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# How the Pace of Adoption of Electric Vehicle Smart Charging Impacts the Energy System?

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# Introduction

## UK POLICY CONTEXT

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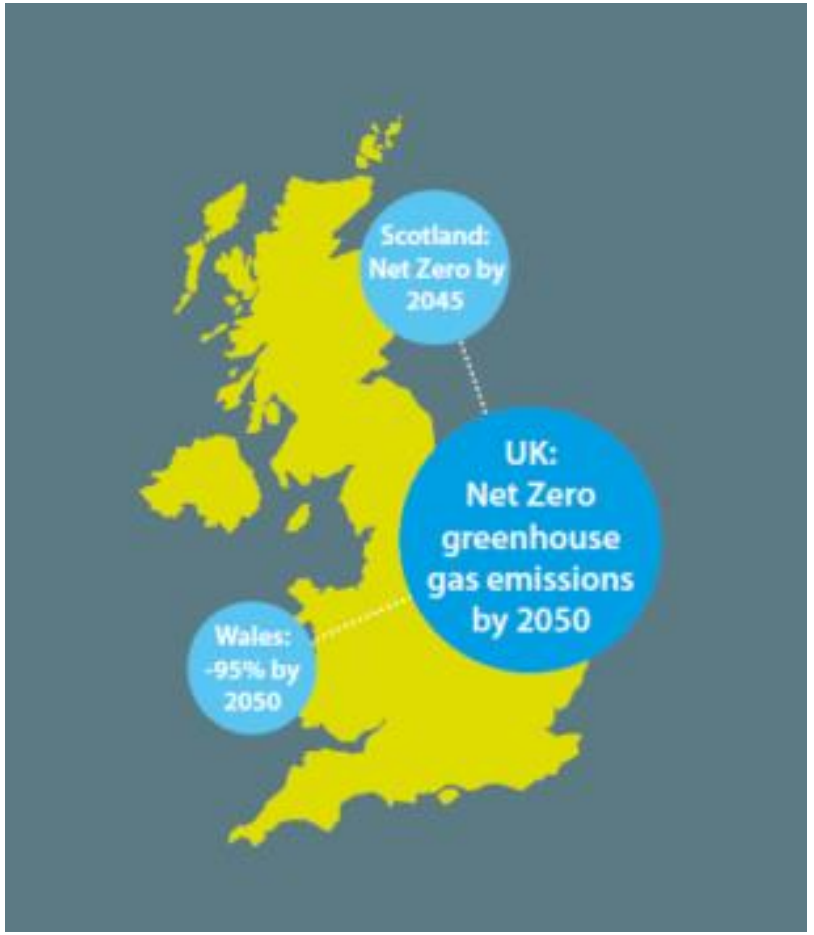
# The UK policy context

The UK Committee on Climate Change (CCC) recently published the report ´Net Zero – The UK's contribution to stopping global warming´ (CCC, 2019).

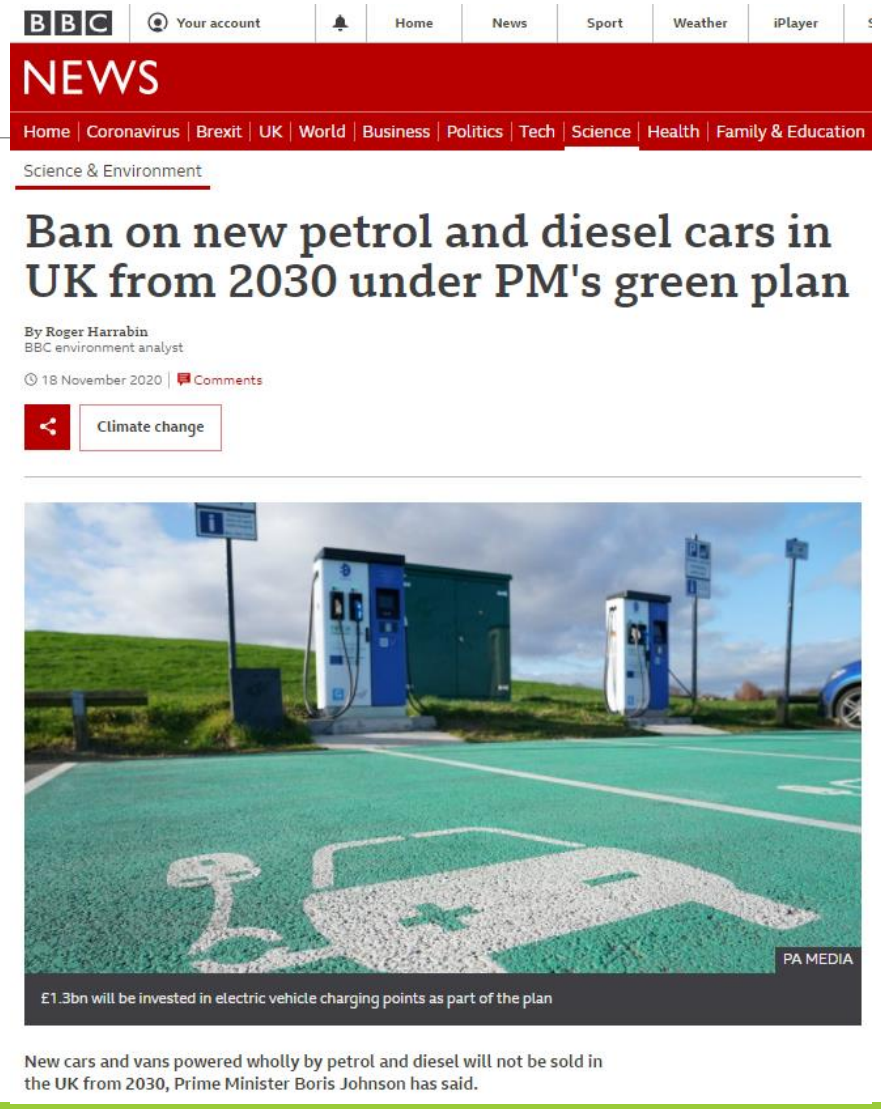
- ´The UK can end its contribution to global warming within 30 years by setting an ambitious new target to reduce its greenhouse gas emissions to zero by 2050´



# The UK policy on EVs

The UK Government has moved forward the target of all new cars and vans to be effectively zero direct emission by 2030 (UK Government, 2020).

