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Adapting the Past to Improve the Future

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How reintroducing electric rail and the people's car can help the United States reduce emissions and increase the sustainability of the transportation sector.

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ABSTRACT:

Though the trend of greenhouse gas emission is declining, the equivalent of 6,870 million metric tons of CO_2 was emitted in the United States in 2014.[1] About one quarter of this pollution is emitted by the transportation sector.[2] Instead of waiting for the next technological development in transportation to provide us with clean vehicles, what if we could adopt past transportation systems to reduce our emissions and increase future sustainability? This study explores the idea of adopting intra- and inter-urban electric rail and a people's car to reduce the annual U.S. transportation emissions using historical examples, the most recent studies published on emissions, and articles discussing the sociological impacts of transportation. Recently, the U.S. has seen the biggest railroad investments in the last 100 years, giving the country a huge opportunity to reintroduce electric rail. Since it is not feasible to reach everyone with public transit, private vehicles also need to shift towards sustainability as well by using low-emission technology currently available in a flexible manner so it is possible to upgrade the vehicle when newer technology is released. The major limitation of this study is the scope of this issue, and due to this the cultural feasibility of adopting these systems, the financial cost, detailed estimates on the actual amounts of emissions prevented, and alternative transportation systems were not heavily addressed.

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[1] Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014*. Washington D.C., 2016.

[2] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks.*

Introduction

In the last few decades there has been a push to reduce greenhouse gas emissions in the United States, such as President Obama's goal of reducing emissions by 17% of 2005 levels by 2020. Since 1990, greenhouse gas emissions from the transportation sector have increased by 17%, and in 2014 transportation across the country emitted 26% of the total GHG emissions that year—second to only the electricity sector at 30%.[3] Efforts have been made to find viable energy sources to replace fossil fuels, but instead of waiting for the next scientific breakthrough to improve the sustainability of both public and private transportation, what if we could adopt transportation concepts from the past to improve our future sustainability? By reintroducing intra- and inter-urban electric rail transit and an environmentally conscious people's car, the United States could drastically reduce greenhouse gas emissions and increase the sustainability of the entire transportation sector.

Before the 1880s, rail transit in the United States was dominated by the coal-powered steam train. The newly developed electric train quickly began to replace these models in urban areas, and by the turn of the century the new electric trains carried 5 billion passengers a year—seven times the passengers of steam trains operating in urban areas.[4] In 1902 alone, $2 billion (nearly $54 billion in 2016 dollars) was spent on 22,000 miles of electrified rails across the U.S.[5] Although huge capital investments were made to put this new transit technology in place, the majority of these electric rail systems were replaced with diesel-powered motorbuses just 50 years later. How could such a successful and well-invested system fail in mere decades?

The rising popularity of the automobile is typically believed to have caused electric transit's decline. Although there is some truth in that idea, there are other factors that played a more significant

[3] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks.*

[4] Stephen B. Goddard. *Getting There: The Epic Struggle Between Road and Rail in the American Century*. New York, NY: BasicBooks, 1994. 67.

[5] Goddard. 66-67.

role. By 1920, the majority of interurban electric trains—colloquially called 'streetcars'—were out-of-date. To remedy this aging system, the Presidents' Conference Committee was formed in 1929 to design a new streetcar. The new model provided significant comfort and noise improvements, but never widely replaced the older models.[6] By the time the new model was introduced, the United States was deep into the Great Depression and most companies could not afford to upgrade. Perhaps the biggest factor in electric transit's decline was the regulatory discrepancy between electric rail and motorbus transit systems. Public transit franchises in the early 20th century essentially allowed the electric transit companies to purchase legal monopolies in the cities they operated in. These franchises allowed the state to regulate transit companies in order to keep the fares cheap for the public and also required the company to maintain and repair the streets close to their tracks.[7] Because of these restrictions and fees, electric transit companies found it difficult to turn a profit and upgrade their systems at the same time. The conditions of these franchises could only be changed if the transit company changed vehicle type, which further incentivized companies to replace their aging electric rail systems with motorbuses. In addition to these franchise restrictions, highway policy helped create even more of an unfair advantage for motorbuses. Immediately following World War II, the direction of U.S. transportation funding began to promote flexibility in order to adapt to future growth.[8] Because railroads were confined to pre-existing tracks they were deemed incompatible with the future of U.S. transportation. Motorized vehicles, however, are free to travel wherever roads exist. While roads were considered an important public investment, rail transit continued as a private business that was required to serve a public need without any public funding. The federal government gave motorbuses a significant financial advantage over rail by funding highway construction throughout the mid-20th century.

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[6] David J. St. Clair. *The Motorization of American Cities*. New York, NY: Praeger Publishers, 1986. 5.
[7] St. Clair. 104-106.
[8] St. Clair. 99.

