UNIVERSITY of STRATHCLYDE
CENTRE FOR ENERGY POLICY

26.10.2021
https://doi.org/10.17868/78270

Policy Brief

Understanding the trade-offs involved in driving economic growth in the transition to electric vehicles

Summary

The decarbonisation of transport is a key component of reaching mid-century net zero targets now set in statute across the UK. Previous work at CEP[1] has shown that upgrading the electricity network and the wider rollout of electric vehicles (EVs) can ultimately deliver net benefits across the economy. This policy brief builds on our previous work to focus attention on important trade-offs associated with the rollout including electricity price impacts, labour supply constraints and wider price pressures.

Key research questions and findings

What benefits can the rollout of EVs bring to the UK economy?

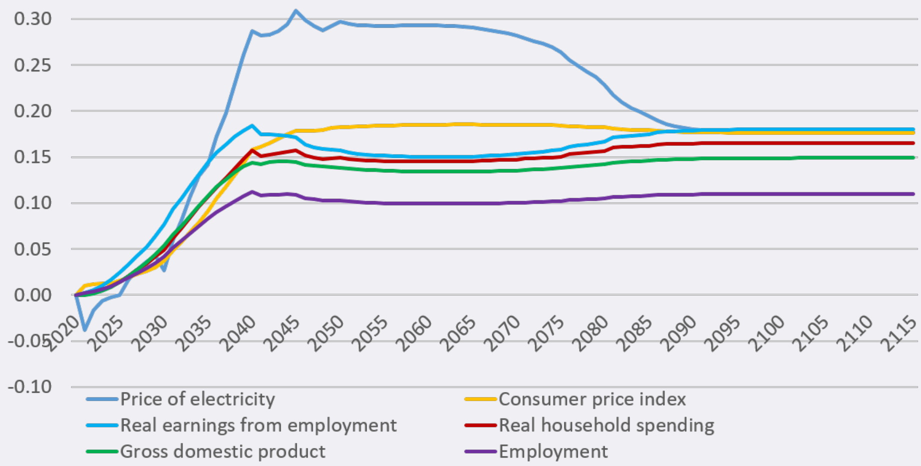
- We considered a scenario involving £10billion of spending to upgrade the UK electricity network, spread over the timeframe between 2020 and 2050 (with roughly one-third of the investment involving spending directly in the UK - largely on construction activity) to enable a full rollout of EVs in the private transport fleet by 2050. Our scenario involves the £10 billion cost being entirely recovered through consumer bills over the 45-year lifetime of the assets created.
- When we consider the combined impact of this investment activity and the EV uptake it enables, even with no further technological progress or other productivity gains in the electricity sector or the wider economy, the outcome is one of sustained net gains in GDP per annum (ultimately +0.15% above what it would otherwise be). This is associated with net gains in employment (+0.11% or 32,177 additional full time equivalent, FTE, jobs), and real earnings from employment (+0.18%).
- However, given the scale and timeframe of both the investment and the full EV rollout, the full adjustment of the economy takes a long time - to the early 2090s. Figure 1 overleaf shows that during the transition slightly smaller GDP, employment and real income gains are observed in the 2020-2050 timeframe. Moreover, it is not a steady upward progress, given that the economy is moving through phases, where initially the network upgrade is the dominant driver of expansion, through ones where the impacts of the EV rollout itself take over.
- Beyond 2050 (when the network upgrade phase ends), the observed gains are driven largely by the shift from using petrol and diesel to EVs to fuel private transportation. This is predominantly a result of electricity generation in the UK relying more on domestic industries compared to more import-intensive petrol and diesel, with the implication that a greater share of the households spend on transportation fuels is directed to UK industries.
- As the need to recover costs through energy bills slows (though this is not fully completed until the early 2090s, with the last of the new assets created in 2050), employment and real income gains dominate the response of UK households, with greater consumer spending ultimately enabling a spreading of gains across multiple sectors of the UK economy. The only net losers are those sectors supplying conventional vehicles and fuel.