National Grid (the British TSO) expect an almost complete EV penetration by 2050 (National Grid, 2020).



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Science & Environment

**Ban on new petrol and diesel cars in UK from 2030 under PM's green plan**

By Roger Harrabin
BBC environment analyst

18 November 2020 | Comments

Climate change

PA MEDIA

£1.3bn will be invested in electric vehicle charging points as part of the plan

New cars and vans powered wholly by petrol and diesel will not be sold in the UK from 2030, Prime Minister Boris Johnson has said.

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# The EV challenge on the energy system

A large penetration of EVs is likely to bring important challenges to the energy system, potentially requiring **new generation capacity and network reinforcements**.

Also, **the timing or 'smartness'** of EV charging could potentially **increase or mitigate the undesired impacts of the EV rollout.**

Many studies have been developed to address these challenges.

- However, most of them fail to analyse the implications of a large penetration of EVs outside the power sector;
- Not considering, for example, the changes on fuel use and consumer costs, and other potential impacts on the rest of the energy system and the economy.

The objective of this paper is to provide insights on this issue, using a whole energy system model (UK TIMES).

# The TIMES model

## A (VERY) BRIEF DESCRIPTION

# The TIMES model a (very) brief description

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TIMES is an energy system-wide bottom-up model that cover all the processes of the energy system.

- Uses linear-programming to find a least-cost future energy system scenario, according to a number of user constraints (including GHG emissions, energy use, etc.).

Due to this holistic approach, TIMES is a widely used tool to analyse decarbonisation scenarios.

***Examples of policy questions:***

How would the energy system look like in 2050 if we:

- Decarbonise the economy?
- Electrify transport?
- Use hydrogen for heating?
- Improve the energy efficiency of buildings?
- Etc.

What technologies will need to be promoted?

What investments are likely to be made?

# Scenario description

CASE STUDIES

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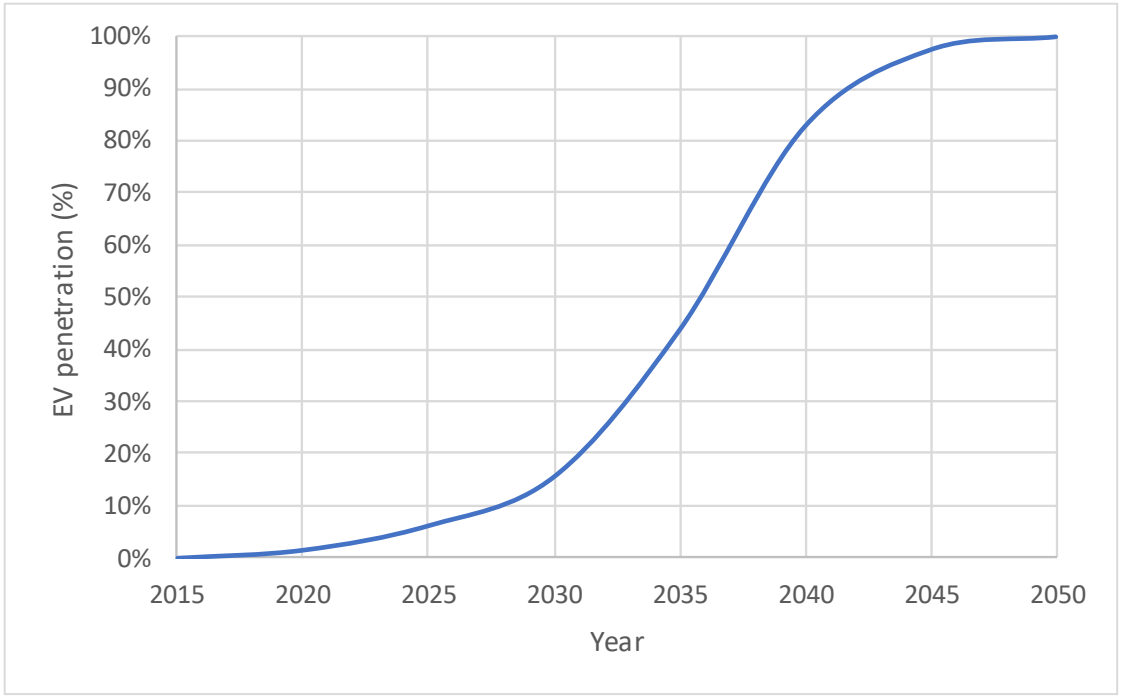
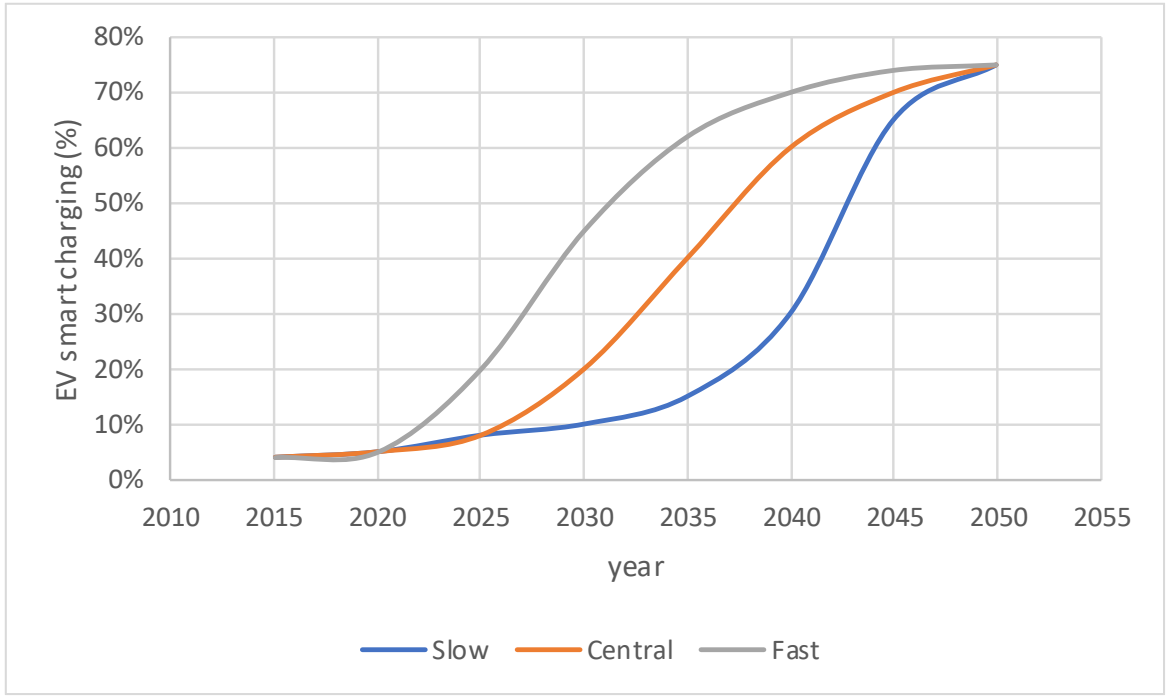
# 2 case studies

