuel” – actually electricity – with the same energy content as one gallon of gasoline. A gallon of gasoline is roughly equal to 34 kilowatt-hours of battery power.

Another way to look at it is how far can I go per dollar, compared to gasoline cars. The cost to put electricity from KIUC in a Leaf is about the same as gasoline in a hybrid car (for example a Prius that gets 40-50 miles per gallon). One dollar is 3 kWh or 12-15 miles, same as one dollar is 1/4 gallon, which is 10-12 miles.

If you have solar panels on your house, a typical kWh costs you about 10 cents. So one dollar is 10 kWh or 40-50 miles. At \$4 per gallon, that is like 160-200 miles per gallon-dollar equivalent.

## **Range, Range Anxiety, and Uphills**

A 2014-2016 Nissan Leaf or Kia Soul with an OK battery (20-24kWh) will get you anywhere on Kauai and back if you live between Puhi and Anahola, with the exception of Kokee. In 2016 for some Leaf models, 2017 for all and 2018 for Kia they switched to a bigger battery (30kWh) that can make it up to Kokee from Kapaa, to the Kalalau lookout and back.

All 2019 EVs have better ranges than the previous generations, 8 EVs have a range above 200 miles, among them the Leaf Plus, Chevy Bolt (not serviceable on Kauai, need to buy on Oahu), Kia Niro, Hyundai Kona and Tesla model 3 (buy online, but serviceable on Kauai, mechanic comes over if needed).

There are older, used EVs on Kauai with 40-50 mile range. For some people it's perfectly fine, if they don't drive much, or have a second car, or can plug in at home and at work. These cars can be fairly cheap on craigslist.

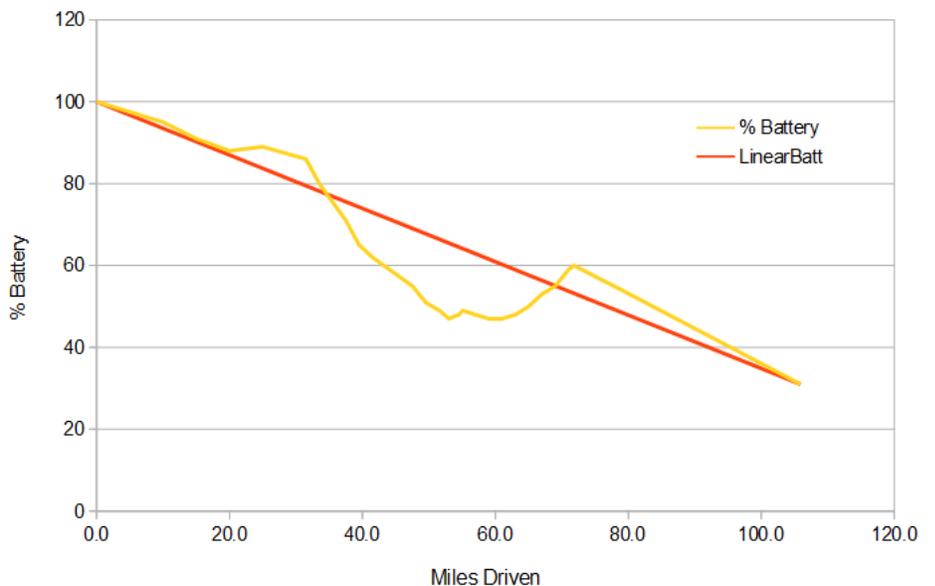
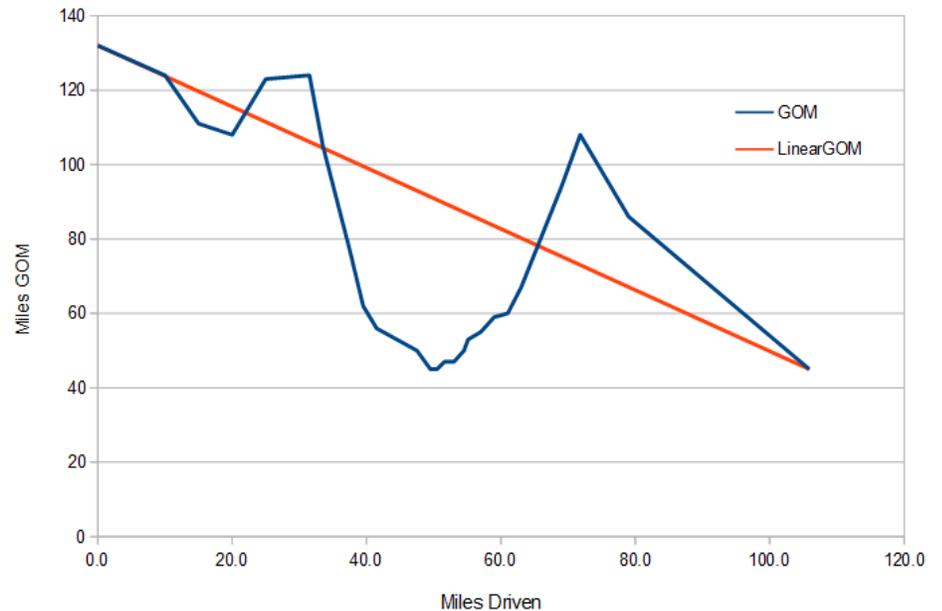
Going uphill uses more energy and the range displayed on the dash goes down faster. But going downhill later is like coasting, and even recharges the battery with regeneration, which makes the range go up again. None of the hills around the island (such as Kalaheo and Moloa'a) really make much of a difference when driving.

