Sabine Hossenfelder video analysis on the topic
https://www.youtube.com/watch?v=UNBLhGsjHQI

- Best option to care the environment: leave the car at home: walk or use bicycle!

Some statistics:
- Transportation accounts for 29% emissions (US and EU) globally it's 23%
- Aviation 4% and passengers cars / vans 15%

Types of electric cars:
- Battery electric vehicles
- Plug-in hybrid electric vehicles
- Hybrid electric vehicles --> run most of the time with gasoline, so they are about as electric as a big mac is vegetarian just because there's leaf of salad :)
- Fuel cell electric vehicles (runs on hydrogen) --> the fuel cell powers the battery and the battery powers the motor: hydrogen chemical reaction --> electricity. The former is not an efficient process (difficult to turn up and down chemical reactions, the same reason is why it's difficult to produce hydrogen from intermittent energy (green hydrogen).

Major problem with transition to electric vehicles:
- Our entire transport infrastructure was built around fossil fuels. Changing infrastructure is costly and time consuming. --> unfeasible to make hydrogen cars affordable.

What about electric (non hydrogen) vehicles?,
- We have electric grids: This helps transition to be done faster and at a lower cost.
- Globally in 2022 ~14% of new passengers vehicles were electric vehicles. Most electric cars currently sold by BYD followed by Tesla. However this percentage varies a lot across countries: greece: 1%, US: 7% and Norway: 50%. THIS ARE NEW CARS SALES (NOT OLD ONES) THE LATTER HAS A CONSIDERABLY LARGER MARKET.

A 2022 report by IEA estimates that share of e-vehicles in total new car sales needs to reach 60% by 2030 to reach net zero in 2050. UK will stop sales of new diesel and petrol fuel cars by 2030. The EU will stop sales by 2035, same for Japan and China. Exception is US.

The main problem which slows adoption of e-vehicles is finding charging places.
The deployment of charging stations is uneven and especially in rural areas it might be hard to find one. To make things worse, a significant fraction of charging stations are out of order at any given time, in 2022 was 1 of 5 in the US. Also there are other reasons why the car won't charge: e.g problems wit the connectors, issues with the mobile app for payment. Ok you would say, this will eventually pass. But it does make the switch unappealing for many potential buyers, "**range anxiety**". You can charge the car at home but the time it takes to charge the battery depends on the power you can deliver to it, which depends on the voltage and amperes available at your home, and that depends on the country you're for example located.

How long it takes to charge the car depends on many things:
E-vehicle chargers:
1. AC slow charging (~a day)
2. AC fast charging (few hours)
3. DC rapid charging (30 minutes to get the battery up tp 80%), the last 20% takes much longer..

All batteries charge with DC current, so if you use AC there must be a conversor in your car.

To overcome range anxiety the number of charging places should increase dramatically in number. The International council clean transportation estimates by 2030 there will be 26 million of e-vehicles on American streets, they will need about 1.3 million slow chargers, 900k public fast chargers and 180k rapid chargers. For the rapid charging it would cost 125k per charger (contemplates cost of installation), so for 180k would cost 20 billion USD (only rapid chargers), and for rural areas that can be a problem as those become a money sink due to lack of customers. The market won't do it on its own, and would need subsidies or regulations. This problem often occurs in sparsely populated areas, as for example telephone or the internet coverage, so the market will have to wait until the prices for the technology drop.

Alternative charging methods are under research. (e.g Germany)

Another issue is if the e-grid will cope. The US department of energy estimates that 80% of charging will be done at home and typically at night. But the current grids weren't built for such high demand. They don't have the capacity to support e-vehicles in addition to e-appliances. If you overcharge, the transformers could fuse or blow for example in residential areas. The transformers are designed to cool during the night after being heated during the day.
This could be particularly a problem in the summer when the nights are warm and everybody is running the air condition.
You can upgrade the transformers to some that supports more power but those are bigger and might not fit where they sit now. In the US there are ~180 million of those that would have to be replaced, this will take time.. Right now, municipalities control what type and how many chargers can be added to each street. In many countries you need to apply for a permit for a car charger, there are even laws that permit suppliers to interrupt power to certain lines temporarily to avoid charging all at the same time.

