Transport electrification

Infrastructure killed the electric car

When prices are adjusted for quality, electric vehicles stood their ground to petrol cars in the early twentieth century United States. If the electricity grid had developed twenty years earlier, they might have reached a 68-79% market share and CO2 emissions per car could have declined by sixty percent, a new study finds.

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Within the diffusion of innovations, a long-running debate has been what comes first, the product or the system supporting it: ocean-going vessels or modern harbours, appliances or the grid, cars or hardened roads, planes or airports. This timing concern is particularly salient for technologies that require new infrastructure to achieve mass scale adoption, such as electric vehicles (EVs) which need a network of charging stations. Now, writing in *Nature Energy*, Josef Taalbi and Hana Nielsen address the issue by measuring the role of infrastructure in resolving the combustion engines versus EV automobile technology competition [1] at the beginning of twentieth century, and find significant contribution of delayed grid development in favouring the uptake of combustion engine vehicles.

In 1900, cars based on steam, electricity and petrol technologies accounted for 40%, 38% and 22% of the 4,200 cars produced [1]. In 1905, over half of commercial vehicles were electric [2]. Conventional wisdom has it that the gasoline car won because it was more efficient, and thus lower-priced. Carefully analysing the historical data, Taalbi and Nielsen cast doubt over this explanation and compel us to look deeper.

The researchers gathered and analysed large datasets including details of over 37,000 different passenger car models introduced between 1895 and 1942, and linked data at the county level on electricity and gasoline infrastructure availability, roads and household incomes.

The study investigates whether EVs were outcompeted due to better performance and lower price of petrol cars, and if not, what could then explain the demise of EVs by

1920. It finds that average petrol car prices were never lower than 85% of EV prices. When adjusting for quality, EVs were not more expensive than petrol cars until 1910, but were aimed more towards urban consumers.

The question remains what could then explain passenger EVs' downfall. An important factor was the availability of electricity infrastructure. Taalbi and Nielsen first study the impact of infrastructure development on technology selection for automobile development. They then build a counterfactual that finds that if the 1922 diffusion rate of the US grid would have been reached by 1902, 64-79% of models introduced by the 1920s would be electric. Though electricity might not have won all-out, EVs would likely have been dominant for urban trips, while petrol cars would still be used for long-range driving [3].

Taalbi and Nielsen's findings are consistent with present-day studies on that find that infrastructure development is important for EV adoption and retention decisions [5]. Increasing the number of charging points, for example, is an essential part of the UK government's recent £2.8bn push for EVs [6].

Taalbi and Nielsen also tentatively estimate the consequences for pollution, had EVs won. They suggest CO_2 emissions per car would have been reduced by 0.4 kilograms per mile in 1920, to just 42% of a petrol car's emissions, and total emissions by twenty million tons.

Of course, it is not clear whether, at the time, better decisions on infrastructure development could realistically have been made. Social scientists sometimes distinguish three degrees of this 'path dependence' problem: the decision does not matter or optimal decisions cannot be made; the decision leads to regrettable outcomes but these were unknowable initially; the decision leads to regrettable outcomes that were known and remediable [7,8]. Considering pollution, the electricity infrastructure was probably somewhere between the second and third degree of path dependence. CO_2 emissions and other exhaust was likely to be seen as less of a problem at the time, especially given the enormous city centre pollution by horse manure. Yet at the system level some foresight might have been possible. A petrol car nowadays generates about the same CO_2 emissions per mile as an EV in 1920, yet it took us a lost century to get to that level [9].

One does wonder however whether the spread of electricity grids could have been considerably faster. Electric utilities had the second-fastest productivity growth of all US industries between 1899 and 1941, at 5.0 percent per annum for 42 years, followed by cars with 4.7 percent. Electric machinery achieved 2.0 percent [4]. These rates are stellar compared to present-day productivity growth rates and underline that these were highly dynamic industries that could have responded well to earlier infrastructure diffusion.

One impeding factor perhaps was the famous ‘war of the currents’, over DC and AC, between Edison and Westinghouse in the late nineteenth century and a subsequent patent pool. This returns us to the question what came first, the product or the system. AC won, but not totally: the last DC power station in New York City, for example, was closed only in 2007. Edison and Westinghouse might have come to an agreement much earlier, would they have realised how important fast adoption was for electricity applications that faced competition from other technologies.

Future studies could explore whether the same results hold for other countries historically, and for other competing technologies, such as zeppelins versus passenger planes, steam versus diesel trains, steam versus diesel ships, bicycles versus scooters, or ferries versus hovercrafts.

The challenges encountered in this kind of historical research are many: the farther back in time we go, the sparser the data become and the more inventive we need to be to test hypotheses. Taalbi and Nielsen’s study shows ways of doing this and highlights how relevant infrastructure development can be for EV adoption, how far-reaching and long-lived the consequences of decisions 120 years ago can be for the present, and how impactful our present decisions can be for the future.

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References:

[1] Josef Taalbi and Hana Nielsen, “How slow electrification gave us gasoline cars and why infrastructure matters”, *Nature Energy*, forthcoming.

[2] Mom, G. *The Electric Vehicle: Technology and expectations in the automobile age* (Johns Hopkins University Press, Baltimore, 2004).

[3] Kirsch, D. A. *The Electric Vehicle and the Burden of History* (New Brunswick, N.J., 2000).

[4] G. Bakker, N. Crafts and P. Woltjer, “The Sources of Growth in a Technologically Progressive Economy: The United States, 1899-1941,” *Economic Journal*, Vol. 129 (2019), pp. 2267-2294.

[5] Tran, M., Banister, D., Bishop, J. D. & McCulloch, M. D. Realizing the electric-vehicle revolution. *Nature Climate Change* 2, 328 (2012).

[6] B. Johnson, “Now is the time to plan our green recovery,” *Financial Times*, 17 November 2020.

[7] Paul A. David, “Clio and the Economics of Qwerty,” *American Economic Review*, Vol. 75 (1985), pp. 332-337.

[8] Liebowitz, S J & Margolis, Stephen E, 1995, “Path Dependence, Lock-in, and History,” *Journal of Law, Economics and Organization* 11(1), 205-26.

[9] US Environmental Protection Agency, Office of Transportation and Air Quality, “Greenhouse Gas Emissions from a Typical Passenger Vehicle, ”EPA-420-F-18-008, March 2018. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U8YT.pdf