In the 21st century, this funding discrepancy has shrunk due to the largest railroad investments the United States has seen in over 100 years. $10 billion has been spent on expanding tracks between 2000 and 2012, and another $12 billion expansion has been planned.[9] 20% of the Transportation Investment Generating Economic Recovery (TIGER) federal grants have been awarded to railroad improvement projects, and since the Staggers Act of 1980 $460 billion has been invested in the railroad industry.[10] While these investments certainly sound like good news to those who support improving U.S. railways, the vast majority of the demand for rail today is for freight rail, not passenger rail. Rising diesel prices, semi-truck driver shortages, and highway congestion have all driven up demand for freight rail. An Association of American Railroads report estimates that to meet freight demand over the next 30 years, an additional $148 billion investment will be needed.[11] Currently, transportation policy still favors the needs of the freight market over public interest, but what if the U.S. directed investments to serve both the needs of the market and the public? Although such a project would require significant funding, the ongoing developments of the next few decades will provide a great opportunity to expand electrified rail across the United States.

Though an electric rail system has the potential to reduce greenhouse gas emissions, it cannot be considered a clean method of transportation until the power grid becomes clean itself. In 2015, almost exactly two-thirds of the United States' electricity was produced by fossil fuels: 33.24% by coal, 32.73% by natural gas, and an additional 0.7% by petroleum oil. Sustainable renewable fuels only account for 13.47% of electric production in 2015.[12] Though the U.S. has been moving away from producing electricity with natural gas and coal in favor of more sustainable fuels, the grid is still far from clean. This does, however, illustrate the advantageous flexibility of using electric power. As electric

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[9] Stich, Bethany, and Chad R. Miller. "A New Public Philosophy for a New Railroad Era." *Administrative Theory & Praxis* 34, no. 4, 2012. 606.
[10] Stich & Miller. 610.
[11] Stich & Miller. 606.
[12] U.S. Energy Information Administration. "Electricity Data Browser." Generation for 2015 by megawatt hours.

technology increases throughout this century, improved methods of producing electricity will likely arise. Very little—if anything—will need to change on the trains in order to use these forms of energy once they are converted into electricity.

An increase in passenger rail systems across the United States would also help to reduce the number of cars on the road, especially in urban areas. Globally, the number of cars is expected to triple by 2050, and the percentage of people who live in urban areas is expected to double by the same year.[13] Some industrialized countries already have 850 cars for every 1000 people.[14] While all of these cars will never be on the road at the same time congestion is expected to increase through the future. For the last 50 years, the solution for congestion has been to build more roads or to make the existing roads wider to accommodate more vehicles. This cyclical solution to congestion cannot go on indefinitely. Congestion also affects parking just as much as it does road travel. When urban residents decide to take public transit around the city instead of taking the car, the most cited reason for doing so is the lack of parking.[15]

While there is no doubt that reintroducing electric rail transit across the United States will lead to a reduction in greenhouse gas emissions and an increase in the overall sustainability of the country's transportation sector, public transit is only part of the equation. Even if the majority of the U.S. adopted electric public transit, some people will still rely on private automobiles for transportation. In particular, the elderly and rural citizens rely on private transportation more than their younger and more urban counterparts. 90% of drivers 60 years or older use a car for daily shopping trips, and when asked if they were willing to reduce this by one trip a week in order to improve air quality and road congestion, 40%

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[13] Firnkorn, Jörg, and Martin Müller. "Selling Mobility instead of Cars: New Business Strategies of Automakers and the Impact on Private Vehicle Holding." *Business Strategy and the Environment* 21, 2011. 265.

[14] Firnkorn & Müller. 265.

[15] Hagman, Olle. "Morning Queues and Parking Problems. On the Broken Promises of the Automobile." *Mobilities* 1, no. 1, 2006. 65.

of those drivers were unwilling to do so.[16] Mobility is a quality of life issue, and forcing the public to abandon their vehicles for rail transit at a 100% rate is not feasible. The United States has long had a close relationship with cars, and this is unlikely to change anytime soon. Therefore, in order to make our entire transportation system sustainable, the U.S. needs to pair the proposed electric rail transit with an environmentally conscious people's car to reduce private vehicle pollution.

