

Science AMA Series: I'm Jeremy Martin, here to talk about gasoline, ethanol, electricity and the future of transportation fuel. AMA!

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[Toyota wants to move away from batteries because the limits have supposedly been reached there.](#)
[They want to hype the fuel cell.](#) Tesla (and now also [Volkswagen](#)) are going full on battery. Mercedes had a little fling with Tesla but is now back on going the fuel cell way.

So who's right?

Edit: Added links

[I-am-redditor](#)

Both battery electric vehicles and hydrogen fuel cells are important technologies to get to zero emissions transportation, and they have complimentary advantages. Batteries are more efficient, but fuel cells have advantages for heavy duty or long range transportation. My colleague David Reichmuth recently wrote a [blog and several fact sheets](#) on this you can check for more information.

-Jeremy

I've heard that ethanol is not as corrosive as methanol, does it still damage fuel systems not specifically set up for e85? There is a lot of swirl (here in the Midwest) about upping the minimum ethanol content to 15% from 10%. In my experience, adding ethanol reduced mileage significantly enough it was not price competitive with pure gas (which I still buy here a few places).

[RenegadeFarmer](#)

It is certainly important to make sure that you only use fuels that are compatible with your car or you can have problems. Ethanol does have about a third less energy per gallon than gasoline: generally, higher blends of ethanol like E85 (85% ethanol) will only be a good deal if they are sold at a significant discount to gasoline, about 25% (and only if you have a flex fuel vehicle). The fuel economy differences between E10 and E0 (gasoline with no ethanol) will be fairly subtle, not more than 3%, so which fuel is a better deal depends upon the price difference. Some cars are also compatible with E15, but not all of them, so any changes to fuel blends will need to accommodate older cars as well. Octane is another a complicating factor, because different ethanol blends will also have different octane levels which will affect different cars differently (but that's a whole different story).

-Jeremy

Is the idea of being carbon neutral and 'green' by running diesel engines on oil crop biofuels bogus or real?

[vtjohnhurt](#)

Biodiesel and other biofuels are not generally carbon neutral, but they can be less polluting than petroleum-based fuels. For biodiesel the most important thing is what you make the biodiesel out of, and as you mention, vegetable oil accounts for the majority of biodiesel, particularly soybean oil. Most analyses find that soybean oil biodiesel is less polluting than diesel, but palm oil biodiesel is a disaster. And, as I [explained at great length in a recent blog](#), there is just not that much vegetable oil available. So while a little vegetable oil biodiesel may be helpful, biodiesel can't scale up that much from where we are now.

-Jeremy

What haven't you been asked but you would like to answer?

[psylence1](#)

Thanks for asking. I would like to address the >90% of our transportation fuel that comes from oil. It's obviously important to explore the problems with ethanol and other biofuels and the challenges to rapidly scaling up electric vehicles and low-carbon electricity, but the vast majority of emissions from transportation come from oil. Sometimes this fact fades into the background as we fixate on these other challenges.

Emissions from oil extraction and refining have been rising as oil companies go after more polluting sources and methods, but this is by no means inevitable: we just need to hold the oil industry to the same level of accountability as all other fuel producers. Check out our [new web feature](#) or my report, [Fueling a Clean Transportation Future](#), to learn more about this important topic.

-Jeremy

About fifteen years ago, my father told me it takes more energy in gasoline and electricity to produce ethanol than the amount of energy produced. Is this still true?

[Breadsecutioner](#)

No, this is not true. It does take a lot of energy to make ethanol -- especially the distillation that separates pure alcohol from a dilute beer-like solution that comes out of the fermentation process -- but generally less energy is used than the amount of energy in the ethanol.

These days most experts, including myself, focus on the global warming emissions rather than the net energy. Depending on the efficiency of the facility and which source of heat and power is used (coal, natural gas, or renewable energy) you can get a very different emissions picture. Most modern ethanol plants are powered by natural gas and reduce emissions by about 20% compared to gasoline, but the most efficient facilities can be considerably cleaner. Quick plug: lots more details on this are in Chapter 3 of my recent report [Fueling a Clean Transportation Future](#), which is all about ethanol.

-Jeremy

I own a lawn care business and this has been on my mind for a long time. If ethanol has been studied extensively, and deemed to be safe for engines, then why is it that running ethanol fuel in my small engines cuts their life short by almost half? Also, at what point will electric vehicles become comparable in price to gasoline vehicles? When that happens are gasoline vehicle prices going to skyrocket?

