Brian Chan

Controversy in the Popular Press – Electric Cars

Scientific American published the article "Electric Cars Are Not Necessarily Clean" on their website on May 11, 2016. (Biello, Electric Cars Are Not Necessarily Clean, 2016) The author of the article is David Biello, a journalist that primarily writes about energy and the environment. The article is a response to the announcement of Tesla's new Model 3 that received over 300,000 preorders within a few months of its introduction. Biello argues that electric cars are not necessarily clean because it depends on the power source that provides electricity to the region where the electric car is charged. He notes that in America, coal fired power plants are the largest source of greenhouse gas pollution and if there are more electric cars on the road, it will only increase the demand for electricity from coal fired plants thus increasing the CO_2 emissions at the plants. As a result, Biello makes the case that conventional hybrid vehicles end up emitting less CO_2 per vehicle than an electric car powered by electricity from a coal-burning power plant. He acknowledges electric vehicles in states like California, Texas and Florida emit less CO_2 than hybrid cars, but in the American Midwest and the South where coal fired plants produce the majority of the electricity, electric cars end up producing more CO_2 than hybrid cars.

News about energy and technology do not often make headlines because it does not put human lives and the natural environment at immediate risk. Most people assess electric vehicles based on preference in regards to one's personal lifestyle, the relationship of vehicles to the environment is often secondary. The most common concern with electric cars is the range and people are willing to side with gasoline cars because of the few times they may need to travel further than what an electric car can allow. The discussion over electric cars, even for those who purchase them, glosses over the connection to climate change and instead focuses on efficiency, comfort or savings on gasoline. The controversy really lies in how Western society is holding on to gasoline cars simply due to routine and preference, while masking the environmental concerns created by our transportation systems. People fail to be critical of our current transportation systems and this is a significant issue when in Canada, between 2011-2015, the number of registered vehicles increased by 9% while the population increased by 4% in the same period. (Statistics Canada, 2016) With the number of vehicles on the road increasing faster than the population of Canada, and with newly industrialized countries like India and China adopting a standard of living similar to North America, the issue of automobile and energy production emissions is more important than ever, yet many still cling to the dominant car culture.

Opinion:

Despite Biello giving a fair analysis of the realities behind electric cars and the source of electricity, electric cars still provide more environmental benefits than internal combustion engines (ICE). Biello's criticism of the cleanliness of electric cars is misdirected and his comparison of electric cars to hybrid cars is deficient. Electric vehicles (EV) provide more environmental and health benefits over any vehicle that utilizes an ICE.

The title of Biello's article, "Electric Cars Are Not Necessarily Clean", is misleading because it conveys to the reader that there are environmental issues with electric cars themselves. Just as Biello explains, the source of the problem is the emissions from electricity production from coal-fired plants, but it is then a problem with electricity production, not necessarily the electric car. The source of the electricity may not necessarily pose a problem either since the amount of megawatt hours produced by coal in the US has dropped by 22% between 2011-2015 while solar generated electricity increased by an extraordinary 1269%. Other renewables excluding hydroelectricity and solar have also increased by 41% in the same period. (U.S. Energy Information Administration, 2017) In Canada, 55% of our electricity is from hydroelectricity and only 7% is from coal and coke. (National Energy Board, 2017) While China experienced an 11%

increase in the gigawatt hours produced from coal between 2011-2014, it also increased its gigawatt hour production of solar PVs by 1021% in the same period. (International Energy Agency, 2016) The clear trend for many industrialized countries is to move away from producing electricity by burning coal. Coal fired plants are to blame for the greenhouse gas emissions, not the electric car. Even though an increased adoption of electric cars would increase the electricity consumption, countries are turning more towards clean energy instead of electricity produced from burning coal so EVs will only become cleaner over time.

While Biello points to the source of electricity as the factor making electric cars less clean, he does not compare it to the source of fuel for gasoline cars; he only makes the comparison to emissions from the car itself. A proper comparison should consider the energy used to refine gasoline. Biello states that the average CO_2 emissions for the entire USA produced from a Toyota Prius versus a Nissan Leaf is roughly the same. (Biello, Electric Cars Are Not Necessarily Clean, 2016) However, Devin Serpa estimates that refining fuel adds an extra 2.4581 pounds of CO_2 for every gallon of gasoline produced. (Serpa, 2008) Other estimates can be even higher from 3.35 to 6.7 pounds per gallon according to the Sierra Club. (Sierra Club, 2017) It is difficult to get an exact calculation of the CO_2 produced from refining oil since refineries produce more than just gasoline; however, it still adds an amount of greenhouse gas emissions to the total emissions of a Prius when accounting for the source of the fuel, as Biello did with the Leaf and its source of fuel. Therefore, if the overall average emissions of EVs and hybrids are the same in the USA when comparing hybrid emissions to EV produced emissions from coal, accounting for the emissions embodied in refining gasoline would only add to the overall CO_2 emissions produced from hybrids, raising their emissions above EVs.

