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Macroeconomic effects of a fossil fuel independent vehicle fleet in Sweden (20-Fifty) – Policy briefing

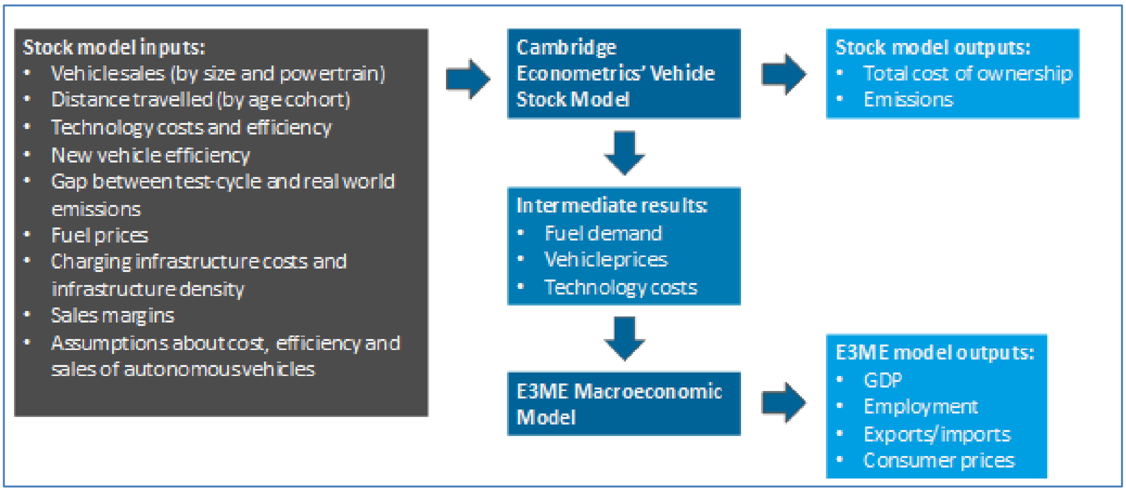
This document summarises the findings of the 20-Fifty project, which assesses the economic impacts of different pathways to meeting Sweden's Climate Law, which seeks to reduce emissions from domestic transport by 70% in 2030, compared to 2010 levels, and aims to establish a fully fossil fuel-independent vehicle fleet by 2045.

The analysis carried out within this project explores the economic and emissions impact of decarbonising both passenger cars and heavy-duty goods vehicles (HDVs), through the deployment of energy efficient technologies and advanced powertrains.

Methodology

The approach to modelling the economic impact of decarbonisation pathways in road transport involved a two-stage process; using a stock model, to introduce new technologies and advanced powertrains into new sales of passenger cars, vans and HGVs, and capture the impact of changes in fuel demand, technology costs, vehicle prices and emissions, and using this data as inputs to Cambridge Econometrics' E3ME[1] macroeconomic model. The overall approach is summarised in Figure 1 below.

Figure 1 The links between the models used in the 20-Fifty project



[1] See www.e3me.com, and the project website https://20fifty.se/ for further information on the modelling approach.

This toolkit was then used to capture the economic and environmental impacts of different pathways for decarbonising Swedish road transport.

Scenarios

The scenarios considered in the analysis were set up with a specific target in view; how to meet Sweden's ambitious emissions reduction targets. Then different pathways were evaluated and the relevant scenarios constructed. In this briefing, we present only the reference and central technology scenario; however, other pathways were evaluated in the full analysis[2].

Reference scenario – CPI

The reference case for this analysis is the *Current Policy Initiatives* scenario. This reflects a deployment of new technologies to meet only the EU's mandated vehicle emissions standards. As this work was completed in mid-2017, it reflects only the agreed target for 2020/21, of 95 g/km of CO2 in new vehicles, and not the more recent proposals for a further 15% and 30% reduction in the emissions from new vehicles in 2025 and 2030 respectively.

The required reduction in fuel consumption in this scenario is primarily met by improvements in the fuel efficiency of new internal combustion engine (ICE) vehicles. There is, though, a limited deployment of advanced powertrains, representing 6% of new sales in 2020.

Technology scenario – ELEC_BB

This technology scenario sets out to meet the specific targets set out in Sweden's Climate Law, agreed in June 2017, of a reduction in CO2 emissions associated with domestic transport by 70% in 2030 (compared to 2010 levels), as well as an increase in biofuel blending quotas in line with announced Swedish policy (see Table 1). This policy aims to increase the proportion of biofuel used in conventional fuels to 40% in 2030. Biofuel blends were then held constant from 2030 out to 2050.