**Case study one**: to analyse the impacts of **different smart charging adoption rates** (up to 75%), considering an EV penetration reaching 100% of total travelled car kilometres by 2050



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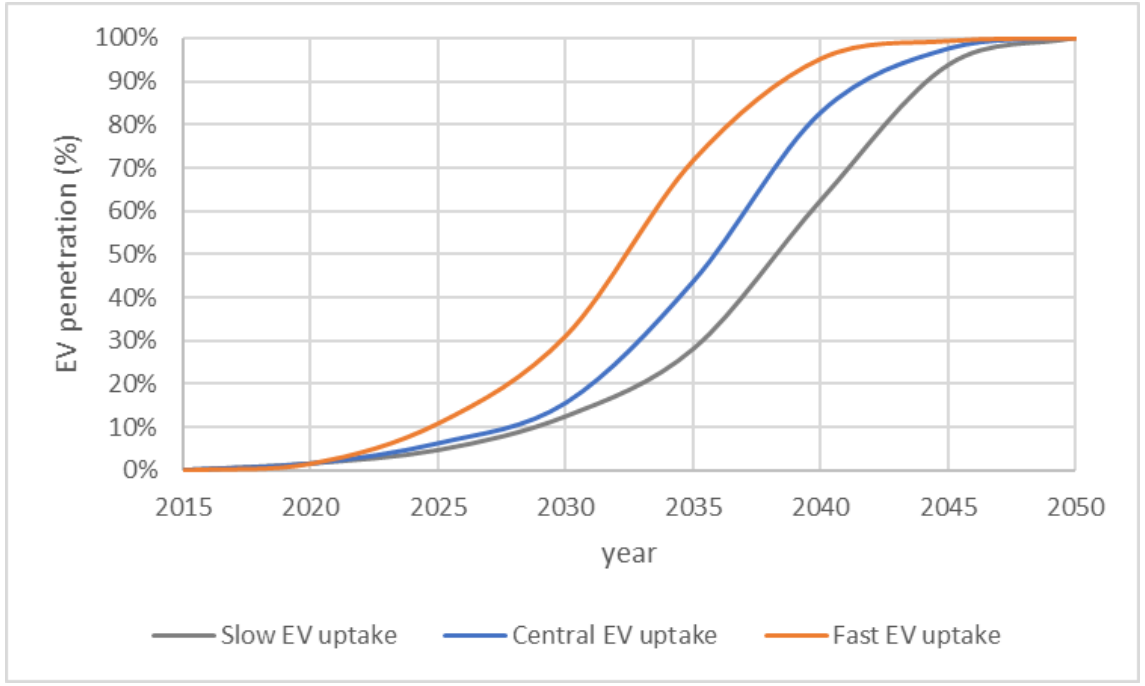
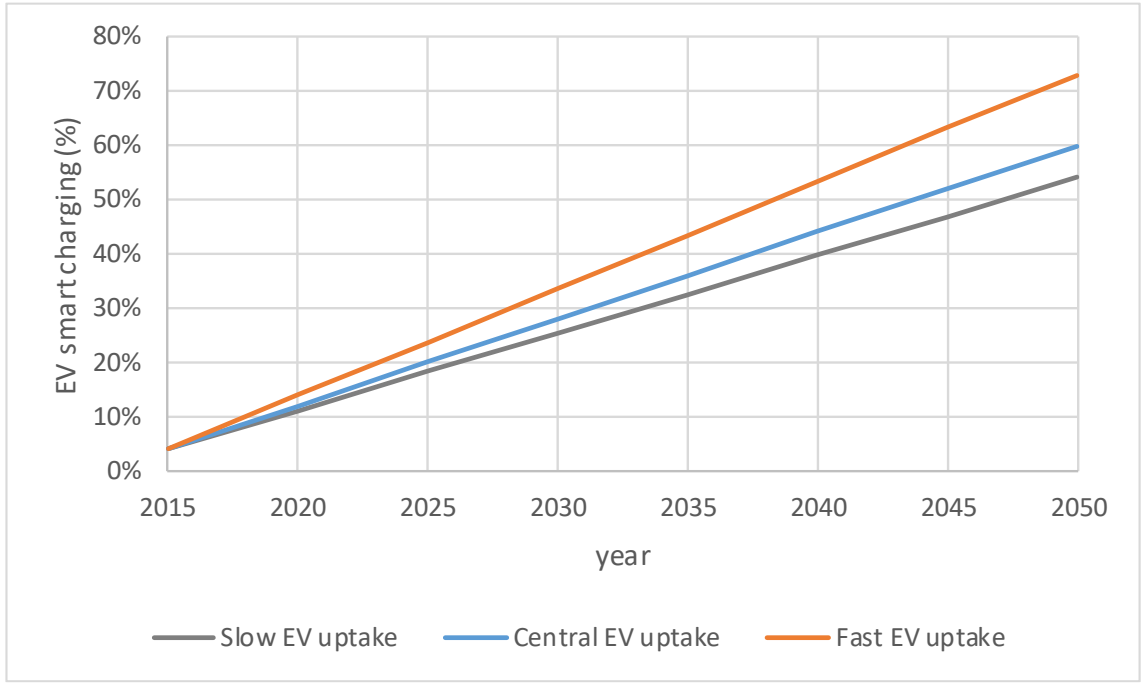
# 2 case studies