“Emerging positive and sustained outcomes are largely driven by the shift from petrol and diesel to EVs for private transportation. This is predominantly a result of electricity generation in the UK relying more on domestic industries compared to petrol and diesel. However, the economy-wide expansion..........has price impacts.”

26.10.2021
https://doi.org/10.17868/78270

Summary

Figure 1. Key macroeconomic impacts (% change) of £10 billion network upgrade spending between 2020-2050 and 100% EV roll-out by 2050

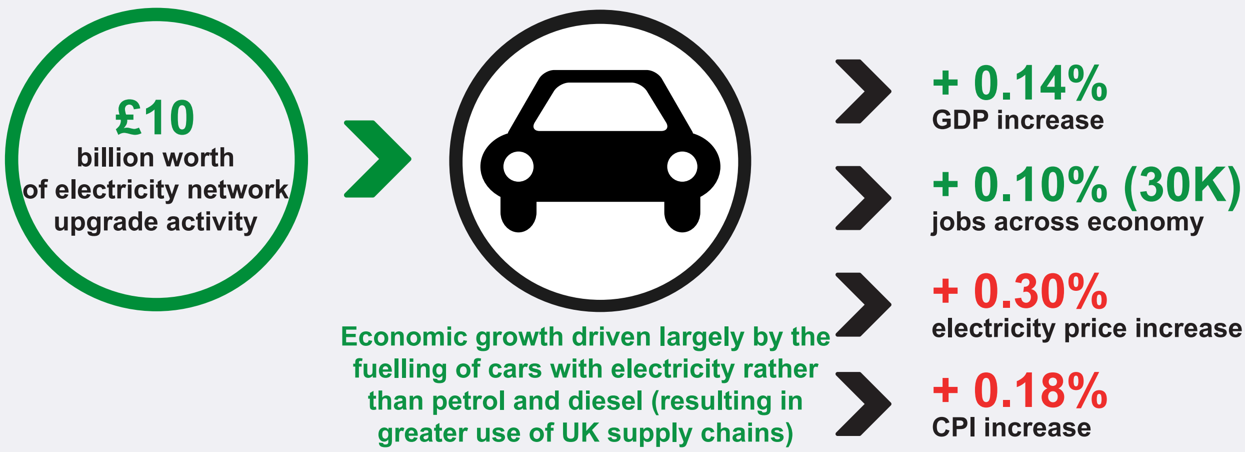


What impact does enabling and realising the rollout of EVs have on the price of electricity and the cost of living?

- However, the economy-wide expansion associated with enabling (through network upgrades) and realising the EV roll-out has price impacts. Figure 1 shows the trajectory of both the price of the electricity and the wider consumer price index (CPI), where the latter is taken to be an indicator of the cost of living. The increase in the electricity price is maximised at +0.31% above what it would otherwise be in 2045, while the CPI increase settles at between +0.18% and +0.19% from 2045. Both ultimately settle at +0.18% by 2090.
- Transitory increases in the electricity price are partly driven by the recovery of investment costs through the electricity price. Over time, the sustained impact on the price of electricity is driven by two factors. The first is increased demand for electricity to fuel EVs. The second is that the electricity industry must grow to meet this demand in the context of a wider economic expansion that is constrained by the presence of a lasting labour supply constraint which increases the cost of labour faced by all production sectors in the economy.
- Figure 1 shows that rising labour costs does equate to net increases in real wage rates and incomes, which helps power the wider economic expansion. However, the real challenge will be a distributional one: all households will not benefit equally, or at all, from growing real wage income, or other incomes such as returns on capital invested, but all will face the impacts of increases in the electricity price and the cost of living more generally.