The best example of a successful environmentally conscious people's car in the United States is the Volkswagen Beetle. Though the car was not designed specifically with environmentalism in design, its mechanical simplicity and small size allowed the car to achieve 35 miles per gallon in an era where the average car's fuel mileage rarely broke 20 miles per gallon.[17] The story of the Beetle begins with its Austrian inventor, Ferdinand Porsche. An early electric inventor, Porsche began to shift his focus towards automobiles in 1896. In 1921, Porsche expressed interest in producing an affordable people's car, but the executives at the company Porsche worked for, Austro-Daimler, were not convinced.[18] After years of attempting to sell this idea to automotive companies around Germany, Porsche created his own automotive design firm in Stuttgart, Germany in 1931, where he began to design what would become the Volkswagen Beetle. Three years later, Porsche was chosen by Adolf Hitler to design a people's car funded by the German state. By 1939, $12 million had been spent on research and development alone, yet not a single car was produced before the beginning of World War II.[19] When the war ended in 1945, the factory built to manufacture the Beetle remained under British control. After 4 years of sporadic production and reconstruction of the factory itself, the factory was out of debt and the newly formed Volkswagen company became the lead German exporter of cars.[20] First arriving in the United States in

[16] Nakanishi, Hitomi, and John Black. "Social Sustainability Issues and Older Adults' Dependence on Automobiles in Low-Density Environments." *Sustainability* 7, no. 6, 2015. 7298.

[17] Hiott, Andrea. *Thinking Small: The Long, Strange Trip of the Volkswagen Beetle*. New York, NY: Ballatine Books, 2012. 340.

[18] Hiott. 22, 51.

[19] Hiott. 94, 119, 146.

[20] Hiott. 297.

1950, the car quickly became popular with young Americans due to its stellar fuel mileage, simple design, and low cost. By 1960, the Beetle accounted for 46% of all foreign imports to the U.S.[21] Adapting this concept of a simple, low-emission, and inexpensive car to the 21st century would provide significant reductions in greenhouse gas emissions from the private transportation sector.

Every year, new technology is developed to further increase an engine's efficiency and reduce its greenhouse gas emissions. Though it may seem more sustainable to buy a new low-emission car and drive it for as long as possible, it may be more environmentally beneficial to replace that car before the end of its useable life. Over 60% of older vehicles' life-cycle greenhouse gas emissions are produced when driving with the remaining emissions being produced in the manufacturing and end-of-life stages.[22] Even with the added emissions of manufacturing, the efficiency of newer vehicles can lead to and overall lower level of greenhouse gas emissions. A Japanese study, *Better cars or older cars?*, investigated the potential CO_2 emissions mitigated when vehicular scrapping programs were in place. These programs are designed to get older, more polluting cars off the road by subsidizing the purchase of newer vehicles. In the study, there were four comparisons: A) no scrappage scheme (vehicles scrapped when they mechanically fail, estimated to be at 13 years of age), vehicles replaced with new gas cars; B) no scrappage scheme, vehicles replaced with new hybrid cars; C) scrappage scheme, vehicles replaced with new gas cars; and D) scrappage scheme, vehicles replaced with new hybrids. The life-cycle CO_2 emissions mitigated when a scrappage scheme is adopted and each car is replaced with a new gasoline-powered vehicle (Case A vs. Case C), 1.895 tons of CO_2 per vehicle can be avoided if the older vehicles are replaced at 9 years old.[23] When each car is replaced with a hybrid instead, 8.046 tons of CO_2

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[21] Hiott. 369.

[22] Kagawa, Shigemi, Klaus Hubacek, Keisuke Nansai, Minori Kataoka, Shunsuke Managi, Sangwon Suh, and Yuki Kudoh. "Better cars or older cars?: Assessing CO2 emission reduction potential of passenger vehicle replacement programs." *Global Environmental Change* 23, 2013. 1814.

[23] Kagawa et al. 1808.

per vehicle can be avoided if the vehicles are replaced at just three years old.[24] In 2014, there were 240,155,237 passenger vehicles registered in the United States.[25] If just one-third of these vehicles were replaced with gas-hybrid electrics, 579.7 million tons of CO_2 emissions—10.29% of the 2014 transportation sector emissions—could be reduced over three years. Due to the rapid technological advances of hybrid vehicles, it is more beneficial to replace them for improved models earlier than their traditional gasoline-powered counterparts, however, there will be difficulty in applying this rapid replacement strategy to a people's car. Most Americans cannot afford to replace their vehicle with a newer model every few years. One way to work around this limitation would be to design the people's car with flexibility in mind. As new automotive technology is developed, the older components of the car can be upgraded without having to replace the entire car.

A limiting factor of the *Better cars or older cars?* study is that only two types of cars are analyzed, traditional gasoline-powered and gasoline-electric hybrids, but other types of power exist in the automotive world. In a study by Jason J. Daniel and Marc A. Rosen, 13 different types of fuel were analyzed to determine which power source produced the fewest emissions per vehicle mile traveled. The top two fuels were both grid-independent hybrids, meaning the electricity was produced locally by using renewable methods. The grid-independent diesel-electric hybrid outscored the grid-independent gas-electric hybrid, but this study did not measure particulate pollutions that are more abundant with diesel motors.[26] The typical grid-connected gas-electric hybrid was the 3rd least polluting fuel, the 85% ethanol flex-fuel vehicle was 4th, and the dedicated electric vehicle was 5th. The control of this experiment, the base-line conventional gasoline vehicle, scored 11th.[27] While the dedicated electric vehicle scored 5th overall, improving the current electric grid would place this vehicle above all other

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[24] Kagawa et al. 1808.