The exception is the going up to Kokee State Park, and the Kalalau lookout. If you want to make it all 17 miles and 4000 feet up to the top, you need to have enough charge as if it were 40 miles of flat driving. However, when you go downhill, you coast and regenerate the extra miles, so in the end it is almost like flat driving. With chargers in Waimea now, you can recharge before or after the hill if needed.

To the right are 2 graphs of the drive up and down Waimea Canyon in a 2017 Nissan Leaf, with a 30 kWh battery.

The GOM (guess-o-meter, graph above) reports how many miles the computer estimates are left to drive, based on the last 5 miles or so, resulting in some bad guesses.

The battery levels as a percentage (graph below) is a much more reliable number once one gets to know their car.



People often ask me: “With such a small range, don’t you run out of charge?” - Neither my husband, nor I have ever ran out of charge since we drive EVs, for the last 5 years. BUT. I ran out of gas 5 times before I reached 25. Eventually we all learn to pay attention to the meters and warning lights and at least when our car starts talking to us, about the need to charge.

You do need to plan your trips though. Don’t drive 20 miles to Princeville if you have only have 20 miles of range. Second, the car warns you when there are 12-15 miles of regular driving left. When you get to the last 10 miles, you should find a charger or just a place you can plug in. This can be a friend’s house or business where you can ask to plug in, some parks have outlets in the restrooms. You might need a ride to go home and get your charging cable.

If you keep going until 5 or less miles left, the car will go into turtle mode (at least the Leaf does): it slows to a crawl which allows you to get off the road and park it. The car won't drive anymore to keep you from discharging the battery dangerously low. You have several options:

- Reach out to the KauaiEV group, on Facebook or by calling 652-0591, maybe one of us is nearby and can help.
- Plug in with a long extension cord if there is any building nearby. You'll need to ask the owner and offer to pay for the electricity.
- Have a friend with a truck bring a generator and charge that way.
- Have the car towed to a charger or home, some manufacturers include this service like roadside assistance.

## Battery

All rechargeable batteries lose capacity as the number of charges increases. In our 2015 Leaf (bought in 2014, so 5 years old) we lost about 10 miles of useable range, so around 2 miles per year/10,000 miles driven so far. However, it's not linear, it loses less capacity when new, and may lose more as we use it.

There are differences in battery quality and technology between manufacturers. In Teslas, there is very little battery degradation, because they actively heat or cool the battery as needed. Of course it results in higher prices, quality usually does.

For the batteries without thermal management like the Leaf, following a few basic rules can prolong battery life. Charging in the shade is better, as hot outside temperatures add to the heat generated by charging itself. Stop charging around 80% unless you really need a full charge right away is another way to prolong a battery's life. The faster the battery charges, the hotter it will get (more current means more heat). Luckily we don't have a fast charger on Kauai. Just kidding it would be awesome if we had one, I'll talk more about charging later.

Replacement batteries: In North America the price for Nissan Leaf replacement batteries was raised to over \$8000 from around \$5000 recently. Nissan does not sell refurbished batteries in the US (but sells them for the equivalent of \$3000 in Japan).