Wider-economy impacts of the EV roll-out by 2050

100% EV penetration in private transport by 2050



Key Research Questions and Findings

Here we step out the scenario summarised above to separately consider the initial driver of the £10billion investment in electricity network upgrades (which we label the 'enabling stage) regardless of the extent of EV roll-out realised. We then consider the implications for the outcomes summarised above if the full 100% EV roll-out is not actually realised. This involves working through the three distinct research questions of our project. We provide a high level overview of our scenario approach in the Appendix, where we also provide reference details for publications providing details on our economy-wide computable general equilibrium (CGE) model.

1. Could the electricity network upgrade spending required to support 100% EV rollout deliver economy wide gains in its own right?

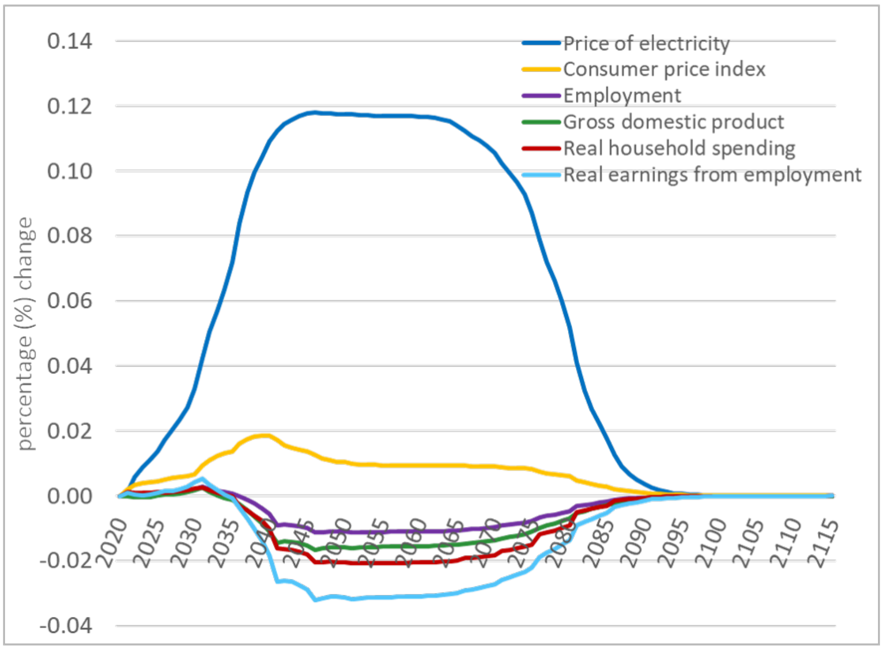
Figure 2 shows how the 'enabling stage' of the electricity network upgrade activity and cost recovery alone impacts key macroeconomic indicators. This involves simulating the introduction of the £10billion spending on the electricity network upgrade, where one-third of the total is directed at the UK construction sector over the period 2020-2050, but with the full amount recovered via energy bills over the 45-year timeframe after assets are created.

Under this scenario, we find that economy wide gains triggered by the enabling stage activity – focussing here on GDP, employment, real earnings from employment, and household spending - are limited (concentrated between 2020-2035) and are actually offset by negative price pressures 15 years before the network upgrade is completed. The gross positive impacts of investment spending are largely driven by additional activity across the economy mainly through the 'Construction' sector and its supply chain. However, once the network upgrade activity has been completed in 2050 there is no other driver of expansion through network investment.

At the same time, following the end of the enabling stage, the recovery of the upgrade costs continues and is reflected in the significant rise in the price of electricity reaching a peak of 0.12% from 2050 until end of 2060's then gradually declining to the end of the repayment period (i.e., early 2090s) (see Figure 2). This drives a wider increase in prices across the UK economy, represented by the CPI, reaching a maximum of 0.02% in 2040, which negatively affects both the domestic consumption and the exports of UK goods and services. In fact, the reduced demand for UK products and services leads to less employment opportunities that reduce the UK households' real earnings from employment and their consumption, leading to further economy-wide losses. However, these negative impacts are temporary. Once the cost recovery period is completed the economy swiftly returns to its base level.