In the long run, upgrading the grid will be very costly. Boston consulting group found that in the US, investment in grid updates would cost around 1.5k - 5k USD per e-vehicle through 2030, this adds to 10 billion USD.
Besides, all transmission lines would have to be upgraded to support e-vehicles, especially if these can act as a energy storage to feed back energy into the grid.
According to an estimate of a non-profit organization American Action Network, by 2035 the cost for the entire upgrade in the US will reach 2.5 trillion USD.
Other estimates have found between 2 and 3.5 trillion USD by 2050 for the upgrade of the entire grid in the US alone. Globally, the cost might be as high as 21 trillion.

And the upgrade will have to be done quickly, by 2050 about 1 million miles would be needed in the US.
In the decade between 2010 - 2020 the US added 18k miles, so they would have to make it done around 20 times faster than previous decades!

Do e-vehicles at least make sense in terms of CO2 emissions?

- The production of e-vehicles has a larger carbon footprint, but electric motors are more efficient than combustion engines.
- Still how much CO2 a e-vehicles emit per distance driven depends on the energy source.
If the power grid is fed with brown coal, that can eventually produce more carbon emissions for e-vehicles than combustion engines.
- How far I have to drive my e-vehicle to save CO2 emissions compared with new gasoline ones?
In the US, the breakeven point is between 25k and 32k kms. In Norway (which uses a lot of hydropower) the breakeven is at 13k kms. But in Poland or China where lot of energy comes from Coal, it's 126k kms.
The CO2 reduction depends on the energy mix at the various locations. Various estimates say that it is "at the moment" somewhere between 15% and 60% for various places in EU and in the US.

The problem is that as we power more e-cars with electricity, the demand for electric power will increase very quickly, which means they will have to add new power plants very quickly. **What the power mix would look like in the future?**

Why is the transition to e-cars going so slowly?

- The grid isn't quite ready for it.
- Fast chargers are expensive and not always worth the investment.

- Repairing e-car is at the moment more expensive and takes longer than fixing one with combustion engine.
- Batteries are expensive as they require lot of raw materials, such as lithium, nickel, cobalt and manganese, copper.
- E-cars use x6 times more minerals than combustion cars.
- The demand of those minerals could grow by x30 in the next two decades.
- The biggest problem are lithium and cobalt.
- The problem with Lithium: In the past 25 years the extraction of lithium increased around a factor of 10 but that was not enough to supply the increase in demand.
Consequently the price for lithium increased (greenflation)
- The problem with Cobalt: Most of the mineral is located in republic of Congo, which has long history of conflict and political issues, besides mines are often unsafe and rely on child labour, something unappealing for business partner.
- Luckily there are some alternatives for Cobalt, based on Lithium Iron phosphate (used by Tesla) (LFP), however they have a lower battery density, but they charge faster, last longer and at the moment are also cheaper. Still it looks for now the prices for batteries and e-cars will likely continue to increase. CEO of Ford said: "I don't think we should be confident in any other outcome than an increase in prices".
- Scientist and engineers are trying to alleviate the problem by developing different batteries (e.g Sodium batteries) or recycling old ones, but unless a miracle happens that won't have an impact on the market in the coming decade.

Who is going to do all that?

- GM announced by 2035 they want to have "100% zero tailpipe emissions for new light-duty vehicles" and Audi plans to stop selling petrol-powered and diesel models by 2033.
- The transition to e-vehicles will change the entire supply chain, from mining to battery production, to software development to maintenance and repair. Jobs will be lost in the sector with combustion engines. The motor of an e-vehicle has fewer parts than a mechanical combustion one and so it's possible that ion the long run the number of working people in the supply chain will decrease. BCG found that by 2030 about 930k jobs will disappear but another 895k new jobs will be added, though another analysis estimates that a total of 275k jobs will be lost in the car industry by 2040.

In summary:

- e-vehicles are well on the way in many places to replace combustion engines, but it will be neither cheap nor easy.
- Switching to e-cars make only sense alongside decarbonization of the power grid. while the switch itself will increase demand and will make decarbonization more difficult.
- E-grids will have to overhauled substantially and like many infrastructure changes it's unlikely that free market economies will take care of it without substantial subsidies.