# Report summary: the macroeconomic and environmental impacts of decarbonising Japan's passenger car fleet

## 1. Introduction

Automobiles are one of the most significant sources of GHG emissions. In Japan, 16% of emissions were attributable to automobiles, including passenger cars and trucks, in 2019. Fossil‑fuel cars (ICEs, HEVs and PHEVs) are the main drivers of GHG emissions in the transport sector. A rapid global transition to zero carbon vehicles is vital to not only meet the goals of the Paris Agreement, but also to achieve Japan's goal of carbon neutrality.

However, Japan is lagging behind much of the rest of the developed world in terms of the take-up of all-electric vehicles (BEVs and FCEVs). Although the Japanese government has announced plans to ban the sales of conventional internal combustion engine vehicles from the mid-2030s, there is currently no date for the phase-out of the sale of other fossil‑fuel cars (HEVs and PHEVs). As it stands, Japanese carmakers run the risk of losing their competitive advantages in the global automotive market as other economies are taking ambitious actions to phase out fossil‑fuel cars. This lack of action will position Japan to be seen as a decarbonising laggard in the world, losing huge opportunities for jobs and growth, cleaner air, improved public health, and energy security.

This study assesses the macroeconomic and environmental impacts of decarbonising passenger cars in Japan in the medium (by 2030) and long term (by 2050). It provides details about real GDP projections, job gains, and CO2 emissions reductions in the transition to low-carbon mobility, as well as implications in policymaking and investment in charging infrastructure and related technologies.

## 2. Methodology

A scenario approach has been developed to envisage various possible vehicle technology futures, with economic modeling then subsequently applied to assess the impacts.

### 2.1 Scenario Description

The four core scenarios analyzed for this study are summarized in the Table.

| Scenario | Description |
|---|---|

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| | |
|---|---|
| REF (Reference) | ● No change in the deployment of efficiency technology or the sales mix from 2021 onwards.<br>● Some improvements in the fuel-efficiency of the vehicle stock, due to stock turnover.<br>● The power generation is based on the Sixth Basic Plan for electricity. 33% renewable energy will be used to generate electricity by 2030 and 34% by 2050. |
| CPI (Current Policy Initiatives) | ● Efficiency improvements and deployment of new powertrains.<br>● Phase-out of the sale of new petrol or diesel ICE vehicles by 2035, with no further change in sales mix or vehicle efficiency after 2035.<br>● No phase out of HEVs and PHEVs<br>● The power generation is based on the Sixth Basic Plan for electricity. 33% renewable energy will be used to generate electricity by 2030 and 34% by 2050. |
| TECH 2030_central (Phase-out ICEs by 2030) | ● Efficiency improvements and ambitious deployment of EVs, mostly BEVs.<br>● Phase-out of the sale of new petrol or diesel ICE vehicles, HEVs and PHEVs by 2030, with no further change in sales mix or vehicle efficiency after 2030.<br>● The power generation is based on the Sixth Basic Plan for electricity. 33% renewable energy will be used to generate electricity by 2030 and 34% by 2050. |
| TECH 2030_decarbonised (Phase-out ICEs by 2030) | ● Efficiency improvements and ambitious deployment of EVs, mostly BEVs.<br>● Phase-out of the sale of new petrol or diesel ICE vehicles, HEVs and PHEVs by 2030, with no further change in sales mix or vehicle efficiency after 2030.<br>● The power generation is based on research from the Renewable Energy Institute. 41% renewable energy will be used to generate electricity by 2030 and 94% by 2050. |

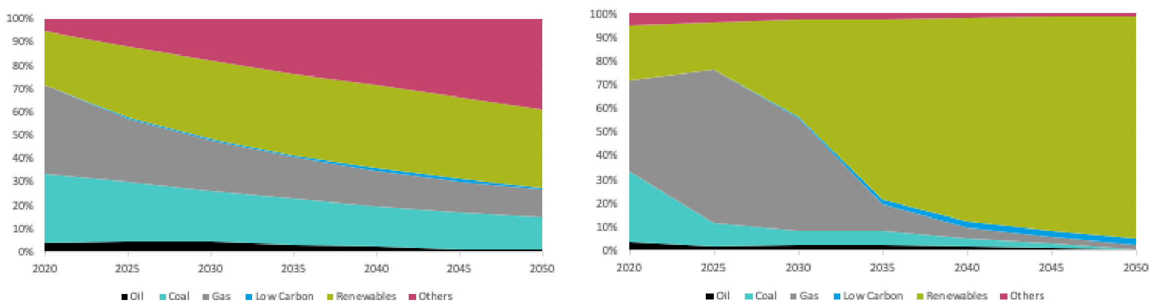
**2.2 Models**

The two models that applied in the research were:

- **Cambridge Econometrics' Vehicle Stock Model**: to assess the impact of alternative low-carbon vehicle sales mix on energy demand and emissions, vehicle prices, technology costs and the total vehicle cost of ownership
- **Cambridge Econometrics' E3ME model**: to assess the wider socio-economic effects of the low-carbon vehicle transition.

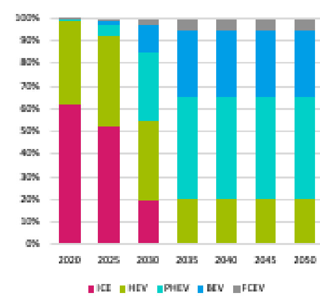
### 2.3 Key Assumptions

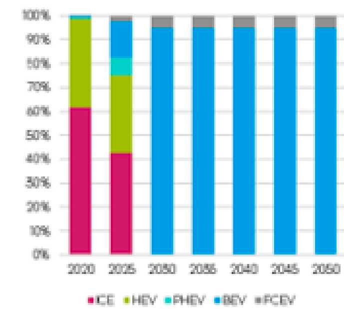
- Energy sector structure




Annual electricity generation in the 'Central' power sector and the 'Decarbonised' power sector

- Sales mix

| Scenario | Powertrain | 2030 | 2035 | 2050 | Figures |
|---|---|---|---|---|---|
| CPI | ICE<br>HEV<br>PHEV<br>BEV<br>FCEV | 19.5%<br>35.0%<br>30.0%<br>12.5%<br>3.0% | 0.0%<br>20.0%<br>45.0%<br>30.0%<br>5.0% | 0.0%<br>20.0%<br>45.0%<br>30.0%<br>5.0% |  |

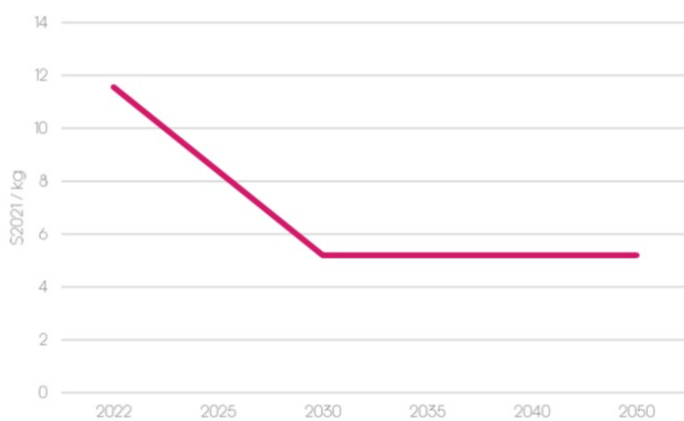
| | | | | | |
|---|---|---|---|---|---|
| TECH 2030 | ICE<br>HEV<br>PHEV<br>BEV<br>FCEV | 0.0%<br>0.0%<br>0.0%<br>95.0%<br>5.0% | 0.0%<br>0.0%<br>0.0%<br>95.0%<br>5.0% | 0.0%<br>0.0%<br>0.0%<br>95.0%<br>5.0% |  |



- Total cost of electric powertrain and battery ($2021)

| Powertrain | Market segment | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|
| PHEV | Mini | 1,922 | 1,271 | 1,143 | 1,026 |
| PHEV | Ordinary & Small | 2,434 | 1,534 | 1,378 | 1,234 |
| BEV | Mini | 6,748 | 3,351 | 3,261 | 3,181 |
| BEV | Ordinary & Small | 8,782 | 4,275 | 4,173 | 4,083 |

- Hydrogen price($2021/kg)[1]




The production of hydrogen is expected to increase substantially, driving down the price globally.