Crucially, here we find that the upfront and large-scale electricity upgrade activity to enable the rollout of EVs will introduce price pressures and crowd out other activity in the economy. Thus, there is a need for cautious and careful consideration regarding the impacts on electricity prices, particularly in recovering the electricity network upgrade costs and the impacts on the price of other goods and services/ cost living. This is both in terms of the potential impacts on those least able to pay, and how household real earnings from employment and spending/expenditure will be affected. These have the potential to trigger or increase fuel poverty and income inequality gaps, which could

Figure 2. Key macroeconomic impacts (% change) of £10 billion network upgrade spending between 2020-2050 to enable 100% EV rollout by 2050

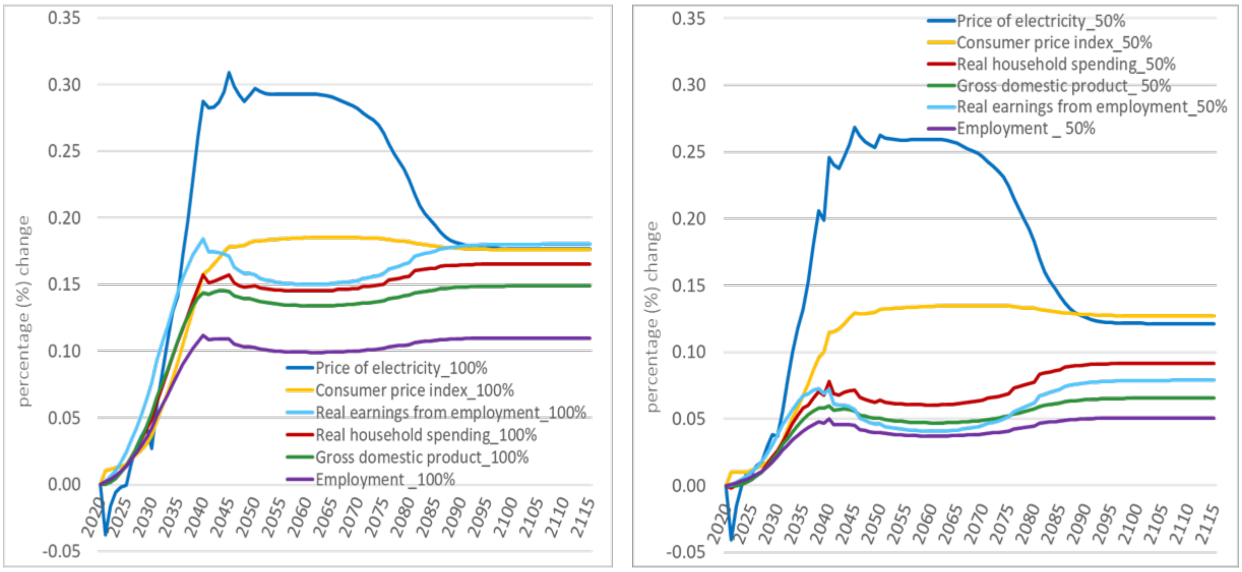


2. Could the introduction of the EV rollout change the economy wide picture?

As shown above, the electricity network upgrade activity and cost recovery in insolation triggers relatively small, transitory enabling stage impacts over the transition period and until the full electricity network upgrade cost is recovered. Could introducing the realising stage (i.e., the rollout of EVs) exacerbate or offset the enabling stage outcomes and the economy wide picture?

Figure 3 illustrates the impacts of introducing the 'realising stage' with an EV rollout of 100% and 50% respectively and the interaction with the enabling stage outcomes. This involves simulating scenarios involving a shift away from buying and fueling conventional vehicles towards electric ones. Note that the 50% rollout represents a case where the projected 100% EV uptake does not materialise. This may occur for several reasons including for instance affordability challenges, households' unwillingness to adopt and if the available EV manufacturing capacity is insufficient to meet implied demand. However, each EV rollout path involves same level of required network upgrade spending, and conditions across the wider economy, including the lasting labour supply constraint, remain the same. Our focus is to generally understand the extent to which picture of wider economy gains set against increases in the price of electricity may be affected if there is essentially an over-investment in the capacity.

