

PRACTITIONER'S CHALLENGE

Reducing CO₂
emission in transport



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■



MEET THE TEAM

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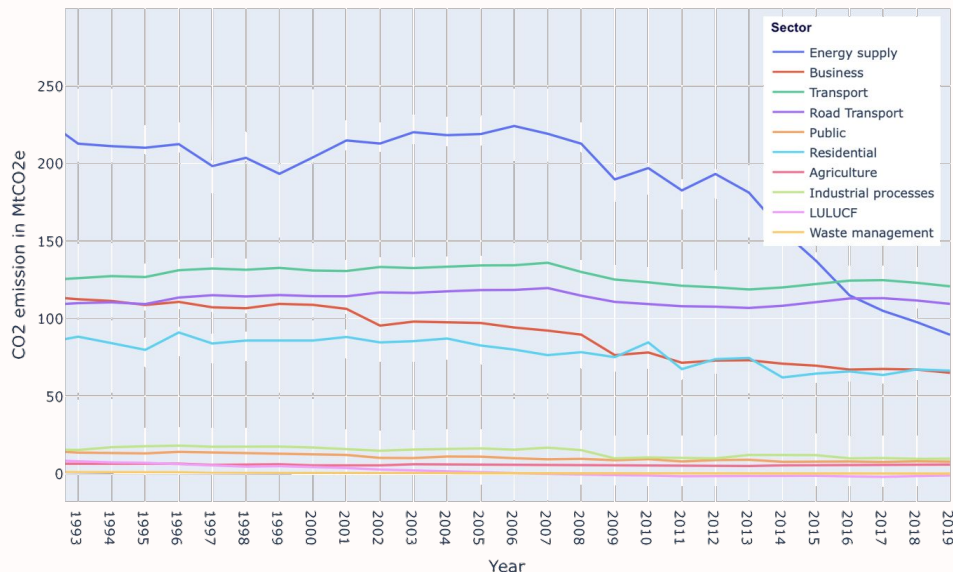


An aerial photograph of a city river, likely the Chicago River, which is almost entirely frozen with a layer of ice. The river is flanked by tall, modern skyscrapers and older brick buildings. A bridge is visible in the background. The year '2041' is superimposed in large white text in the center of the image.

2041

THE WHY

CO2 emission per sector



Global warming is a menacing disaster

- Global average temperatures are up by almost **1°C** since mid-1970s
- 2010-2020 was the **hottest** decade in history
 - With 2020/2016 tying for **hottest** year ever
- **150,000** deaths annually from climate change
 - **6.7mil** displaced in 2019

The UK is one of the major CO₂ contributors

- CO₂ in the atmosphere highest in **650,000** years
- UK is **17th out of 195** countries with **1.1%** of global GHG emissions and emitting **351.5 mln** tonnes of CO₂ in 2019

The UK's transport sector is its main CO₂ contributor

- **33%** of total CO₂ emission (2019) which is more than the energy sector

THE HOW



EV cars



Less traffic

Drivers and Risk factors of EV growth in the UK

Drivers



Cultural shift

80% said that the positive effect for the climate is the reason they want EVs (Shell study)



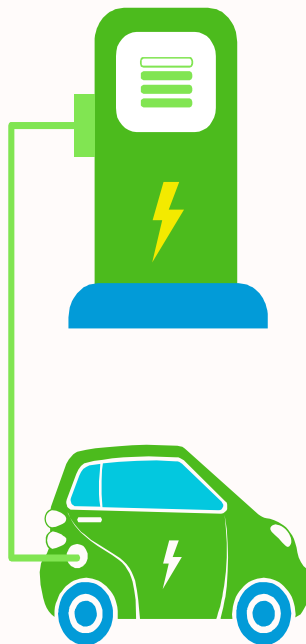
Government Incentives

Plug-in grant up to **£3,000**;
Free parking; Tax Exempts;



Affordability

Battery is **21%** of total EV price.
Its cost has decreased by **89%** in comparison to 2010.



Risks

Battery production

59% more CO2 emission from EV production, due to battery manufacturing;



Infrastructure

Low availability to **off-street** parking, thus less charging points.