[25] United States Department of Transportation. "Table 1-11: Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances." Number of registered light duty vehicles in 2014, both short and long wheel bases.

[26] Daniel, Jason J., and Marc A. Rosen. "Exergetic environmental assessment of life cycle emissions for various automobiles and fuels." *Exergy, an International Journal* 2, 2002. 292-293.

[27] Daniel & Rosen. 292, Figure 7.

forms of fuel. The primary issue with using electric power for a people's car is the reliance on batteries to store electricity. When these deplete, it often takes hours to fully charge. With a hybrid, gasoline or diesel can be used once the charge is depleted, allowing the car to continue to travel almost immediately. An electrically powered people's car could work for people who do not need to drive long distances every day, but a hybrid or flex-fuel option should be offered for those who need cars that travel longer distances.

In 2008, an Indian auto manufacturer called Tata released its own people's car, the Nano. The company intended to help the growing middle class in India move from motorized scooters to traditional cars by introducing a simple, cheap car. When it launched in 2008, the Nano cost 100,000 Rupees ($1500 USD).[28] Though this seems incredibly cheap for a new car, the average income in India for 2008 was only 49,932 Rupees, putting the car out of reach for the lower classes.[29] To put this into perspective, the cost of the original Ford Model T and Volkswagen Beetle in 2008 dollars is $21,000 and $11,000, respectively. Indian culture is very status conscious.[30] To be a part of the new Indian middle class meant you had to upgrade from a scooter, and the Nano was the answer to this motorization. In January 2008, there were 200,000 orders placed for only 100,000 Nanos, and buyers were willing to spend "up to 30% more…[to] get the car as soon as possible."[31] Unfortunately for Tata, the Nano was plagued with issues from day one. Reports of spontaneous combustion—most likely caused by cheap electrical switches—were the most damaging to the Nano's reputation.[32] Though the company could produce 20,000 Nanos a month, sales fell to between 3,000 and 8,000 per month in mid-2008, and in the 2014-2015 fiscal year,

[28] Nielsen, Kenneth B., and Harold Wilhite. "The rise and fall of the 'people's car': middle-class aspirations, status and mobile symbolism in 'New India'." Contemporary South Asia 23, no. 4, 2015. 371.

[29] The World Bank. "GNI per capita, Atlas method." Currencies corrected for inflation and the average 2008 USD to INR exchange rate used.

[30] Nielsen & Wilhite. 376.

[31] Nielsen & Wilhite. 379.

[32] Nielsen & Wilhite. 380.

only 16,901 Nanos were sold.[33] Since then, the basic Nano has been retired and replaced with the 235,000 Rupee Nano Twist. Offering more features and trendier colors than the original Nano, the Nano Twist has been rebranded as a hip and youth oriented second car for Indian families.[34]

The story of the Tata Nano showcases one of the greatest challenges to introducing a people's car in the 21st century: how can we convince people to drive simple, barebones cars when other more luxurious models are available? The original Nano came equipped with a manual gearbox, no power steering, no ABS, drum brakes, one windshield wiper, one gauge, no heater, and non-adjustable seats.[35] This level of automotive discomfort has not existed in the United States for decades. What hurt the Nano the most, however, was the stigma placed upon it that the car was somehow lesser than everyone else's car, and that it was a car designed for the lower class. Indians believed the primary reason people had Nanos was because they were unable to afford a different car.[36] Cars convey social status, wealth, and standing in public places. By driving a Nano, Indians were publically announcing that they could not afford any other kind of car. New Indian middle class consumerism led to the failure of one of the most promising people's cars in the last 50 years, and a similar vein of consumerism could hurt the chances of the United States adopting a people's car as well.

Though there will be both financial and cultural difficulty, adopting both intra- and inter-urban electric rail transit with the addition of an environmentally conscious people's car in the United States will lead to a reduction in greenhouse gas emissions. The sustainability of both of these systems also relies on improving the cleanliness of our current energy grid. Due to the scope of this project, many issues relating to this topic were not explored, such as alternative transportation models like car sharing, in-depth cultural examinations on the feasibility of adopting both electric rail and a people's car in the

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[33] Nielsen & Wilhite. 380.
[34] Nielsen & Wilhite. 382.
[35] Nielsen & Wilhite. 381.
[36] Nielsen & Wilhite. 381-382.

United States, and detailed estimates on the actual reduction in greenhouse gases these systems would cause. The addition of future studies on these topics would greatly strengthen the argument for implementing these transportation systems in the United States.

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