**Case study two**: to analyse **different EV rollout speeds** to reach 100% penetration by 2050, following National Grid's Future Energy Scenarios (FES2020)



# Result analysis

# Network investment due to the EV rollout in the UK

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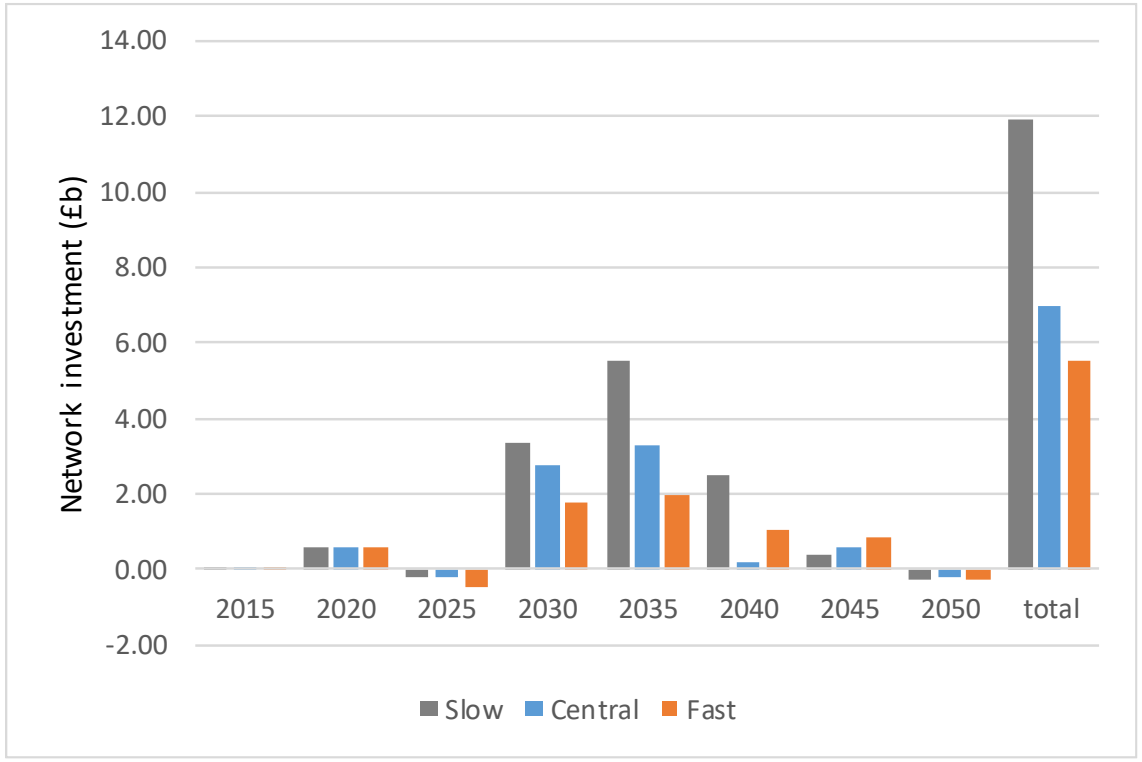
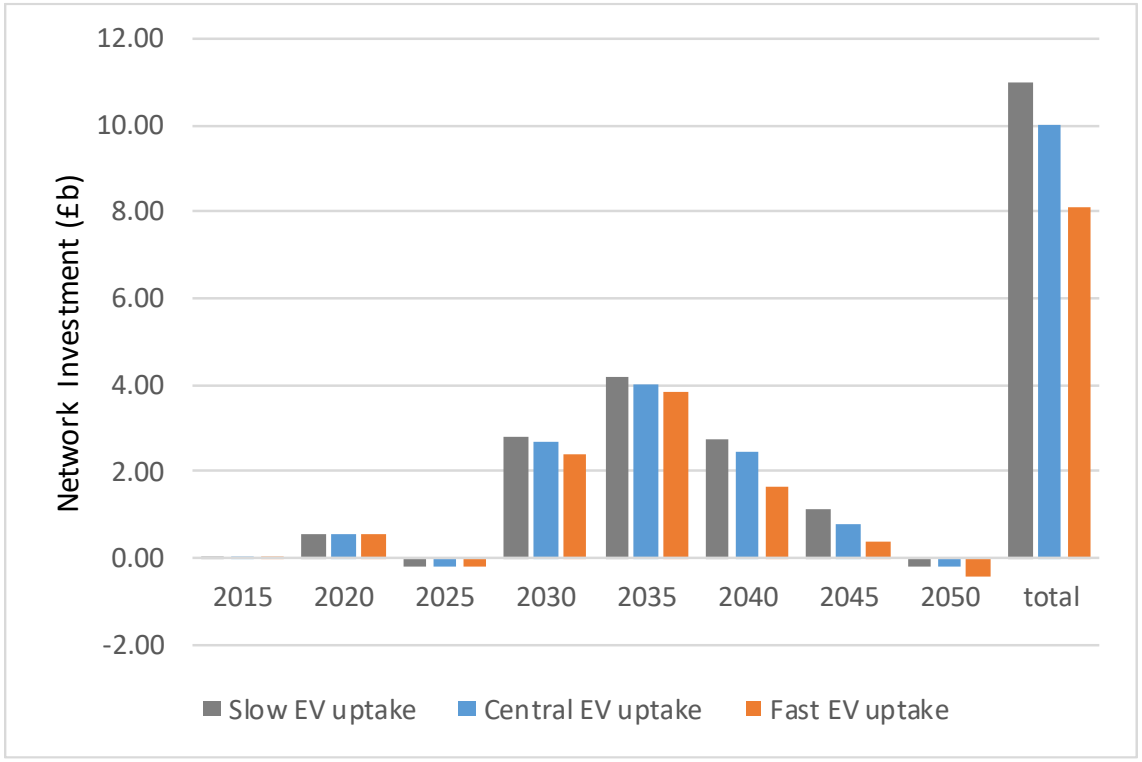
Total network investment per scenario by 2050, relative to a base case with no EVs