In general, there are not enough failing batteries yet for a big manufacturer to develop knock-off batteries, but several startups are working on new battery packs and range upgrades for older EVs. China manufactures batteries for about \$100 per kWh. Here at KCC, they are trying to develop courses to teach mechanics how to refurbish EV batteries.

## Public Charging

There are public chargers in Princeville, Kapaa, lots in Lihue, Puhi, and Waimea. If you live north or west/south, you can drive to Lihue and charge up before going home. If you live on the East side, you can drive north or west and charge if needed.

Some chargers are totally free to use, others are free for an hour or two, others require payment by the hour or kilowatt.

3 apps on a smartphone really help to get an overview about the Kauai charging situation:

- Plugshare (there is also a plugshare map on <http://kauaiev.org/chargers/> ) has the most comprehensive and up-to-date database of electric vehicle charging stations in North America. It's a crowd-sourced map that includes all brands of charging stations. It gives EV owners the ability to add, review, and edit station information, report them occupied or broken and also gets data from the charger networks.
- The ChargePoint and the SemaConnect app are brand / network specific, I use these for paying, although recently people have reported paying via Plugshare, and that works well too.

If your EV has a GPS and map display, it will also remember where you charge and display those locations on the map.

In general I tell people not to expect free charging on Kauai for much longer, more and more station owners charge for usage. It is not easy for renters, people who live in condos or off grid or can't charge at home for other reasons. There are too many people dependent on the public chargers at the moment, and too many who just like to charge for free. There have been bad arguments between EV drivers, and with facility managers or station owners. If you rent long term, talk to your landlord or try to see if any of your neighbors are open to the idea of letting you charge. It's easy to see how many kWh were used, and pay only for what you use.

There are several new chargers every year. Fortunately at the moment there are grants available for business owners to install more of them. 4 new ones were installed or turned on recently, West Kauai Tech Center in Waimea, Coconut Marketplace and Big Save in Kapaa, and Rice Street Shopping center.

- Lihue has many chargers, the county allows the public to use several of theirs for free, so does the Home Depot, Kukui Grove is free for two hours. Hokulei Village chargers and other chargers in Lihue cost between 33c (Costco) and 70c (Walmart) per kWh.
- The South side has only hotel-owned chargers that are sometimes made available in an emergency.
- Waimea has 2 chargers, one at the West Kauai Technology Center, one at the Baptist church across the street.

- Princeville has 2 chargers behind the Princeville shopping center and several at the Westin.
- Kapaa has only 2 chargers at the Safeway shopping center, hopefully the new ones at Big Save and Coconut Marketplace will come online soon.

Kauai has no fast chargers, super chargers, or DC chargers (Level 3 chargers). The maximum at the moment is 6.6 kW every hour, filling the 24 kWh battery (about 100 miles if driven conservatively or in eco mode on Kauai) of an old Leaf in 4 hours, and a 60 kWh battery in 10 hours (about 240 miles, I don't have Kauai specific numbers). It also depends on your car: some charge at 30 miles per hour, others at 15 miles per hour.

## Home Chargers

People often ask: Do I need a charger at home? Is it expensive? Who installs it?

One can use the Level 1 "trickle charger" that comes with the vehicle and plugs into a normal outlet (110V). It adds about 1 kWh or 5 miles per hour. Most charging cables can be modified to double that if plugged into a dryer outlet (220-240 V). It does need to be a dedicated outlet on a dedicated circuit (not plugging and unplugging all the time), and an engineer or electrician needs to make the modification of the cable.

A wall-mounted Level 2 charger will usually charge between 3.3 to 6.6 kWh depending on your car, or up to 17 kWh (80 Amps) for Teslas. This adds 15-30 miles hour, up to 60 miles per hour for Teslas. Most standard wall chargers are between \$400 and \$800, with parts and labor about \$1500 to install a dedicated 220V circuit and breaker box. If you get solar PV, some Kauai installers include the installation of an EV charger in the price.

I think all electricians should know how to install it, here is a list of Tesla installers:  
<https://www.tesla.com/support/find-electrician>

If you have solar PV electricity, there is a special charger you can buy that monitors your energy export and charges the car from that surplus. That way it adjusts the charging if you have more or less output, for example if it gets cloudy. For example  
<https://myenergi.com/product/zappi/>

Wall-mounted Level 2 chargers also qualify for a 30% tax credit (up to \$1000).

Just to add a technical term here: Chargers are sometimes referred to as EVSE (electric vehicle supply equipment).