- Cumulative investment in infrastructure

[1] As defined by the Hydrogen Council (2020)

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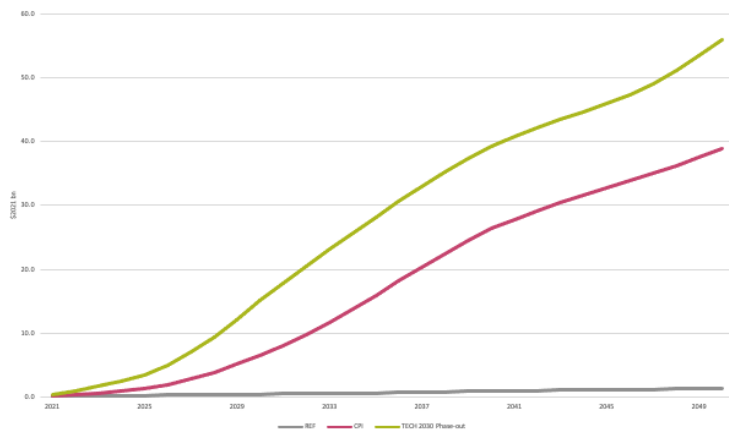
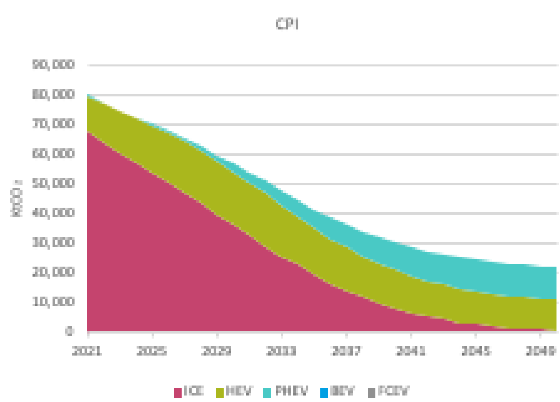


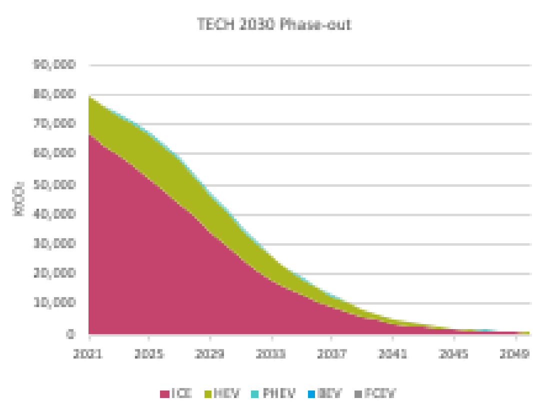

The cumulative infrastructure investment in the TECH 2030 Phase-out scenario reaches $56 billion by 2050, while in the CPI scenario it is more than $39 billion.

## 3. Key Findings

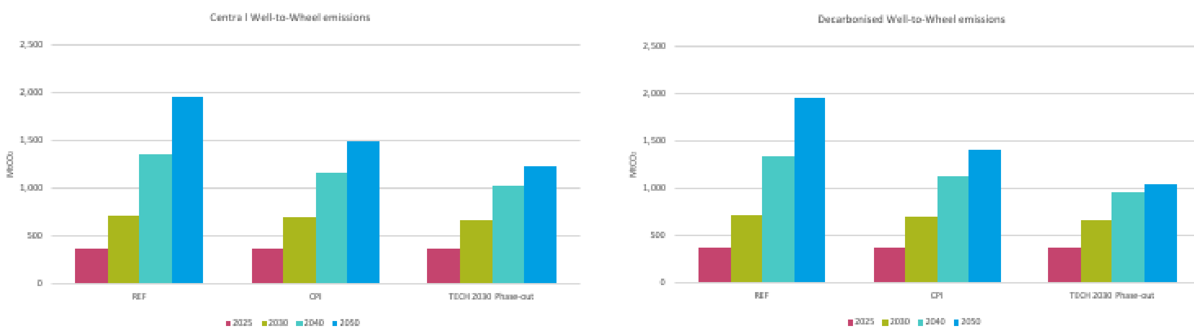
The study shows that a rapid transition to phase out internal combustion engine and hybrid vehicles by 2030, replacing them with a fleet dominated by battery electric vehicles, will bring significant macroeconomic and environmental benefits:

- **Achieve major carbon emissions reductions**, even taking into account the indirect emissions that are related to the generation of electricity. Tailpipe CO2 emissions are reduced by almost 99% in 2050 if ICEs and hybrid vehicles are phased out by 2030. Once emissions embedded in electricity generation are included and decarbonised, cumulative emissions from the vehicle fleet can be almost halved over the period to 2050 through the phase-out. The current government policies are not enough to mitigate CO2 emissions from passenger vehicles to meet net-zero goals unless aggressive offset measures are taken and the energy sector is decarbonised at the same time.