Case study 1




Case study 2



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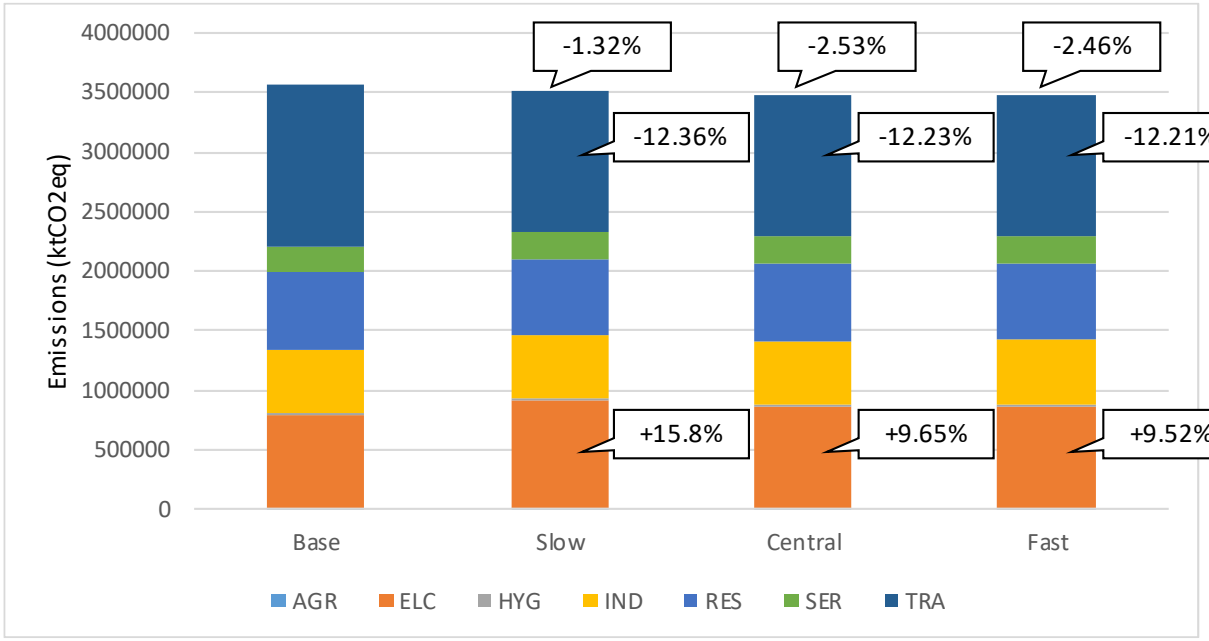
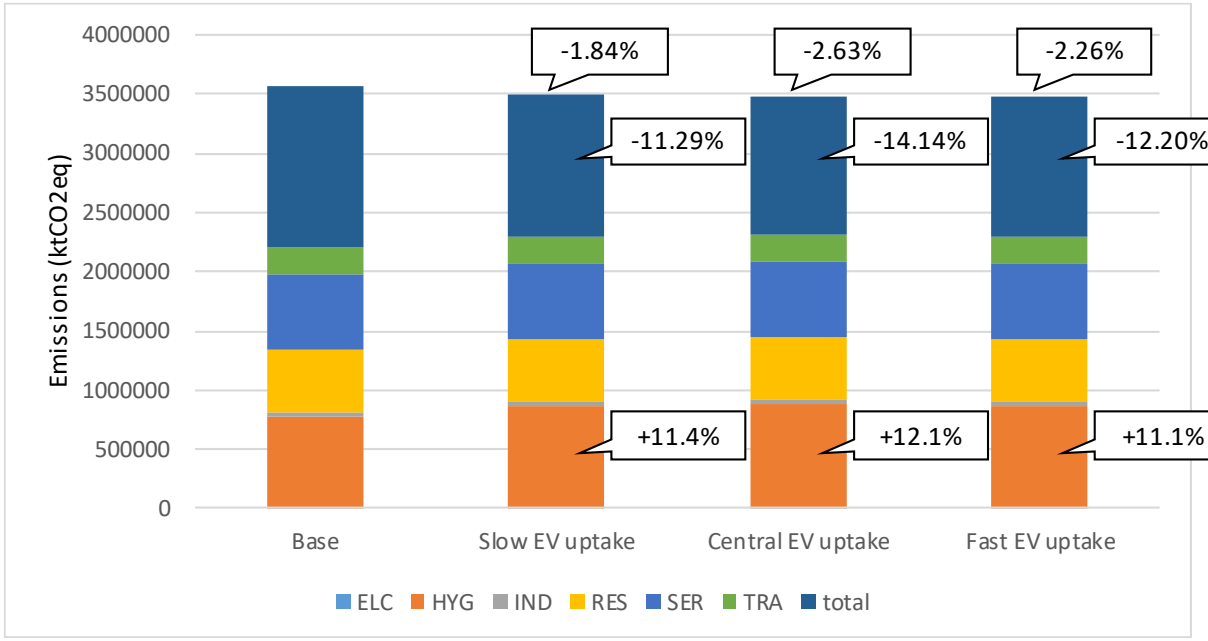
# CO2 emissions