Charging times and peak loads

35% of people charge at home, typically between **5pm-8pm**



CO₂ emission model



Climate Change Act 2008

Achieve Zero
Net Carbon by
2050

Constraints



Increase EV
share to **43%**
and EV sales to
97% by **2030**

THE WHAT

CO₂ model predictive tool

$$CO_2 = \beta_0 + \beta_1 * (Petrol + Diesel Cars) + \beta_2 * UK population$$

Variable Selection for the model:

Predictors	BIC	Adjusted R-squared
Total Cars + Petrol fraction	48.98	.713
Total_Cars + UK Population	53.35	.660
(Petrol and Diesel cars) + UK Population	59.39	0.571
Petrol fraction+UK_Population	77.30	0.145
All EV + UK Population	77.71	0.132

Forecasting

Total vehicles: ARIMA model/ARIMAX model

- Test the stationarity and difference itself
- Find the suitable order of lags of residuals and y
- Fit the model and make prediction

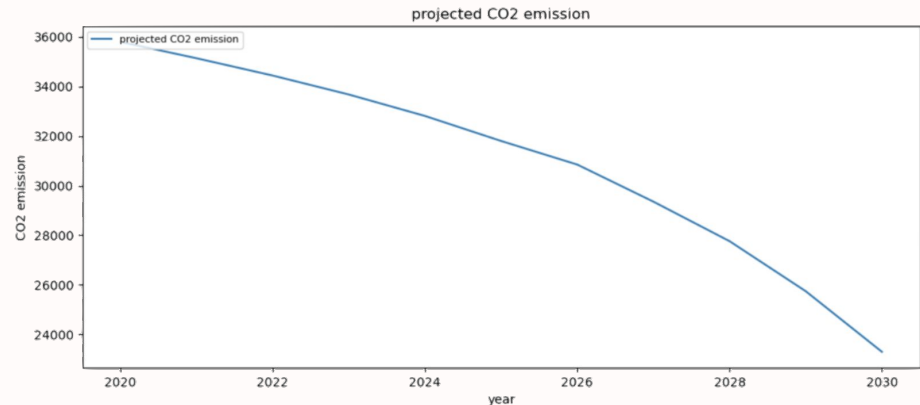
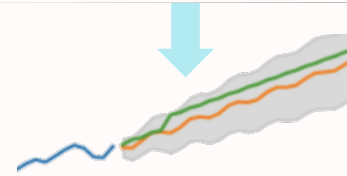
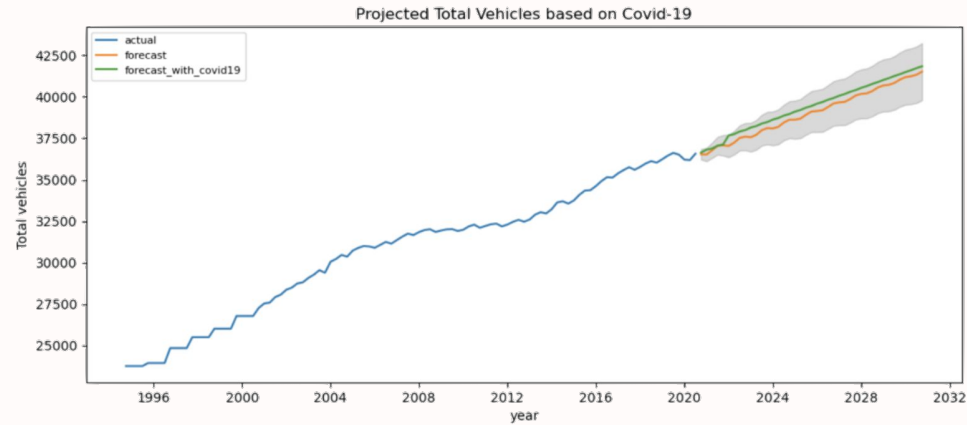
$$(1 - \phi_1 L - \phi_2 L^2) \Delta y_t = c + (1 + \theta_1 L + \theta_2 L^2) \varepsilon_t$$

Population: use the projection created by Office for National Statistics

Petrol + Diesel

$$\text{Petrol + Diesel} = \text{total vehicles} * (1 - \text{EV Fraction})$$

→ *We can get the projection of CO2 emissions by using previously chosen linear model, it will reach 23295 in 2030(around 34.9% of 2020)*