Aside from the debate over greenhouse gas emissions from an electric vehicle, there are other environmental benefits of EVs over hybrids or typical gasoline engines. Since EVs do not require motor oil to lubricate the engine, it does not create any demand for the production or recycling of motor oil, which requires more resources and energy. No motor oil also means no oil filters, which decreases the amount of waste produced over the lifespan of the car. According to the US Department of Energy, gasoline vehicles are only 14-30% efficient and hybrid cars are only 25-40% efficient as the majority of the combustion energy is lost to heat whereas the electric cars are 74-95% efficient. (U.S. Department of Energy, n.d.) By using electric cars in the urban setting where there is a higher density of vehicles, cities like Beijing can decrease their urban heat island effect by cutting down on air conditioning, saving 14.44 million kWh of electricity and 10,686 tonnes of CO_2 emissions per day. (Canbing Li, 2015) Electric cars also utilize a regenerative braking system that charges the battery while breaking or rolling down hills, therefore it lessens the energy they consume from the grid. Regenerative breaking also means that brake pads on the car should last longer, creating less brake dust and less consumption of resources in replacing the brake pads. Electric vehicles also do not require mufflers or catalytic convertors, which further lessens the need for resources in manufacturing and maintaining the car. Overall, electric cars are less wasteful of resources during its operational lifespan.

There are also health benefits to people adopting more electric vehicles. A study in Europe compared the external costs (health and climate impact) of internal combustion engines and electric vehicles. Although the effects are different in each country, practically all countries experienced a lower external cost with EVs over having ICEs. (Jurgen Buekers, 2014)

North America seems to have an addiction to gasoline and articles like Biello's only serve to entrench people's apprehensions about transitioning to EVs. Because of the hesitation in adopting EVs, cities and businesses hesitate to invest in the charging infrastructure to support the EVs, further supporting the complacency North America has with our gasoline driven society.

Contrarian:

Electric cars bring some advantages over combustion and hybrid cars but when analyzing the life cycle and the effects of having EVs on the road, the drawbacks cancel out the benefits and adopting more EVs does not seem necessary. EVs in North America require generous government subsidies to be competitive with gasoline cars and even at that, adoption is slow which points to a low demand for the technology. The infrastructure in place does not support a large-scale adoption of EVs. The concerns over the real environmental benefits and the safety of EVs may be contributing to the low demand for electric cars.

The manufacturing stage of an EV causes more emissions than a combustion car. The lithium-ion batteries are energy intensive to build, resulting in a 15% increase in production emissions over gasoline vehicles when compared to an 84-mile range EV. Increasing the range capacity to 250-miles raises the production emissions of an EV to 68% more than a gasoline vehicle. (Rachael Nealer, 2015) Even before the consumer purchases an electric car, it has already produced more greenhouse gas emissions than a gasoline car.

The battery also causes safety issues. Lithium-ion batteries can produce enough heat on its own to ignite the electrolytes in the battery. The battery can also ignite if there is a short circuit between the two electrodes or by a large object piercing the battery. (Bullis, 2013) When a lithium-ion battery ignites, it is particularly violent and quick. According to another article by Biello in 2013, Tesla recommends to first responders to let a battery fire burn out because it is too difficult to put out. The battery fire can take up to 24 hours to burn out. Tesla places its batteries on the underside of the car, increasing the risk of debris from the road puncturing the battery and causing a fire. (Biello, Should Battery Fires Drive Electric Cars Off the Road?, 2013) The amount of energy stored in the battery poses a danger when electric vehicles get into accidents.

Electric vehicles are not only dangerous when the battery catches fire, it affects people's health more than a gas vehicle. Particulate matter from driving a fleet of gasoline vehicles in Georgia does not spread as far as a fleet of electric cars charged in the same county. Pollution created by the EVs spreads throughout the entire east coast because of the power plants, whereas the gasoline vehicles concentrates their emissions in the county and only spread to the southeast corner of the US. Therefore, the pollution from electric cars affects a wider region and thus more people. (Stephen Holland, 2015)