[HERMANNATOR85](#)

(1) Small engines are very different than modern cars, because modern cars have oxygen sensors and fuel injection systems that adjust the fuel to air ratio to compensate for different ethanol levels in the fuel. (2) Electric vehicles (EVs) are getting more affordable all the time and they are generally cheaper to charge than fueling a gasoline vehicle: which vehicle is most cost effective depends on an individual calculation of needs. But as EVs get cheaper I would expect fewer people to want gasoline powered cars. I don't see why this would make the cost of those vehicles skyrocket. If anything, I would expect this would put pressure on makers of gasoline vehicles to keep costs down to ensure they remain cost competitive. -Jeremy

In Oklahoma, (off to a bad start with this question, I know) we can buy 100% gas or E10 (90% gas 10% ethanol). When gas was over \$3/gallon the price difference between the two fuels was about 10¢. The higher price of straight gas could be justifiably purchased due to slightly higher fuel economy in some vehicles. Now gas is under \$2 but the price split is now over 30¢. How does this make any economic sense? At these prices it seems like ethanol would have to be cheaper than water to account for that price gap.

[PyroPeter911](#)

I can't speak directly to the pricing at a particular station, but I suspect what is happening has to do with octane. Now that E10 has become the main fuel used in the United States, refiners have started producing lower octane base gasoline, which only meets the 87 octane target once 10% ethanol is blended in (ethanol has much higher octane than gasoline). If you want E0, you are getting a mixture of the low octane base blend and the premium fuel, which is now required to bring the sub-octane blend up to the target octane. So it's the higher cost of premium that is responsible for the price difference rather than the ethanol. Before this change the only difference between E0 and E10 was the ethanol, but now it is a more complicated equation. It also may be that there is a different markup on different fuels, but that is another matter. -Jeremy

A few years ago there was promising research into creating biodiesel using genetically modified algae. At the time it was reported the technology was ready to step up in scale. Since then it has been very quiet. Do you think this technology will ever represent an important part of our fuel production?

[bostwickinator](#)

Work on algae continues, but has shifted to focus more on other more-valuable products than fuel. I am not sure if or when algae will ever be a big part of our transportation fuel mix, but I am confident that this technology will be valuable in other higher value sectors. After all, burning something for energy is one of the lowest value uses of any product. - Jeremy

What do you think of Dr. Christian Koch in Germany and his KDV (Catalytic Pressureless Depolymerization) process to turn most organic matter (and his example, mostly cats) into biodiesel fuel?

[rom8n](#)

I have not studied this technology or the use of cats as a biofuel feedstock, but my expertise in lifecycle analysis is perhaps not ideally suited to grappling with the issues raised by this approach. -Jeremy

Hi, thanks for doing this, I read that there are scientists that are promoting the fact that we can drop fossil fuels and switch to clean energy almost immediately. How possible and likely is this this?

[wawaboy](#)

A couple scientists at Stanford and elsewhere have described what a [100% renewable energy future](#) would look like, and it is well worth a read. But the transition will take time, and the transportation sector will be especially challenging because we need to replace most of petroleum powered cars and trucks with electric and fuel cell vehicles (biofuels can play a role, but cannot replace anything like current petroleum fuel demand). I am confident this will happen, but it will take decades, and exactly how many decades depends on how hard we push.

-Jeremy

If ethanol is a net-positive energy source, why don't ethanol plants run on ethanol?

They all seem to be fossil-fuel powered (and yes, I realize that those get special treatment in terms of tax breaks and subsidies).

The final effect seems to be converting fossil fuels into increased prices for food crops and lower-yield transportation fuels.

[LateralThinkerer](#)

The energy balance question misses the other important properties of fuels, and does not provide a complete picture. For example, ethanol turns out to be most valuable when it is used as a high octane blending component of gasoline, and is much better than natural gas for this purpose. But ethanol would not be a very smart source of heat to run an ethanol plant: if you wanted to run a boiler from corn, I would imagine you would be better off burning the corn grain before you made it to ethanol. Natural gas is more cost effective than using grain for this purpose. A more effective renewable fuel to substitute for natural gas at an ethanol plant is biomethane.

The point is that there is a lot more to fuels for cars or ethanol plants than the net energy balance. Most of my analysis has focused on the net climate impacts of different fuels, and climate change—not the net energy balance—is the reason to cut the use of oil and other fossil fuels. But I do discuss the food price question in Chapter 3 of my report on Fueling a Clean Transportation Future.