Trend for EV-Fraction

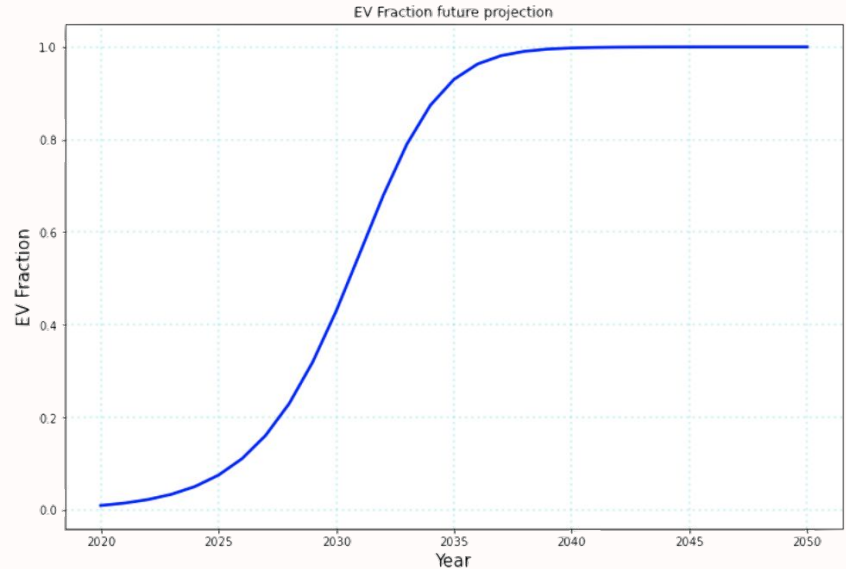
- Follows SI (Susceptible-Infective) model trend
- Time series given by:

$$f'(t) = \lambda f(t) (1 - f(t))$$

- By constraint of 43% LEV on the UK roads by 2030

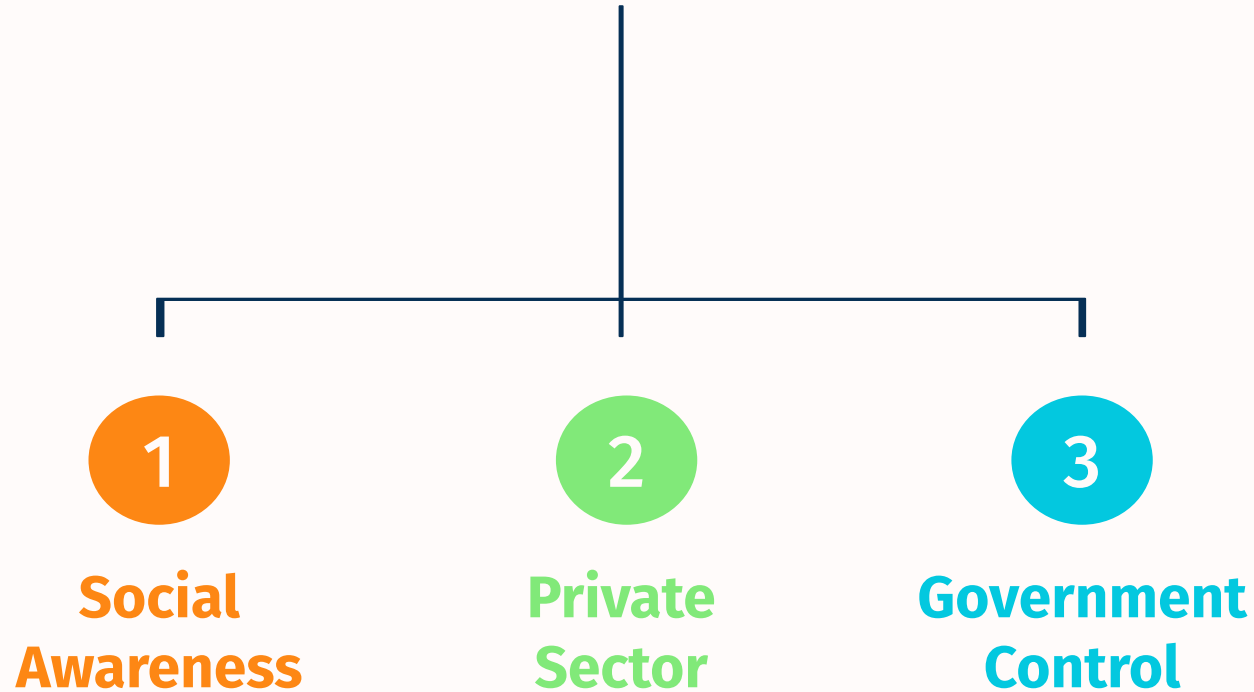
$$\lambda = 0.507$$

- Too optimistic: we have two more feasible scenarios



SOLUTIONS

Proposals for faster decarbonisation of the UK road network



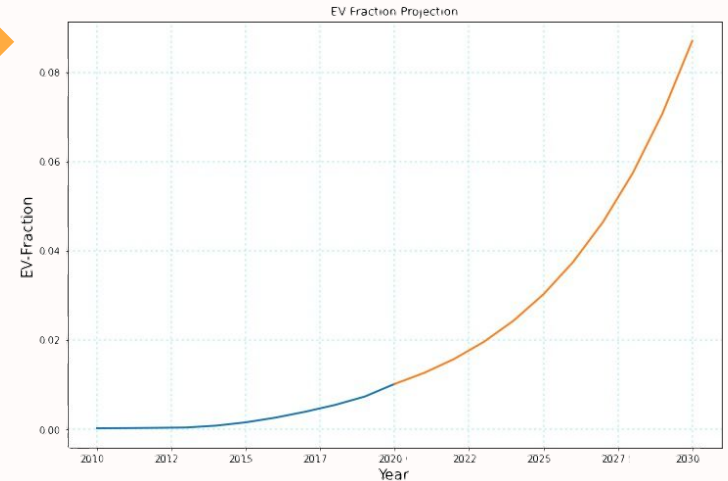
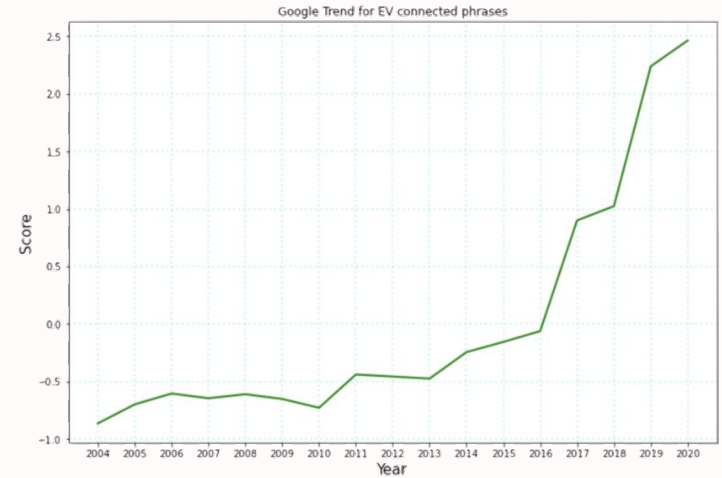
SCENARIO 1

Social Awareness

- SI model for EV popularity
- From Google trend scores:

$$\lambda = 0.247$$

- Current 2030 scenario for EVs: **8.7%**
- CO2 reduction is **6.4%**
- **Feasible:** higher % with Social Media Influence



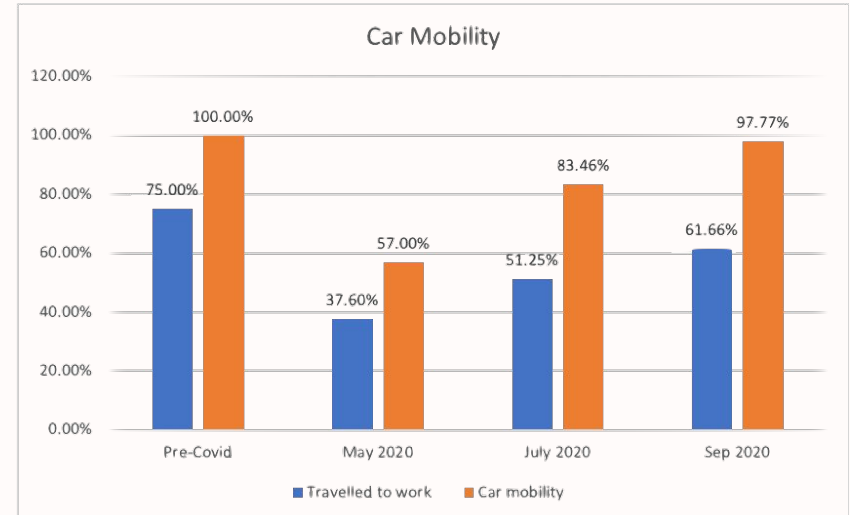
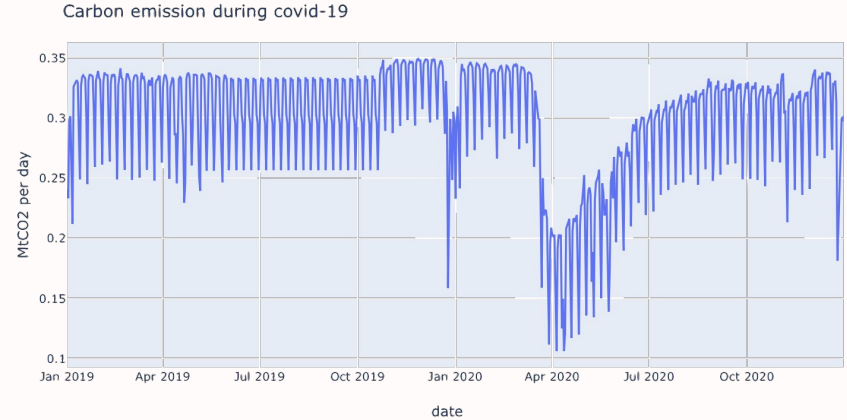
SCENARIO 2