Electric motors run much quieter than gasoline engines and sources like Conserve Energy Future claim that electric cars will decrease noise pollution. (Rinkesh, n.d.) However, Campello-Vincente et al. found that electric cars only show a significant decrease in noise at speeds under 30km/h. At 50km/h, the difference between a gasoline engine and an electric motor is only 1dB because tire noise makes up the majority of the noise produced at typical driving speeds. (Hector Campello-Vincente, 2017) Being too quiet at low speeds has actually created a safety risk of its own. In 2011, the National Highway Traffic Safety Administration released a study that compared the rates of accidents from internal combustion engines and hybrid electric engines. Electric vehicles would be comparable since they are as quiet as hybrid electric cars at low speeds. The study found that the incidence rate for gasoline cars was 0.57% while the hybrid electric cars were at 0.77% meaning more pedestrians get into accidents with electric cars than combustion cars. They made similar findings with bicycle accidents. (Jingshu Wu, 2011) This led to legislation in the U.S. establishing requirements for sound levels on EVs. Therefore, electric cars have no significant benefit when it comes to noise pollution and they end up being more dangerous since they are quieter at low speeds.

The benefits of EVs come with a number of drawbacks. With an existing infrastructure that already supports gasoline cars, it does not make sense to transition to electric vehicles. There is

no natural demand for the product so governments should stop wasting money on subsidizing the purchase of EVs.

* * *

With electric vehicles, there are differing perspectives because of the elements people choose to focus on. Like any innovation, there are positives and negatives. When focusing on the manufacturing stage of the EVs, Nealer et al. notes that it is more energy intensive to manufacture the batteries, but the article also concludes that the operational stage of the EV emits far less greenhouse gasses than a gasoline car. (Rachael Nealer, 2015) Nealer et al. found that the end life of both cars were comparable. Overall, after comparing all three stages of the life cycle of a car, the electric car still produced fewer greenhouse gases over its entire lifetime, even when accounting for electricity sources. News stories of batteries exploding only sensationalize this possible danger. A lithium-ion battery holds 200 watt-hours of energy per kilogram whereas gasoline holds 12,000 watt-hours of energy per kilogram. (Biello, Should Battery Fires Drive Electric Cars Off the Road?, 2013) Combustion cars face the same dangers of catching on fire. Teslas also have warning systems that alert drivers when to vacate the car because of an overheating battery. Moreover, Teslas also come with a fire separator that keeps the fires out of the cabin of the car. With the amount of pollution created by Holland et al.'s analysis, they do not discuss the severity of the effects of concentrating the air pollution from the combustion cars and only focuses on how widespread the pollution is. With noise pollution, Campello-Vincente et al.'s findings do show that overall, electric cars are slightly quieter so if all cars were electric, we would have less noise pollution. Especially in urban centers with many stoplights causing more idle time, electric cars can make a significant impact decreasing noise pollution. With each benefit or drawback of electric cars, one can always find a single component to focus on and use that as the reason to encourage or discourage the adoption of electric vehicles.

Reconciliation:

The common ground between the two extremes would be adopting hybrid cars or hybrid electric cars. That seems to be where the market is heading as there are more new hybrid electric cars entering the market versus full electric cars. The largest barrier seems to be the shift in culture. For about a century now, North America has been using gasoline cars and our entire way of life has revolved around that. Even our infrastructure has been built around the gasoline car and many companies are interested in maintaining our fossil fuel dependency since they benefit from it economically. Gasoline cars have given North America a relative cheap and convenient way to transport ourselves long distances and it makes us forget to ask whether we need to travel that much at all. This has clear connections to the CARE framework as it is a land ethic that would drive someone to choose an electric car for its lower emissions over the convenience of a gasoline car. This issue also has clear ties to Responsibility with cars having an obvious connection to CO_2 emissions and climate change. This issue does not connect with the aesthetic part of CARE but an experience with air pollution and being able to compare that to clean air may lead someone towards developing the land ethic which would result in choosing electric cars over gasoline ones. It is clear from the perspectives above that this is a very complex issue because the environmental friendliness of ICEs, EVs, and hybrids connect to a larger system of fuel production and resource consumption. Most of the arguments above are from a scientific perspective but there are also studies of the social barriers and economic barriers of people adopting electric cars.

Investigating the social barriers towards purchasing electric cars could probably explain why there seems to be a slow adoption of the technology despite there being no significant

drawbacks to the technology in comparison to gasoline cars. The effects on the economy would also provide a deeper understanding of the benefits and drawbacks to all stakeholders. Economically, since EVs are still relatively more expensive, this issue has connections to standards of living, which might pose as one of the barriers towards widespread adoption of EVs. I have already come across some journals that address these topics.

This topic lends itself well towards implementation in my Geography 12 and Social Studies 11 classes. It is a topic brought up in my Geography 12 class when we investigate solutions to our energy consumption in Canada. Students research the benefits and drawbacks of an energy source and in groups, they act as lobbyists for the type of energy and try to sell it to the class. They then defend their energy source by answering questions from other groups. I also add hybrid/electric cars into the discussion even though it is not an energy source, but I want students to consider if it is part of the solution for a sustainable energy plan for Canada.