The short answer is that making more corn ethanol is not the smart path forward for our agricultural system. However, if the fuels are made out of better starting materials like wastes and perennial grasses, there is room to significantly increase biofuel production while protecting our agricultural system.

-Jeremy

What do you think the future of natural gas will be, in terms of modes of use and size of consumption?

[benmww](#)

Natural gas has an important role in the electricity generation sector, but overreliance on it is risky (see my colleagues' report [The Natural Gas Gamble](#)). Natural gas also plays a role in some transportation applications, particularly for delivery trucks or other vehicles that are fueled at a central point. But because natural gas offers limited climate benefits, its future as a transportation fuel is definitely limited. Biomethane produced from wastes can make gas powered vehicles cleaner, but the scale of these wastes and the potential for biomethane generation is limited: I don't think it changes the equation on the future of natural gas powered transportation much. -Jeremy

Traditional ethanol production from grain and corn is a dead-end biofuel unless cellulosic enzyme methods improve and we can change base stocks to switchgrass or other similar plants grown on non-arable land. What is the state of this enzyme technology? Also, what is the future like for biofuels based on butanol produced by bacteria and oil producing algae?

[Gastronomicus](#)

The enzyme technology to make cellulosic ethanol has come a long way, and is being used at commercial scale in the first plants today. I do not have specific cost figures myself, as I don't work for those companies, but I am confident there remains a lot of room for improvement as they build experience at commercial scale. The benefits of commercial experience in lowering costs is almost a universal law of complex manufacturing processes. I think enzymatic hydrolysis of cellulose is more advanced than the other technologies you mention, but work continues on many different fronts. - Jeremy

As an extension to electric cars, how do you view nuclear energy? Electric cars seem to be the way of the future, and cars drawing energy from Coal/Gas reactors can't really be branded as having minimal environmental impact, and renewable energy won't be able to meet our energy needs anytime soon. How do you feel about nuclear energy filling this role?

[SunkenDota](#)

Electric cars powered from the grid are already cleaner than gasoline; exactly how much cleaner depends on where you charge them. My colleagues wrote a whole report on this topic, which you can read [here](#). Other colleagues of mine also have a lot to say about [cleaning up the grid in general](#), and [nuclear energy](#) in particular, but perhaps the short answer is that we support a carbon price.

-Jeremy

Has has the theory of peak-oil, erm, peaked?

[The Kestrel of Doom](#)

It seems clear to me that we need to cut oil use because of its impact on global climate rather than because we are going to run out of it. I have too much confidence that geologists and chemical engineers will find unconventional oil and other fossil fuels that we can make into gasoline and diesel far in excess of what can afford to emit into the atmosphere. - Jeremy

Have bioplastics come far enough to viably replace the massive amount of the other oil-based products that are used worldwide and in practically every industry?

[sendtown](#)

Biomaterials are coming along and some consumer products are packaged in bioplastics now. In the long run, this technology may become a more important part of the bioeconomy than biofuels, because we can replace gasoline more easily with electricity. But while plastics are big business, we use a lot more oil for fuel than for plastic, so transportation fuel has been my primary emissions focus.

To realize a net zero emissions system, we will need to move low carbon technology into other sectors as well, so I expect to see more action in bioplastics and other biomaterials over time. -Jeremy

what energy return ratio would you say is a base for a source to be looked at? like is something was at a 10:1 right now, would that be enough to make you study that fuel source in the hopes of lowering it in 5, 10, 15 years?

[Oldscratch73](#)

I don't have an answer for this question because I am not in the business of deciding what prospective fuels to look at. I will evaluate whatever fuels the industry produces or plans to produce. Generally, I focus on the climate impacts rather than energy return ratio, and in the case of biofuels I also consider how scaling up a new technology will affect the other users of the inputs (corn, switchgrass, etc.). - Jeremy

Hi Jeremy, thank you for doing this!

Has anyone answered the question of how dirty the lithium mining process is? If large machinery is extracting this material out of the earth, how many gallons of oil is needed to extract enough lithium to power an electric vehicle X miles/kilometers? Is it sustainable?

[FJComp](#)

My colleagues wrote a whole report on the full lifecycle of electric vehicles, including the batteries, which you can read here: [Cleaner Cars from Cradle to Grave](#). The short answer is that even taking battery production into consideration, battery electric vehicles are still cleaner than gasoline powered vehicles, and are getting cleaner as the grid gets cleaner.

-Jeremy