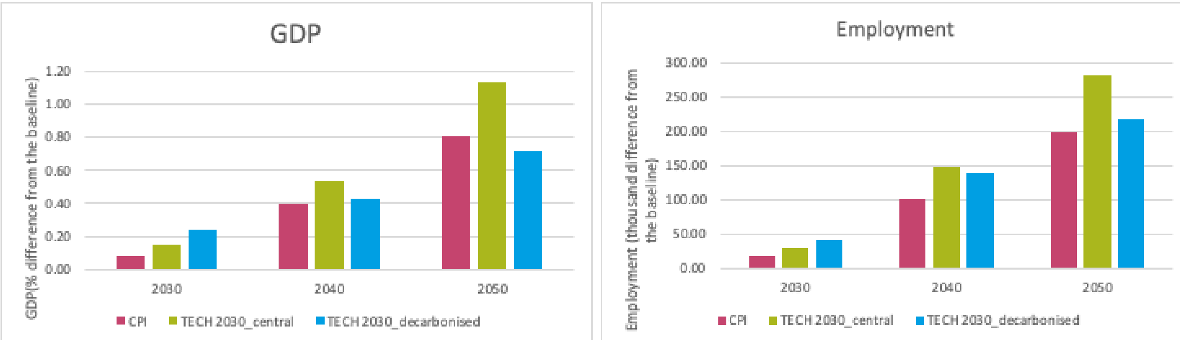
Average stock tailpipe CO2 emissions (KtCO2) in the CPI and TECH2030_central scenarios




Cumulative well-to-wheel CO2 emissions in the 'Central' power scenario and 'Decarbonised' power scenarios

- **Reduce other tailpipe emissions of pollutants, improve urban air quality and reduce risks to health**. In the CPI scenario, particulate matter emissions (PM10) from vehicle exhausts are cut from around 705 t per year in 2020 to around 278 t in 2050 and NOx emissions from vehicle exhausts are cut from 32,722 t in 2020 to 8,031 t in 2050. Air pollution is one of the greatest environmental risks to health. The problems of traffic-related air pollution have been rising in response to the increase of automobiles in Japan. Research shows Long-term exposure to traffic-related air pollution, indexed by nitrogen dioxide concentration, increases the risk of cardiopulmonary mortality. In the TECH2030 scenarios, both values fall by 99%, almost eliminating all harmful PM10 and NOx emissions. By decreasing air pollution levels, the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma can be reduced.

- **Lead to beneficial economic outcomes in the medium- and long-term.** GDP could be up to 0.1% higher in the TECH 2030_decarbonised scenario compared to the Reference scenario by 2030, and TECH 2030_central scenario by 2030 and 0.3% higher in the TECH 2030_central scenario compared to the CPI scenario by 2050. The modeling shows that the price of electric vehicles falls to be lower than combustion engine and hybrid vehicles, and the costs of recharging via electricity are substantially lower than refueling with fossil fuels, resulting in consumers spending less money on buying and running an electric car compared to an internal combustion engine vehicle. This reduces spending on imported fossil fuels and allows consumers to increase spending on other goods and services.