## Cumulative sectoral emissions per scenario

### Case study 1




### Case study 2



# Future and ongoing work

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# Future (and ongoing) work

Analysis of other energy system impacts

- Changes in the energy mix and generation capacity
- Changes in fuel use for car transport
- Changes in energy prices and cost for the final user
- Other sectoral changes

Economy wide impacts of the EV rollout

- Currently ongoing!
- Please also attend the presentation of my colleague:

**Dr. Oluwafisayo Alabi** ***'Can spending to upgrade electricity networks to support electric vehicles (EVs) rollout unlock value in the wider economy?'***
Concurrent Session 118: Electric Vehicle Economics
Room: Parallel Room 18
Date: Tuesday, 2021-06-08, 17:00 - 19:00 CEST

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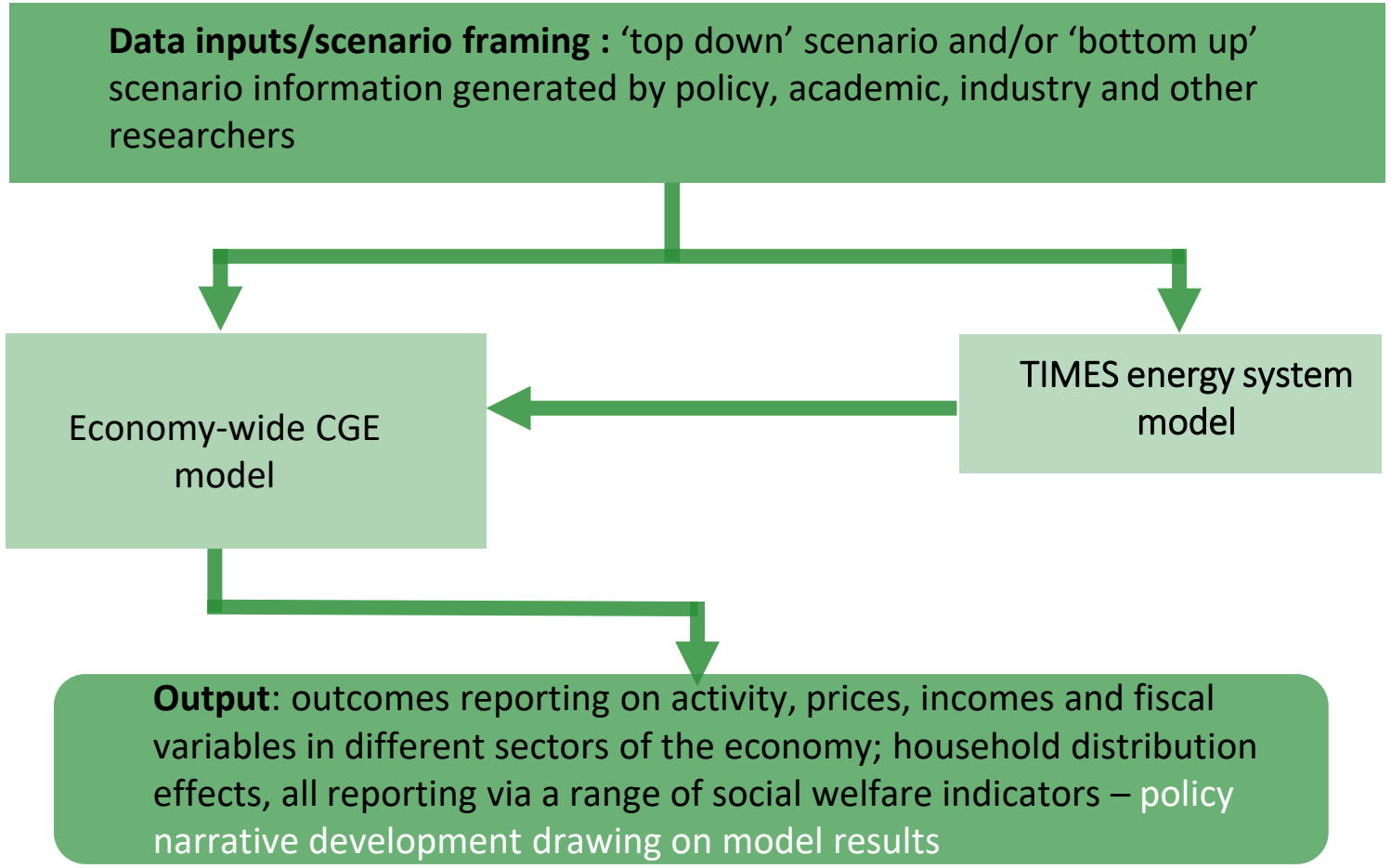
# EV rollout analysis with CGE and TIMES