Figure 3: Key macroeconomic impacts (% change) of £10 billion network upgrade spending between 2020-2050 and 100% EV roll-out (left) and 50% EV roll-out (right) by 2050



In both cases, we find that net positive and sustained outcomes emerge regardless of the EV rollout path - reinforcing our previous research[2,3] findings around the role and importance of shifting to a fuel source (electricity) that is more reliant on domestic supply chains rather than import intensive fossil fuel (petrol and diesel). Specifically, around 60% of the UK's electricity intermediate inputs are sourced from domestic industries. This compares to only 21% in the case of the UK Refined Petroleum industry. However, there are differences in the nature and magnitude of the net positive outcomes due to the shift in composition of economic gains driven largely by the increased demand for electricity and the UK EV manufacturing industry output.

The full projected 100% EV rollout triggers a higher trajectory of UK GDP expansion (reaching +0.15%), accompanied by real earning gains (+0.19%) and sustained increases in employment (+ 0.11% or 32,177 additional FTE jobs) with 100% EV roll out by 2050. UK household spending (+0.18%) receives a further boost via increased efficiency in terms of the spending requirement per mile travelled, but also as more employment opportunities and greater wages manifest. However, because of increased demand for electricity to fuel EVs, there is a sustained increase in the price of electricity (+0.18%) relative to the enabling stage (see Figure 3). This demand-driven increase also aggravates the electricity price pressures observed during the recovery of network upgrade costs via the energy bills, reaching a maximum increase in the price paid by households of 0.31% in 2045. This is also reflected by the cost of living/CPI increasing to as high as 0.19%.

With 50% EV rollout the expansionary power of the 'realising stage' is reduced but remains sufficient to drive positive and sustained wider economic gains in all timeframes. This is reflected by sustained increases in UK GDP (0.07%), real earnings from employment (0.09%) and employment (0.05% or 15,632 additional FTE jobs). Moreover, due to the reduced demand on electricity and EV manufacturing output, the expansion across the economy shifts further in favour of household consumption and sectors that service household demand compared to the 100% EV rollout case. However, even with the reduced demand for electricity, there is sustained increase in the price of electricity (+0.09%) with the transitional impact reaching as high (0.22%) in 2045.

How does this impact the 'Just Transition' implications of enabling and realising the EV roll-out? Perhaps the crucial outcome here is that the electricity price and CPI pressures highlighted during the enabling stage largely persist even if the wider economy expansion is not fully powered by the full 100% EV roll-out. In fact, the increased demand for electricity due to the roll out of EVs exacerbates the electricity and CPI pressures, which are now sustained even beyond the end of the repayment period (i.e., early 2090s). This is likely to be a point of particular policy concern: how can more extensive adoption of EVs be facilitated without negatively affecting those least able to pay?

3. How might the impacts be distributed across sectors of the UK economy?

Figure 4 illustrates the distribution of employment impacts across the different UK industries due the network upgrade activity and the full EV rollout. The number and distribution of net jobs gained reflects the combined impacts of the strength of the domestic electricity sector's supply chain and the increased UK household consumption.