Since the topic is not an overly heated controversy, it would be suitable for discussion in our classroom. With a class of environmental/ecological education students, the best way to present the information is to start with the arguments against electric vehicles. Students in our class probably have a land ethic already and may be pre-disposed to siding with electric vehicles. Challenging their ethic would spark a discussion like the one presented above. For the individual, the common concerns with electric vehicles seem to be the price and range-anxiety. For the larger society, it seems like our complacency with our current fossil fuel infrastructure and economic system poses the greatest resistance to adopting electric vehicles on a grander scale.

References

Biello, D. (2013, November 12). *Should Battery Fires Drive Electric Cars Off the Road?* Retrieved November 12, 2017, from Scientific American: https://www.scientificamerican.com/article/battery-fires-in-electric-cars-danger/

Biello, D. (2016, May 11). *Electric Cars Are Not Necessarily Clean*. Retrieved May 20, 2017, from Scientific American: https://www.scientificamerican.com/article/electric-cars-are-not-necessarily-clean/

Bullis, K. (2013, November 26). *Are Electric Vehicles a Fire Hazard?* Retrieved May 20, 2017, from MIT Technology Review: https://www.technologyreview.com/s/521976/are-electric-vehicles-a-fire-hazard/

Canbing Li, Y. C. (2015, March 19). Hidden Benefits of Electric Vehicles for Addressing Climate Change. *Scientific Reports 5*. Retrieved May 20, 2017, from https://www.nature.com/articles/srep09213

Hector Campello-Vincente, R. P.-O.-D.-S. (2017, January 15). The effect of electric vehicles on urban noise maps. *ScienceDirect, 116*, 59-64. Retrieved May 20, 2017, from http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S0003682X16302845

International Energy Agency. (2016). *China, People's Republic of: Electricity and Hat for 2014*. Retrieved May 20, 2017, from http://www.iea.org/statistics/statisticssearch/report/?country=CHINA&product=electricityandheat&year=2014

Jingshu Wu, R. A.-L. (2011). *Incidence Rates of Pedestrian And Bicyclist Crashes of Hybrid Electric Passenger Vehicles: An Update.* Washington DC: U.S. Department of Transportation: National Highway Traffic Safety Administration. Retrieved May 20, 2017, from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811526

Jurgen Buekers, M. V. (2014, December). Health and environmental benefits related to electric vehicle introduction in EU countries. *Elsevier, 33*, 26-38. Retrieved May 20, 2017, from http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S136192091400128X

National Energy Board. (2017, March 08). *Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040*. Retrieved May 20, 2017, from https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2016/index-eng.html#s8

Rachael Nealer, D. R. (2015). *Cleaner Cars from Cradle to Grave.* Union of Concerned Scientists. Retrieved from http://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions#.WSEIA_krKM8

Rinkesh. (n.d.). *Advantages and Disadvantages of Eletric Cars*. Retrieved May 20, 2017, from Conserve Energy Future: http://www.conserve-energy-future.com/advantages-and-disadvantages-of-electric-cars.php

Serpa, D. (2008, August 28). *CO2 Emissions from Refining Gasoline*. Retrieved May 20, 2017, from AfterOil EV: http://www.afteroilev.com/Pub/CO2_Emissions_from_Refining_Gasoline.pdf

Sierra Club. (2017, January 8). *How much CO2 is generated by producing and transporting a gallon of gas?* Retrieved May 20, 2017, from http://www.sierraclub.org/sierra/green-life/hey-mr-green-how-much-co2-generated-producing-and-transporting-gallon-gas

Statisics Canada. (2016, September 28). Retrieved May 20, 2017, from Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted): http://www5.statcan.gc.ca/cansim/a26

Statistics Canada. (2016, June 28). *Vehicle registrations, annual (number)*. Retrieved May 20, 2017, from http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=4050004&&pattern=&stByVal=1&p1=1&p2=31&tabMode=dataTable&csid=

Stephen Holland, E. M. (2015, August 9). *Analysing environmental benefits from driving electric vehicles*. Retrieved May 20, 2017, from VOX: http://voxeu.org/article/measuring-environmental-benefits-electric-vehicles#fn

U.S. Department of Energy. (n.d.). *Where the Energy Goes*. Retrieved May 20, 2017, from www.fueleconomy.gov: http://www.fueleconomy.gov/feg/atv.shtml

U.S. Energy Information Administration. (2017, April 25). *Net Generation by Energy Source: Total (all Sectors), 2007-February 2017*. Retrieved May 20, 2017, from https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_1