Method and approach



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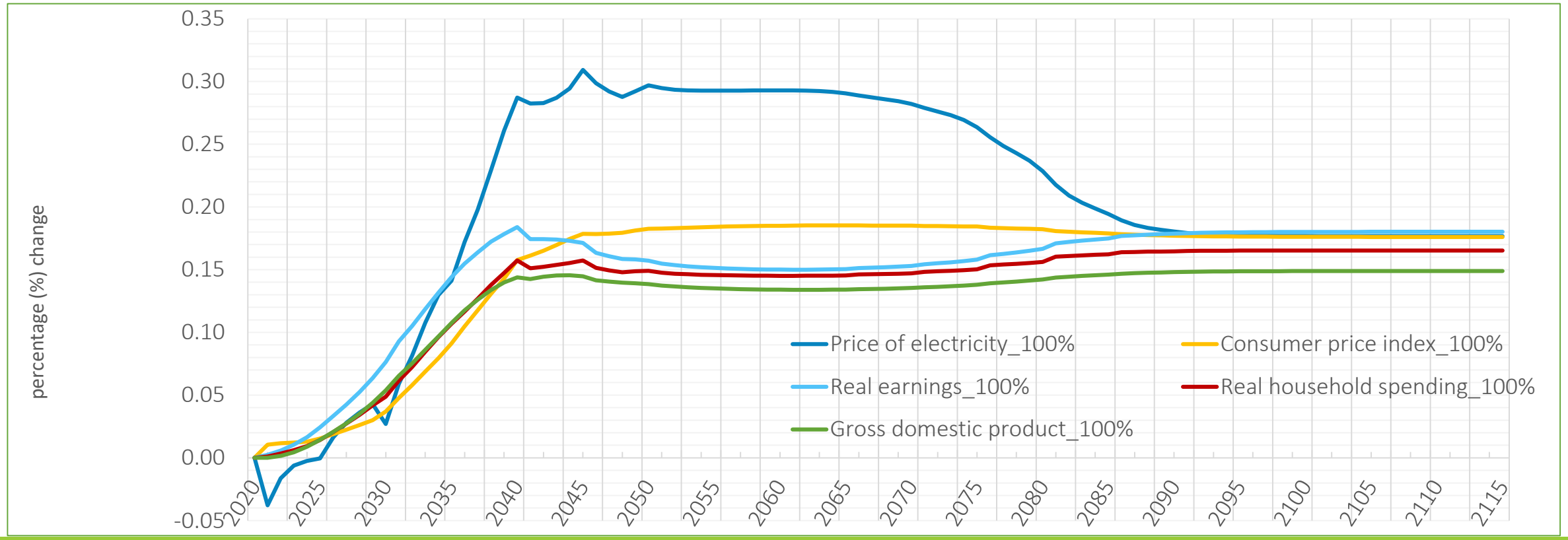
# Results: economy wide impacts

Evolution of net impacts on the wider economy of £10 billion network upgrade spending and 100% EV rollout by 2050 ('central' scenario)



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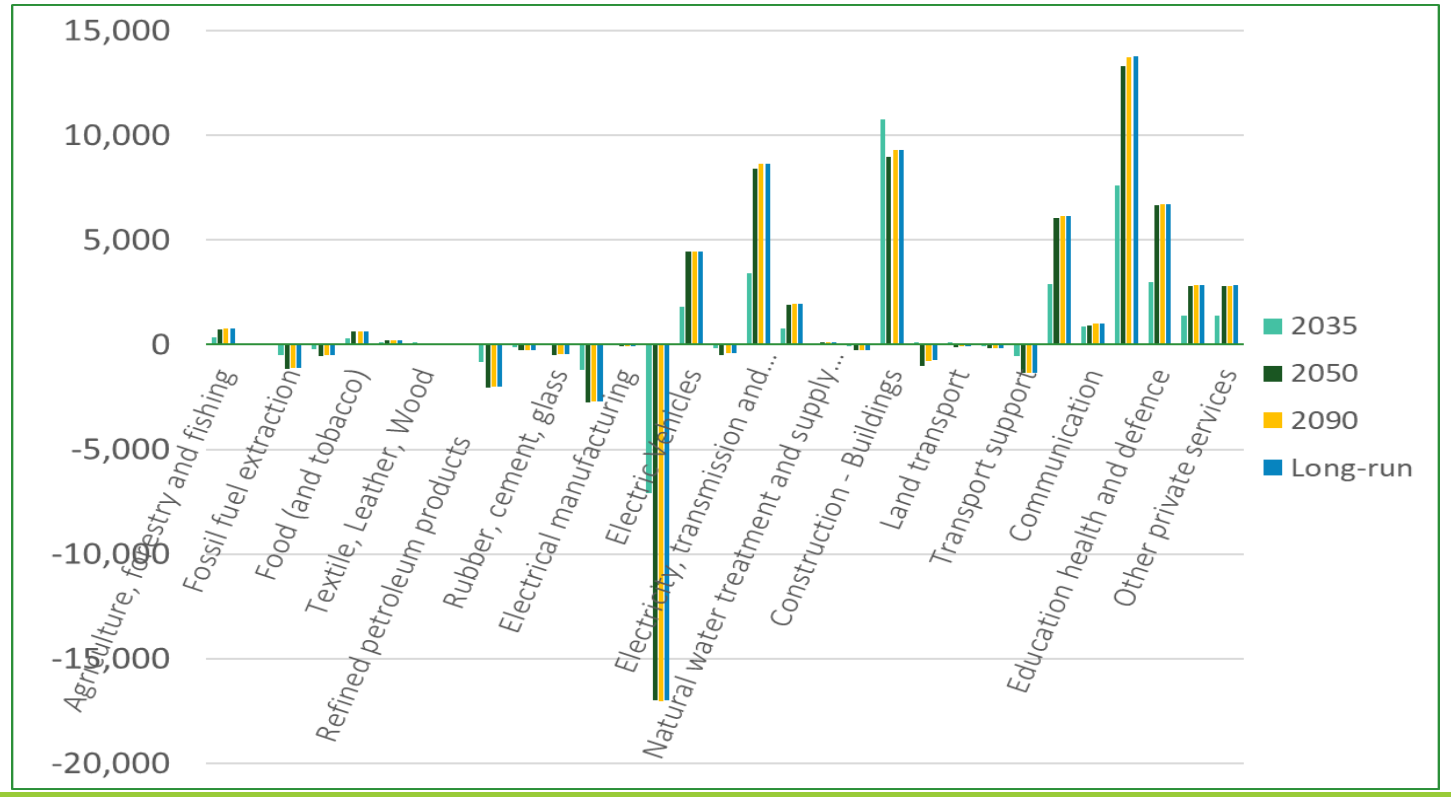
# Results: employment change

Net impact of sectoral employment (FTE change relative to base year values) from 100% EV rollout by 2050, enabled by £10 billion ('central' scenario) electricity network upgrade spending



# Conclusions

The results obtained show **the importance of the 'smartness' of EV charging abd uptake speed** in terms of network reinforcements

**Network investment costs are passed to final consumers** as an increase in energy marginal costs (energy prices).

We observed a **shift of sectoral emissions** as the power sector, required to generate more energy to meet EV demand.