Table 1 Biofuel blends in conventional fuels in the ELEC_BB scenario

Fuel	2017	2020	2025	2030
Petrol	3%	4%	20%	40%
Diesel	17%	21%	32%	40%

Fuel efficient technologies were introduced into new vehicles across the different powertrains, broadly in line with the technology deployments envisaged by Ricardo AEA in their work for the European Commission[3], and as used by CE in a number of different studies, including *Low Carbon Cars in Germany*[4]. This improves the fuel efficiency of each powertrain (although increases purchase prices) and therefore reduces the demand for fuel.

Advanced powertrains were then introduced into new sales to ensure that total CO2 emissions in 2030 were in line with the 70% reduction target. The percentage of new sales which were required to be electric vehicles (defined in this scenario as battery electric (BEV), plug-in hybrid electric (PHEV) and hybrid electric (HEV) vehicles) is shown in Figure 2 below.

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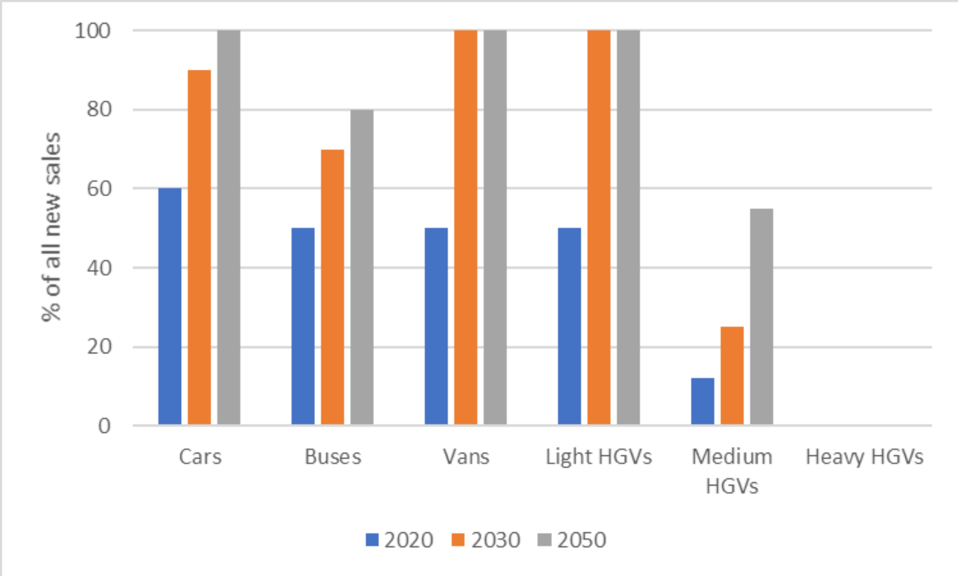
[2] See https://20fifty.se/ for a copy of the full project report.
[3] See https://www.theccc.org.uk/wp-content/uploads/2015/11/Ricardo-Energy-and-Environment-for-CCC-Light-duty-vehicle-cost-and-efficiency-scenarios1.xlsx.
[4] See https://www.camecon.com/how/our-work/low-carbon-cars-in-germany/.

Figure 2 Share of new sales which are electric vehicles (BEV, PHEV, HEVs) in the BB_ELEC scenario in selected years



The implications of the modelled transition

The decarbonisation pathway modelled in the BB_ELEC scenario has three different shifts within it which affect the emissions associated with road transport;

- The deployment of fuel efficient technologies into new vehicles, which reduce energy consumption across all powertrains
- The rollout of advanced powertrains, which require different fuels (and have different levels of energy efficiency), and the installation of supporting infrastructure
- The blending of biofuels into conventional fuels, which influences the tailpipe emissions associated with all vehicles within the fleet

All three shifts have an influence on the total emissions from road transport; however it is the third which has the most profound implications, primarily due to the fact that changes in the extent of biofuel blending affect not just new vehicles sold but all vehicles across the fleet (based on the assumption that all vehicles can make use of heavily blended fuel without the need for retrofitting). Below, we set out the impact of these changes on emissions, and then the channels through which these influence the economy.

Emissions impacts

Fuel efficient technologies reduce the energy consumption of vehicles per kilometre driven; therefore, for vehicles with tailpipe emissions, they serve to reduce CO2 and local particulate emissions. For electric vehicles (or hybrids running in electric mode) they reduce electricity consumption, although since fossil fuels play only a small role in Swedish electricity generation, this has only a minor impact on economy-wide emissions.