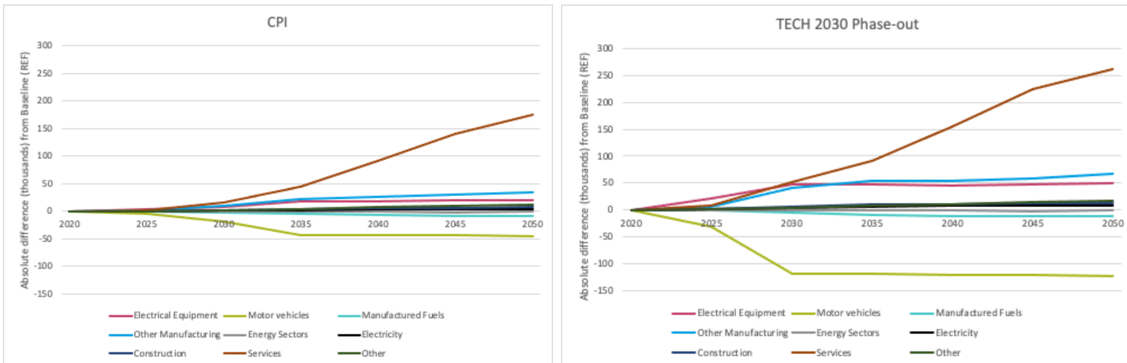

GDP growth and employment projections in the CPI and TECH 2030 scenarios

**Summarized Macroeconomic Impacts**

| | Under 'Central' power Sector | | Under 'Decarbonised' power sector |
|---|---|---|---|
| **Scenario** | CPI | TECH 2030_Central | TECH 2030_decarbonised |
| 2030 Impact | | | |
| GDP | 0.1% | 0.1% | 0.2% |
| Employment(000s) | 18 | 29 | 42 |
| 2050 Impact | | | |
| GDP | 0.8% | 1.1% | 0.7% |
| Employment(000s) | 200 | 281 | 219 |

- **Create jobs across the economy, most notably in the services and manufacturing sectors.** Despite fears that a shift to BEVs would lead to widespread unemployment, the modeling shows that job gains in the medium and long term will more than outweigh the jobs lost in the conventional motor vehicle industry and fossil fuels. By 2030, 29,000 additional jobs will be gained in the TECH 2030 scenario as compared with 18,000 gained in the CPI scenario, and by 2050 281,000 additional jobs (TECH 2030) as compared with 200,000 under CPI. The largest number of jobs are created in services. These primarily come about as a result of the low cost of mobility. As the purchase price of BEVs falls and their maintenance and fueling costs are significantly lower, the total cost of ownership of BEVs becomes lower than a petrol or diesel ICE vehicle.

Consequently, consumers are spending less on transport, which frees up household income to be spent on other goods and services.




The employment impact per sector in the CPI and TECH2030_central scenarios

- **Deliver rapid reductions in fossil fuel use and oil import.** Japan has been highly dependent on energy imports historically, with more than 90% of energy imported from other countries. This makes Japan susceptible to the effects of international situations, causing difficulties in securing energy in a stable manner. The report shows that by 2040 petrol and diesel demand will decrease by 51% and 89% in the CPI and TECH 2030_central scenarios respectively. The reductions further widen until 2050 when demand for petrol and diesel will have fallen by more than 99% compared to 2021 levels in the TECH 2030 Phase-out scenario. As a result, oil imports will be reduced by up to around 4900 million barrels of oil equivalent by 2050.

## 4. Policy implications & recommendations

- In order to achieve carbon neutrality by 2050 and improve automotive industrial competitiveness in the world, Japan should embrace a faster transition to low-carbon vehicles, through the phase out of the sale of new fossil-fuel cars (ICEs, HEVs and PHEVs), and ambitious deployment of all-electric cars (BEVs and FCEVs) by 2030.
- Huge investment is required for a faster EV transition and deployment of charging infrastructure, including public charging, private charging, green hydrogen stations, etc. The Japanese government has provided a total of 37.5 billion yen for e-mobility in a supplementary budget for 2021. However, it's far less than needed as the modeling projects a cumulative total of 6300 billion yen (56 billion US dollar) by 2050 is required to achieve a faster EV transition. This investment would need to be provided by both government and industry, and is not significantly higher than what is already needed under current government policy approach (38.9 billion US dollar).
- The Japanese government should create more policy incentives for expanding the EV

market and charging infrastructure such as subsidizing battery recycling and green hydrogen production, adding new criteria for the installation of chargers in new building construction, promoting the introduction of equipment necessary for utilizing EV as an energy infrastructure etc.

- Japanese automotive companies should commit to phasing out fossil‐fuel cars by 2030 and create concrete roadmaps to achieve carbon neutrality by 2050. Industry leaders should acknowledge the urgency of transitioning to zero tailpipe emission vehicles and take responsibility to match their scale of business. They should ensure Japan's auto technology stays competitive in the global market.
- The government and automakers must leverage all tools at their disposal to ensure a "just transition" for workers in the automotive industry, particularly against the job loss caused by increasing automation. For example, the government and companies can provide strong financial support and skill training during transition periods.
- Decarbonizing passenger cars alone can't achieve a real low-carbon transition if the power sector still relies on fossil fuels. The transition must be accompanied by an ambitious deployment of renewable energy in line with the Paris Agreement, aiming for 50% or more renewables by 2030 in Japan.