- A holistic approach is needed.
- Policies that target a particular sector (e.g. promoting EV uptake) need to be accompanied with other policies that ensure that there is no emission transfer to other sectors or 'outsourced' to other countries.

We need to analyse the impact of these changes in the economy!

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# Thank you!

## Please get in touch if you want to learn more or collaborate with us!

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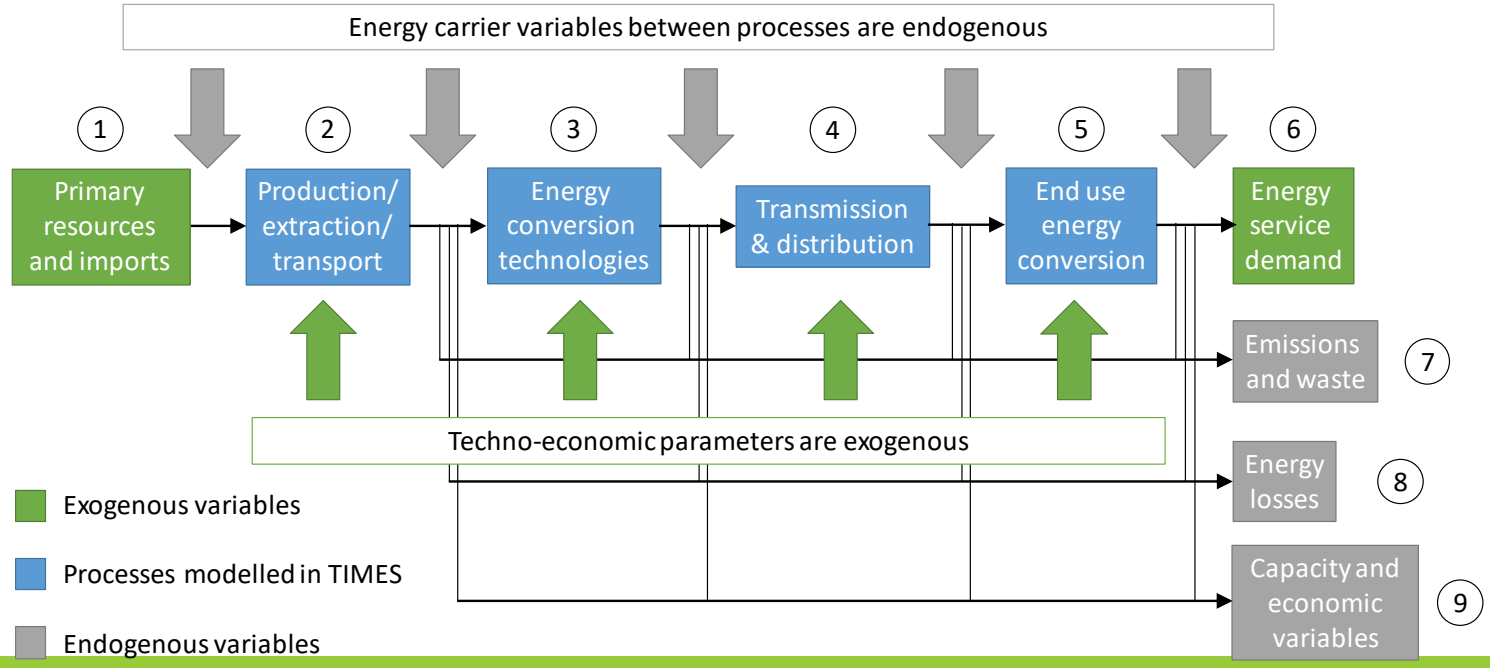
# The TIMES model inputs and outputs

The inputs, or exogenous variables of the model, are the data of the supply and demand side (end-use service demand)

The outputs of the model, or endogenous variables, include emissions and waste, energy losses associated to processes, technology capacity planning and different economic variables including energy prices, costs, etc.



# The CGE economic model a (very) brief description

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CGE is a multi-sector economy-wide generally top-down model that covers all sectors and markets

Uses input-output tables (National Accounts) as core structural database – SIC classification of industries

For any given policy or industry action, or economic disturbance, solves for supply and demand in all markets simultaneously, under set of condition/constraints for functioning of different markets and macroeconomy

**Examples of policy questions:**

How would the wider economy and incomes/prices/activity in different production and end consumer sectors look following/during implementation of actions to:

- Improve labour and/or capital productivity in energy supply or other production sectors
- Support increased energy efficiency (e.g. through construction sector activity on retrofitting – break into 'enabling' and 'realising' stages)
- Support roll out of new low carbon solutions via investment in infrastructure in different sectors

How would exports, imports, employment, investment and GDP be affected in different time frames?

Would energy use reduce across all sectors of the economy?

Which household income groups would enjoy/suffer greatest boosts/reductions in real income and/or spending?

# Other parameters

EV parameters

| | 2010 | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|---|
| **Lifetime (years)** | | | 12 | | |
| **Technical efficiency (vehicle km/MJ)** | 1.45 | 1.62 | 1.75 | 1.84 | 1.89 |
| **Vehicle cost* (k£/vehicle)** | 43.21 | 22.06 | 20.92 | 19.77 | 18.63 |
| **Fixed operation & maintenance cost* (k£/vehicle)** | 2.93 | 1.68 | 1.62 | 1.55 | 1.48 |

Transmission and distribution network reinforcement cost parameters

| | Technical lifetime (years) | Investment costs* (m£/GW) | Fixed operation & maint. cost* (m£/GW) |
|---|---|---|---|
| **Transmission** | 40 | 628.26 | 6.34 |
| **Distribution** | 25 | 328.13 | 12.61 |