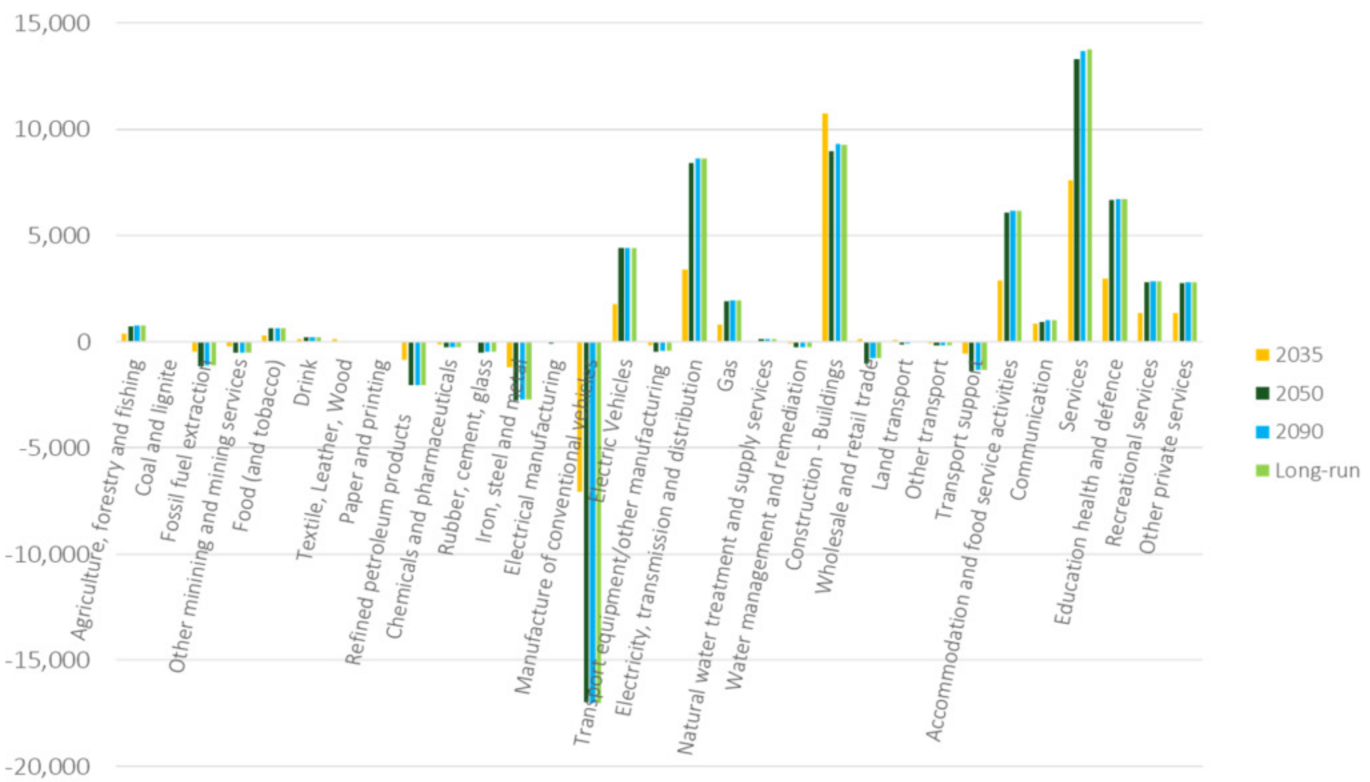
A key finding from previous CEP research is that the UK electricity industry largely relies (directly and indirectly) on UK service activities (e.g., the aggregated service sector that includes 'Financial and Insurance Services').[4] Again, here the largest employment gains are observed in the Services sector (13,776 FTE jobs), as well as the Construction (9,289 FTE jobs) and 'Electricity' industry (8,621 FTE jobs). These employment impacts reflect shifts and gains in sectoral employment in favour of labour intensive industries (e.g., 'Education and Health' and 'Accommodation and Food Services') associated with increased domestic electricity demand and wider increases in household consumption in enabling and realising the EV rollout.

However, there are employment losses concentrated in the 'Manufacture of Conventional Vehicles' (-17,010 FTE jobs) and Refined Petroleum (-2030 FTE jobs) sectors and their supply chains, e.g., 'Iron, Steel and Metal' (-2712 FTE jobs) and Fossil Fuel extraction' (-1125 FTE Jobs)). Export intensive industries such as 'Chemicals and Pharmaceuticals' (-259 FTE jobs) and 'Electrical Manufacturing' (-66 FTE jobs) also suffer loss in competitiveness due to sustained increase in labour cost and the wider price increase/pressures reflected by the CPI increase in Figure 3.