Advanced powertrains shift the energy source away from fossil fuels and towards alternative fuels (in the BB_ELEC scenario, this is exclusively electricity, although it could include pure biofuel or hydrogen). Where these alternative fuels have a lower carbon footprint (as is the case with Swedish electricity), CO2 emissions are reduced.

The use of blended biofuels also shifts energy consumption away from carbon-intensive fuels (petrol, diesel) and to fuels with a lower (or zero) carbon footprint, and as such reduces CO2 emissions.

Economic impacts

These shifts impact upon the economy in several ways. Fuel efficient technologies increase the purchase price of vehicles, thereby increasing consumer expenditure on motor vehicles, but reduce the costs of refuelling/recharging (i.e. expenditure on petrol/diesel or electricity) by more than this; so overall, they reduce expenditure on road transport, and free up consumer expenditure to be spent on other goods/services. Since these other items typically have more domestic content, and create more domestic jobs, this has a net positive economic impact.

The deployment of advanced powertrains shifts demand away from conventional fossil fuels, which are largely imported from overseas, and towards electricity, which is domestically produced. As such, this deployment reduces leakage from the economy, which has a positive impact on Swedish GDP. In addition, because advanced powertrains are more expensive than internal combustion engines, they increase expenditure on motor vehicles, but by less than they reduce refuelling/recharging costs, leading to a further boost to the domestic economy. The installation of supporting infrastructure for these advanced powertrains will provide a short-term boost to the economy, as either private providers or government invest in the new equipment – although such investment will be recouped either through direct payment from consumers (i.e. up-front payment for home charging equipment) or through higher utilisation costs (i.e. higher electricity costs paid for recharging at a rapid charging station, in the same way that the cost of refuelling at a motorway service station is currently more expensive than refuelling at a suburban station).

The shift away from fossil fuels also has a small impact on government revenues, due to the taxation revenue on these fuels that is foregone. However, this is largely negated by increased tax take elsewhere across the economy (as a result of increased economic activity); the gap is addressed through an increase in sales tax rates, which reduces slightly household consumption (as prices increase).

Finally, the use of blended biofuels has a number of effects on the economy. Due to high production costs, all biofuel (whether domestically-produced or imported) requires a subsidy, to ensure that the pump price is the same as it is for conventional fossil fuels (i.e. that fuel prices don't increase as a result of blending, encouraging the purchase of non-blended fuels). This subsidy is paid by government, and in the economic modelling carried out for this analysis, the impact on the government balance is counteracted by an increase in tax rates (to ensure that the government is not increasing debt levels or cutting spending elsewhere to facilitate this expenditure). Specifically, it is balanced by an increase in sales tax (VAT) rates. This increases the price of goods and services that are subject to the tax and reduces household consumption. The additional impact of biofuels depends upon whether they are domestically produced or imported. If domestically produced, they represent a shift from imported oil to domestically-produced fuel, which reduces leakage from the economy and creates domestic economic activity and jobs. If imported, they simply represent a shift from a cheaper imported fuel to a more expensive imported fuel. This increases leakage from the economy and has a negative impact on GDP and employment. Overall, the net impact of biofuels depends very much on whether they are domestically produced or imported; and as such capacity for domestic production is a key determinant of the overall economic impact of a decarbonisation pathway which foresees a significant role for biofuels.

The modelled macroeconomic impacts

The economic modelling of the ELEC_BB scenario shows the positive economic impact of the transition, as compared to the CPI scenario. The drivers of this are as set out above; the replacement of imported fuels with domestically-produced electricity (and some biofuels), plus a stimulus from the increased investment in charging infrastructure, and increased economic activity driven by the lower total cost of ownership of vehicles (which passes through to consumers directly, in the case of cars, or indirectly, through lower prices, where the cost of van or HGV transportation is concerned). However, there is downward pressure on GDP due to the subsidy provided on biofuels and, to a lesser extent, the reduction in fuel duties; both have a negative impact on the government balance, which is maintained through increases in sales taxes in the modelling. This increases prices faced by consumers, and lowers consumption in real terms, dampening the positive impact on GDP from the other effects.

Total GDP is 0.3% higher in 2030, and 0.4% above CPI in 2050. Employment is 0.6% higher in 2050, equivalent to an additional 30,000 jobs in the Swedish economy.

The observed outcomes are the net impact of the effects described in the previous section. So, while biofuel subsidies, and biofuel imports, put downward pressure on GDP and employment, in this scenario those effects are more than counteracted by other changes in the cost of transport (i.e. increased efficiency and reduced costs of other powertrains) and other economic effects (such as the domestic production of biofuels and electricity).

