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December 17, 2022

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Subject: <u>Electric Vehicle Energy Efficiency</u>

Dear XX. XXXXXX:

To verify the obvious, I performed an analysis which shows that EVs cannot be an energy efficient alternative in the U.S.

The EV's energy efficiency is limited by the efficiency of our electrical generation, transmission, and distribution system, the power grid. Over 85% of our electricity is thermally generated. Thus, a heat engine is the prime mover at those generating plants. Just knowing that alone, I do not understand how anyone can as much as think about EVs, much less be manufacturing them. If I am misunderstanding something, please let me know what that may be.

To get a number, I performed an analysis using readily available data from the Energy Information Administration. The result of my analysis in the attached document shows a power grid energy efficiency of 36.13%. Thus, about 64% of the energy consumed by a generating plant does not reach your electrical outlet.

Between your electrical outlet and the motor's output shaft are the following components and their estimated energy efficiencies:

- Battery Charger 90%
- Battery 90 %
- Inverter/Variable Frequency Drive 90 %
- Induction Motor 90 %

The combined efficiency is 65.61%.

Since the motor is driven by an inverter, its efficiency is decreased by 20%, giving a combined efficiency is 52.49%. Multiplying that by the efficiency of our power grid, you get a net efficiency of 18.96% for an EV. That is less than the efficiency of a gasoline and especially a diesel engine powered vehicle. Since there appears to be no energy efficiency advantage, there probably is no, or not much of an advantage from an emissions perspective.

I some places, Canada for example, it is a completely different story. That country is unusually blessed with geography conducive to hydro-electric power generation, 90% efficient. Canada gets nearly 60% of its electric power from hydro. Providing that range and charging times issues could be resolved, there the EV would be a good solution.

Here in the U.S., we are nowhere near as fortunate. We only have are the Columbia River, Hoover Dam, the TVA, Niagara Falls, and some small-scale hydro-electric plants.

An engineer I met who works in the automotive industry and an expert in thermal sciences said that the efficiency of the EV is probably even less than my analysis revealed. He also said that the decision to make EVs was political, not science, nor market based.

In the 1990's, General Motors, on its own volition was developing an EV, the EV1. That went nowhere. Why? Could it have been because they don't work?

Afterwards, EVs weren't discussed until about 2008 when the government was bailing out GM and Chrysler. That's when the government, not the market, dictated that they had to build EVs.

If EVs were a good idea, the free market would've demanded them many years ago. The government didn't tell Henry Ford to make cars, and didn't tell the oil companies to build gas stations. Instead, they got their marching orders from a much more qualified, much more powerful authority, the free market.

Furthermore, if well all drove EVs, where would all that extra power come from?

The Detroit News published an article titled:

> **Electric vehicles are coming: Can Michigan's power grid hold up?**
>
> https://www.detroitnews.com/story/business/autos/2021/02/03/electric-vehicles-coming-can-michigan-power-grid-hold-up/4237045001/
>
> ""There's something like **6 to 7 million vehicles in Michigan**," said Benjamin Burns, marketing director for DTE Energy Co.'s Charging Forward EV program. "**It's not until there's 1 million to 1.4 million electric cars** before we could see a significant number of quality issues."
>
> To travel 100 miles, the average electric vehicle needs the same amount of electricity an average American home uses each day to run appliances, computers, lights and heating and air conditioning. Adding several million vehicles at the same time in need of regular charging risks overwhelming the system."

I assume that the DTE system can power the EVs only if charged in the nighttime. So, what do Detroiters do on a holiday weekend when they take a trip to the Upper Peninsula? Before getting to the Mackinac Bridge, they will all have to re-charge their cars at the same time, in the daytime. The only apparent reason why the utilities are promoting EVs is so they can then utilize their currently unused fossil fuel powered nighttime capacity, hence increasing their revenues.

As a selling point, EV proponents say that building the EV infrastructure will create a lot of jobs. A very much simpler way of creating similarly useful jobs would be to give people a shovel, have them dig a hole for four hours, then, after lunch they can fill it back in.

Please feel free to share. Comments, questions and substantiated critical feedback will be welcomed. I look forward to your detailed response.

Thank you.

Sincerely

John Zupanc

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ELECTRIC VEHICLE ENERGY EFFICIENCY.

The energy efficiency of a motor vehicle is defined as the percentage of the energy contained in the vehicle's primary fuel that arrives at the vehicle's traction wheels. The primary fuel for conventional vehicles is the fuel in the vehicle's fuel tank. The primary fuel for an electric vehicle (EV) is the fuel used by an electrical generation facility. Thus, the energy efficiency of the electric generation, transmission and distribution system limits the efficiency of the EV.

1) Electric Generation Energy Efficiency

a) Thermally Generated Electricity

From the U.S. Energy Information Administration website:

http://www.eia.gov/electricity/annual/html/epa_08_01.html

We get the following heat rates, and the calculated thermal efficiency:

Source	Heat Rate - BTU/KWH	Thermal Efficiency %
Coal	10,498	32.50
Natural Gas	8,039	42.44
Nuclear	10,479	32.56
Petroleum	10,991	31.04

b) Renewable Source Generated Electricity

From the U.S. Energy Information Administration website

http://www.eia.gov/totalenergy/data/annual/pdf/sec17_3.pdf

We get the following conversion efficiencies

Source	Conversion Efficiency %
Conventional Hydroelectric	90 %
Geothermal	16 %
Solar Photovoltaic	12 %
Solar Thermal	21 %
Wind	26 %
Biomass	25 % (est)

2) **U.S. Electric Generation by Energy Source**

From the U.S. Energy Information Administration website

http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3

We get the following energy generation distribution

Source	Percent Generation
Coal	37 %
Natural Gas	30 %
Nuclear	19 %
Hydropower	7 %
Biomass	1.42%
Geothermal	0.41 %
Solar	0.11 %
Wind	3.46 %
Petroleum	1%

Combining the above tables:

Source	Conversion/ Thermal Efficiency %	Percent Generation by Source
Coal	32.50 %	37 %
Natural Gas	42.44 %	30 %
Nuclear	32.56 %	19 %
Hydropower	90.00 %	7 %
Biomass	25.00 %	1.42%
Geothermal	16.00 %	0.41 %
Solar	15.00 % *	0.11 %
Wind	26.00 %	3.46 %
Petroleum	31.04 %	1%
Weighted Average	38.85 %	100%

*Average of solar photovoltaic and solar thermal.

Electrical transmission and distribution efficiency is approximately 93% thus giving the U.S electrical generation, transmission, and distribution system an energy efficiency of 36.13%.

Hence the energy efficiency of electric vehicles is limited to 36.13%

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11/14/2014