## **KIUC and the grid, or how clean is the electricity we run on**

I'll start by saying - once more - the efficiency of the electric motor makes our EVs cleaner than gas cars, even if they are run on pure coal electricity (sources below) BUT: When we plug in an EV into a cleaner grid, even less greenhouse gasses are released per mile driven. And it's almost none if we are lucky enough to be able to plug it directly into our own solar PV.

In 2019, roughly 55 percent of the electricity generated on Kauai is coming from renewable resources, up from 8 percent in 2010. (12.7 million gallons of fossil fuel avoided 2018). On most sunny days, 90 percent or more of Kauai's daytime energy comes from renewable sources, and their solar farms contain batteries to store the solar energy produced during the day and release it in the evening.

In 2017 KIUC added the world's largest utility-scale solar plus battery storage generation facility, the Tesla plant near Wailua Falls, and early 2019 they added one twice that size in Lawai. The combined total is 150 MWh, this covers forty percent of Kauai's evening peak load or would be enough to drive 500,000 - 800,000 miles in Electric Vehicles.

KIUC, Kauai Island Utility Cooperative is very proactive in the use of renewable energy and was recognized by the Smart Electric Power Association (SEPA) as top utility in the nation for annually added energy storage (batteries) per customer both in 2018 and 2019. Going forward, KIUC has committed to using solar, biomass and hydropower to produce at least 70 percent of the island's electricity by 2030, 100% by 2045 and are well on track.

We are hoping that one day there will be enough chargers on Kauai that all the plugged in EVs can also act like one big battery, charging or releasing back to the grid as needed. Japan is on the forefront with the research.

<http://website.kiuc.coop/annual-reports>  
<https://sepapower.org/2019-top-10-winners/>

## **Cost and Range or Which EV is right for me?**

Where do you live, where do you want to go? Can you charge while at work?

Cost varies enormously, as with gas cars as well, sometimes one can find an older Leaf with a new battery for \$6,000 (as I'm writing that, I'm looking at a 2011 model with new battery pack and 105 mile range, available for \$6,700 on Oahu). The reason they are so cheap is that the rebates trickle down into the used car market.

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Niro, Hyundai Kona and Tesla model 3 (buy online, but serviceable on Kauai, mechanic comes over if needed). They start from \$35,000 to \$40,000 (more for the better trims) and many makes still qualify for the \$7,500 federal tax rebate. <https://plugstar.com>

At the moment, KIUC members who buy a 2019 LEAF receive a \$3,500 rebate. Combining the special rebate and \$7,500 in federal tax incentives, this is an \$11,000 savings over the MSRP, more info is available on their website: [www.kiuc.coop](http://www.kiuc.coop). The offer is valid through September 30, 2019. The flyer can be downloaded at <http://website.kiuc.coop/sites/kiuc/files/documents/pr2019-0719-NissanLeafRebate%20flyer.pdf>

If you want to buy, keep watching for rebates, especially when they change model years and styles. The old Leaf had a \$10K rebate before they introduced the new Leaf.

## Renting an EV to test the experience

Whenever I travel and need a car, I rent an EV or EREV on [turo.com](http://turo.com), like AirBnB for cars. This is an excellent way to familiarize yourself with a new car. On Kauai there is also an EV rental company "Mission Zero Hawaii" - renting one at home will additionally give you more insight in the public charging situation.

Or - if you are interested in a particular car, it's good to go to specific EV forums and Facebook groups to read what their owners have to say. Also, every September since 2015 there have been EV Ride&Drives or EV festivals where EV owners talk story with people who are curious. An EV festival is coming up in Kilauea, on Sept. 21 at Anaina Hou, 9 different EVs are registered so far.

If you want to test-drive a Leaf see me after class, or email me later, more than 40 people tried my 2015 Leaf. We can't leave from KCC though, we can't even take people for a ride.

## Where to Buy New Cars

Kuhio employs the only Blue Planet certified EV experts! Kudos, to them, 7 of their salespeople are certified now <https://www.stchawaii.org/find-an-ev-expert/kuhio-auto-group/>

Personally I have dealt with Ben Salud and Steven Shioi, both were very knowledgeable even before they got certified. They usually have Nissan Leafs in stock. Sadly, last time I inquired they were still not selling or servicing the Chevy Bolt, which is a big loss for Kauai. According to Kuhio it has to do with Chevrolet policy, and with them not expecting to sell enough of them to ever recover the initial investment.