Implications for policy

The first conclusion that can be taken from this analysis is that the economic impact of the decarbonisation of road transport is small and positive – in contrast with the oft-repeated fear that the transition will be costly for both society and individuals.

However, beyond this, there are clearly important policy messages, both in the context of the specific transition in Sweden and the broader movement across Europe. The transition that is enshrined in Sweden’s Climate Law is extremely rapid, by European standards. Such a rapid transition, in such a short period of time, cannot be met solely by altering the characteristics of new vehicles; in the 12 years between now and 2030, given historically rates of turnover in the vehicle stock, it would be impossible to meet the required reduction in CO2 through new vehicles alone. The scale of transition envisaged, were it to be met without biofuels, would require the majority of the vehicle stock to be BEVs, and such a transition would have to happen more or less instantly (i.e. an ‘overnight’ transition away from sales of ICEs and to BEVs). More realistically, reaching this target requires the deployment of a low-carbon option that can be used in the existing vehicle stock as well. In the Swedish case, this policy is built around the use of drop-in biofuels.

However, the carbon emissions associated with biofuels remain a contentious issue in a European policy context. The recast of the Renewable Energy Directive proposed by the European Commission (RED II) aims to reduce use of first-generation biofuels (to no more than 3.8% of all fuel in 2030) and sets explicit targets for advanced biofuel use (of at least 3.6%). The European Parliament voted through higher targets in January 2018; at the time of writing, no final target has been agreed. However, the environmental impact of first-generation biofuels is a subject of much debate, and while second-generation biofuels are theoretically zero carbon, the potential for domestic production within Europe is the subject of much debate; while the work carried out in Sweden and referenced in this 20-Fifty study suggested that there is around 36 TWh available in the short run, and up to 47 TWh in the long run, other studies, such as Biofrontiers[5] have found there to be much lower availability. Without such domestic capacity, biofuel would have to be imported, which has implications both for the carbon footprint of the fuel (since the transportation of the fuel would not be

[5] See https://www.theicct.org/series/biofrontiers for more information on this work.

zero-carbon), and the economic impact of the transition, even when the sustainability of the source itself is assured.

From an economic perspective, a shift from imported oil to imported biofuel is a shift from a cheaper imported fuel to a more expensive one; this would result in more money leaving the Swedish economy and mitigating much of the positive economic impact of decarbonisation. Even when biofuel is domestically produced, it currently incurs substantially higher costs than the equivalent volume (as measured by kilometres of motor vehicle travel facilitated) than conventional fossil fuels. As such, all biofuel is supported by a subsidy from government, which brings the pump price down to that of conventional fossil fuels. Large-scale deployment of biofuel across the vehicle fleet would therefore require a substantial increase in the absolute value of this subsidy and would have to be funded through taxation elsewhere in the economy (either further taxes on drivers of motor vehicles, or across broader bases, such as through sales or income taxes).

It is not clear to what extent the path available to Sweden for decarbonisation (through biofuels) is available to other EU Member States. Other Member States do not have the same potential capacity for biofuel production, meaning that in order to follow this pathway, the fuel would have to be imported – and as highlighted, this mitigates many of the economic (although not necessarily the environmental) benefits of the transition. It seems likely therefore that, in fact, much of the rest of Europe will be following a slower transport decarbonisation pathway, based around the deployment of new vehicles which are more fuel-efficient and run on alternative fuels (i.e. electricity and potentially hydrogen) rather than adopting the Swedish biofuel-based pathway. There is also the possibility for Sweden to export biofuels, in a situation where domestic biofuel production has been increased and domestic demand is falling due to the deployment of advanced powertrains (and therefore reduced demand for conventional blended fuels). This could potentially support other EU Member States to decarbonise their own road transport systems, and provide a boost to the Swedish economy, although the scale will depend upon the volume of advanced biofuels that can be sustainably produced within Sweden.

Finally, while biofuels are an important part of the solution to meeting the Swedish transport decarbonisation challenge, this analysis has also shown that there is not sufficient domestic production potential to deliver the transition solely through domestically-produced biofuels. As such, policy must be brought forward which also supports the deployment of advanced powertrains (BEVs, PHEVs and potentially FCEVs). This includes policies aimed at increasing attractiveness to consumers (e.g. direct purchase subsidies for both passenger cars and heavy-duty vehicles) and those which encourage the development of supporting infrastructure (e.g. providing guarantees or other financial support for charging point operators or reducing barriers to the installation and operation of public charging points). Notably, the economic benefits of the transition are largely derived from the transition to lower-cost advanced powertrain vehicles, so in order for the economic benefits outlined in this study to be realised, it is essential that the shift to low-carbon powertrains is brought about.