This element of our research findings highlights the importance of considering the transition from conventional to EVs not only from a climate change perspective. It is also crucial that it is considered in the context of economic returns that are valued by the society in a way that balances (or not) against 'Just Transition' focus building around the net zero agenda.

The outcomes emerging here demonstrate that not all sectors/industries will benefit from the switch/shift to EVs in delivering private transportation services. In fact, we see that it is not simply a case of a straightforward substitution of conventional to electric vehicles, but a transition that changes the cost of private transportation. This in turn affects the household demand for this service, leading to different impacts in the sectors manufacturing vehicles and those providing the fuels (i.e., petrol and diesel and electricity). It is important then to consider how those that are no longer employed in the contracting sectors can be given opportunities in growing sectors. This impacts not only those associated with the manufacturing of conventional vehicles and production of petrol and diesel, but also those in the wider economy that may be impacted by competitiveness challenges driven by increased prices.

Figure 4 : Net impact on sectoral employment from 100% EV rollout by 2050 enabled by £10 billion electricity network upgrade spending between 2020 and 2050



Conclusions and policy implications

In summary, our research demonstrates how net gains do emerge across the wider economy as a result of enabling (through electricity network upgrades) and realising the rollout of EVs in the UK. However, a number of tensions, challenges and trade-offs do arise around a combination of: (a) how the cost recovery and demand pressures may impact energy bills; and (b) how expanding electrification in a constrained economy environment (focussing here on the UK labour supply constraint) may impact electricity prices and the wider cost of living.

Underlying the latter in particular, further challenges emerge. First, not all sectors gain and the distribution of gross positive and negative impacts in different parts of the economy are driven by impacts on costs and prices, which may be associated with competitiveness challenges particularly for more export-orientated sectors. Second, more vulnerable households, which benefit less from wage and other income gains in an expanding economy, are likely to be disproportionately impacted by rising energy bills, even if they cannot buy and benefit from the use of EVs, and by the general rise in the cost of living. Third, in our scenario where the full EV rollout is not realised, despite the full investment in electricity network upgrades being made, then a challenge arises for policymakers and industry in mitigating the risk of 'stranded assets'.

Generally, the key insight and challenge emerging from our research revolves around questions of 'who really pays and who really gains', and how the answers compares with expectations. If attention focuses only on that of who directly pays, particularly where a substantial share of the network upgrade costs will need to be borne across all households regardless of whether they benefit from EV adoption or the wider economy expansion that is triggered, then unfavourable distributional outcomes may emerge.

Further research is required to inform and develop scenarios that more fully consider the distributional impacts of the EV rollout and, crucially, how the network upgrade costs are covered if policymakers are to be effectively informed in considering how to avoid disproportionately affecting the most vulnerable parts of the society. Moreover, such issues and concerns will be common across a number of areas of net zero development, for example decarbonising heat, where similar investment requirements may be required, but where there may not be such a clear source of wider economy gain in shifting the type of fuel uses to deliver household and industrial heating services.

References

1 Our previous policy brief set out the initial research findings generated through a research project funded by the National Centre for Energy System Integration (CESI) which focusses on addressing the question of "Who ultimately pays for and who gains from the electricity network upgrade for electric vehicles (EVs) to support the UK's net zero carbon ambition?" This involved consideration of a range of indirect, unanticipated, and unintended consequences of the electricity network upgrade to enable the rollout of EVs, through impacts on markets, prices, and incomes across the economy

2 Alabi, O., Turner, K., Figus, G., Katris, A., & Calvillo, C. (2020). Can spending to upgrade electricity networks to support electric vehicles (EVs) roll-outs unlock value in the wider economy? Energy Policy, 138, 111117. https://doi.org/10.1016/j.enpol.2019.111117