Not certified, but also super knowledgeable about EVs is the Aloha Kia sales team. They usually have a few Kia Niro EVs on their lot, and used Kia Soul EVs.

If you need something bigger, King Auto Center sells a plug-in Minivan, the [2019 Chrysler Pacifica Hybrid - Fuel Efficient Minivan](#) it has an electric range of 32 miles.

Servco often has Plug-in Priuses. Toyota itself is now playing catch-up in developing fully electric vehicles. After decades of touting their “self charging” hybrid vehicles, “electrified cars” and betting on hydrogen, Toyota now has to throw its considerable resources at developing electric vehicles. (as of Summer 2019)

## Where to Buy Used Cars

Both Garden Island Auto Sales and Ohana Motors usually have a few used Leafs and sometime other electric vehicles on their lots. Craigslist is the best option for personal sales. If you want more choice, Oahu is another possibility, and a bit cheaper (but consider that you pay for plane tickets, \$300 to ship the car over, and maybe a hotel).

## Contacts and More Classes

I hope to continue to talk about EVs on Kauai the second Tuesday of the month. This class is a collaboration of KCC OCET, the Kauai Makerspace and KauaiEV.

Please contact KCC OCET through their website <https://www.kauai.hawaii.edu/ocet> or call (808) 245-8318 if you are interested in this or any of the other great classes offered.

KauaiEV's website is <http://kauaiev.org> On Facebook we post on the page <https://www.facebook.com/KauaiEV/> and moderate the group <https://www.facebook.com/groups/KauaiEV/>

My name is Sonja Kass, I am an engineer, a 16 year Kauai resident and a founding member of the Kauai EV club. I am passionate about sustainable transportation and have been driving exclusively electric since 2014. As a member of the Kauai Makerspace I am working on solutions to make Kauai more sustainable and enjoying the creative process. If you need to reach me email [sonja\\_and\\_andy@yahoo.com](mailto:sonja_and_andy@yahoo.com) or call or text 808-652-0591 Please feel free to contact me if you need guidance, would like to ride, or drive a Nissan Leaf without sales pressure or have more questions about EVs, just remind me you took this class.

The sign up on our Kauai Makerspace website is <http://kauaimakerspace.org/mission-and-vision/> . We also post regularly on our Facebook page <https://www.facebook.com/KauaiMakerspace>, please “like” or follow us.

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## Sources and Useful Links

<https://www.forbes.com/sites/sap/2018/09/06/seven-reasons-why-the-internal-combustion-engine-is-a-dead-man-walking-updated/#7a2cd1ac603f>

[www.kiuc.coop](http://www.kiuc.coop)

<http://website.kiuc.coop/sites/kiuc/files/documents/pr2019-0719->

[NissanLeafRebate%20flyer.pdf](#)

<https://www.thezebra.com/how-electric-car-works/>

### **Nissan Leaf forums:**

<https://www.mynissanleaf.com/viewforum.php>

<https://www.reddit.com/r/leaf/>

### **EVs are cleaner when on coal too:**

[https://www.greencarreports.com/news/1121222\\_dont-worry-about-coal-electric-cars-are-still-cleaner](https://www.greencarreports.com/news/1121222_dont-worry-about-coal-electric-cars-are-still-cleaner)

<https://www.bloomberg.com/news/articles/2019-01-15/electric-cars-seen-getting-cleaner-even-where-grids-rely-on-coal>

(<https://www.forbes.com/sites/energyinnovation/2018/03/14/charging-an-electric-vehicle-is-far-cleaner-than-driving-on-gasoline-everywhere-in-america/#73448c6071f8>)

**Why ICE cars are so inefficient:** <https://www.fueleconomy.gov/feg/atv.shtml>

<http://energy.hawaii.gov/testbeds-initiatives/ev-ready-program/state-and-federal-laws-incentives>

<https://afdc.energy.gov/laws/6566>

<https://www.ucsus.org/sites/default/files/attach/2019/08/sm19-ADVANCES.pdf>

<https://blueplanetfoundation.org>

<http://driveelectricchi.com/>

<https://www.stchawaii.org/>

<https://www.eia.gov/state/analysis.php?sid=HI> “Isolated by the Pacific Ocean, Hawaii is the most petroleum-dependent state in the nation. “

### **How to use the Plugshare app:**

<https://www.plugincars.com/how-to-use-plugshare-guide.html>