Private Sector

Enforce 50/50 work from home scheme for largest employee companies

- **75%** of workers in the UK travelled to work in 2017
- July 2020 :
 - Similar scenario to 50/50 scheme
 - **51.25%** on average travelled to work
 - **-16.5%** less car traffic
 - **-4.84%** less CO2 emission in transport

Feasibility: Very feasible



SCENARIO 3

Government control - Norway emulation

- Norway is the world's EV leader with **74.7%** EV market penetration in 2020 from **0.1%** in 2009
 - **0%** VAT on leased EVs
 - Free parking for EV drivers
 - **50%** decreased company road tax
- UK could have **38%** of EV market penetration by 2030 if Norway's incentives are adopted in isolation
 - Within **5%** of UK's intended goal of **43%** EV by 2030
 - **3.3%** within the UK's 2030 goal of CO2 emissions
- This is feasible because there is an existing roadmap from Norway

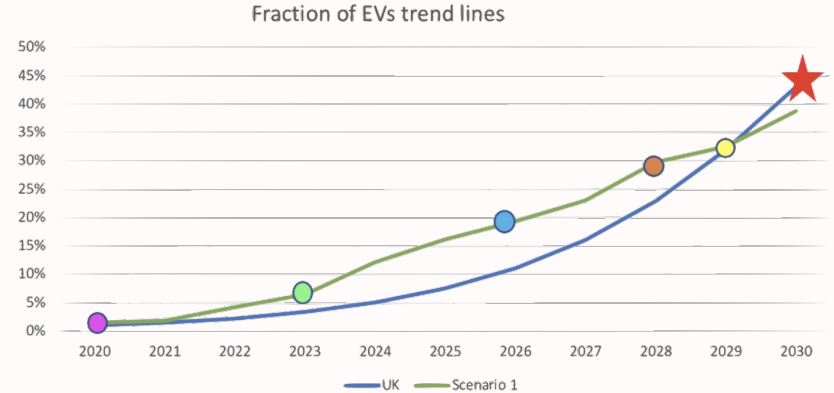


Fig 1: EV market share %age with Norway Incentives

●	free access to road ferries	●	50% discount on parking fees
●	free access to road tolls	●	40% decreased company car tax on EVs
●	0% VAT on leased EVs		

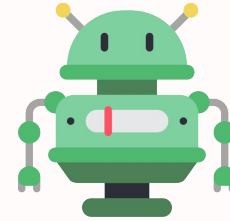
OTHER SOLUTIONS

AI methods to reduce CO₂ of the UK's current fleet of LCVs and HGVs



Artificial Intelligence to Reduce
Greenhouse Gas Emissions in the
Mining Industry

- **Fuel Consumption** = Payload x
Truck Speed x Total Resistance
- **9% fuel consumption reduction**



Robots for efficient pre-sorting for
LCV and HGVs at their end of life.

- Estimated that around **1.6 - 2 million** end of life vehicles (ELVs) are arising in the UK each year
- The robot ELV recycling system will sort at **98% purity**

THANK YOU!

ANY QUESTIONS?