3 Alabi, O., Turner, K., Calvillo, C., Katris, A, Stewart Jamie., and Brod Constantin (2020) Can the Electrification of Private Transport Lead to Economic Prosperity? https://doi.org/10.17868/73568

4 Turner, K., Alabi, O., Smith, M., Irvine, J., and Dodds, P., (2018). 'Framing policy on low emissions vehicles in terms of economic gains: Might the most straightforward gain be delivered by supply chain activity to support refuelling?' Energy Policy, [online] 119, pp.528-534. Available at https://www.sciencedirect.com/science/article/pii/S0301421518303033?via%3Dihub

5 CEP Net Zero Principal Framework and application across of range of decarbonisation actions (including electrification of transportation is available at https://doi.org/10.1177/0269094220984742

6 Full model documentation on the economy wide UKENVI Computable General Equilibrium (CGE) model calibrated using 2016 national accounting data used for this research work is available at https://doi.org/10.1016/j.enpol.2019.111117

7 The UK TIMES energy system model employed to estimate the network upgrade cost requirements and efficiency gains informing the CGE model is available at https://doi.org/10.1016/j.esr.2020.100497. All the energy scenarios considered are implied by the National Grid (2020) Future energy Scenarios (FES) available at https://www.nationalgrideso.com/document/173821/download

Authorship

- Dr Oluwafidayo Alabi, Research Associate
- Dr Antonios Katris, Research Associate
- Dr Christian Calvillo, Research Associate
- Professor Karen Turner, CEP Director
- Dr Jamie Stewart, CEP Deputy Director

Contact

- CEP@strath.ac.uk
- The Centre for Energy Policy, School of Government and Public Policy, Humanities and Social Science, McCance Building, 16 Richmond Street, Glasgow, G1 1XQ

Appendix / Method

Our approach to understand and investigate the economy wide cost and benefits of transitioning from conventional vehicles to EVs, in delivering UK private transportation, is underpinned by CEP's Net Zero Principles Framework.[5] This framework is designed to provide a common understanding of how decarbonisation actions can deliver economic costs and benefits in two distinct stages.

In the case of electrification of transport, we consider the required electricity network upgrade or infrastructural investment and the recovery of the cost as the key components of the enabling stage. Specifically, across all our scenarios, based on informal engagement with regulated private sector actors/industries, we assume that only one-third of the total investment spending is made within the UK, focused on construction (and associated supply chain) activity. While this in itself may be a source of wider economy expansion, the crucial constraints are that: (i) the total upgrade costs need to be recovered by passing the cost to UK consumers via energy bills, spread over the lifetime of assets created (45 years); (ii) and constraints on the availability of capital and labour across the UK economy trigger wider price increases across the economy.

The gradual uptake and replacement of conventional private domestic vehicles with electric ones and the associated change in fuelling from petrol and diesel to electricity, is the core component of the realising stage. We recognise that this stage will also depend on the availability of EVs and the willingness of UK consumers to switch to EVs. Specifically, unless there is demand across UK households to switch to EVs and sufficient EVs to meet that demand, there may be a situation where the network has been upgraded, and paid for, to accommodate a certain level of electricity demand that does not materialise. Thus, we consider a scenario where the planned and projected pace of EV rollout for net zero may not actually be achievable if, for example, there are constraints on EV manufacturing at UK and/or global levels both absolutely and/or in different timeframes.

We investigate the potential individual and joint interaction of the stages, using our UKENVI multi-sector economy wide modelling framework[6] informed by UK TIMES energy systems model[7] to investigate the economy wide impacts of a 'central' scenario requiring a total network upgrade spending of £10 billion (2020-2050) to enable EV penetration reaching 100% in UK private transportation by 2050. Essentially, our integrated scenario simulation approach reflects consideration of how consumers respond to 'smart charging' (i.e., charging at off-peak time, when electricity demand is less) that in turn determines the required levels and timing of spending in different timeframes to support the network upgrades necessary to enable the projected EV rollout.