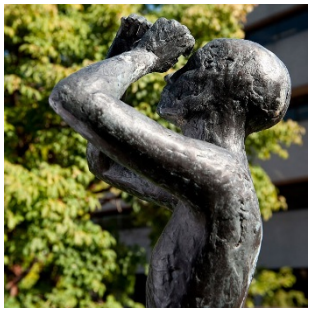

# Top-Down and Bottom-Up Policy Evaluation –

# A Multi-Model Approach

Eamonn Mulholland[a], Fionn Rogan[a], Brian Ó Gallachóir[a]

Club Belambra Les Criques, Toulon| ECEEE Summer Study

02nd June ’15

a. Energy Policy and Modelling Group, ERI, UCC, Ireland

A TRADITION OF INDEPENDENT THINKING

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# Energy in Ireland - 2013

- 4.6 Million Population
- €167 Billion GDP
- 10,729 ktoe Final Energy Consumption - 1% of Europe
- 84.8% of Energy Imported

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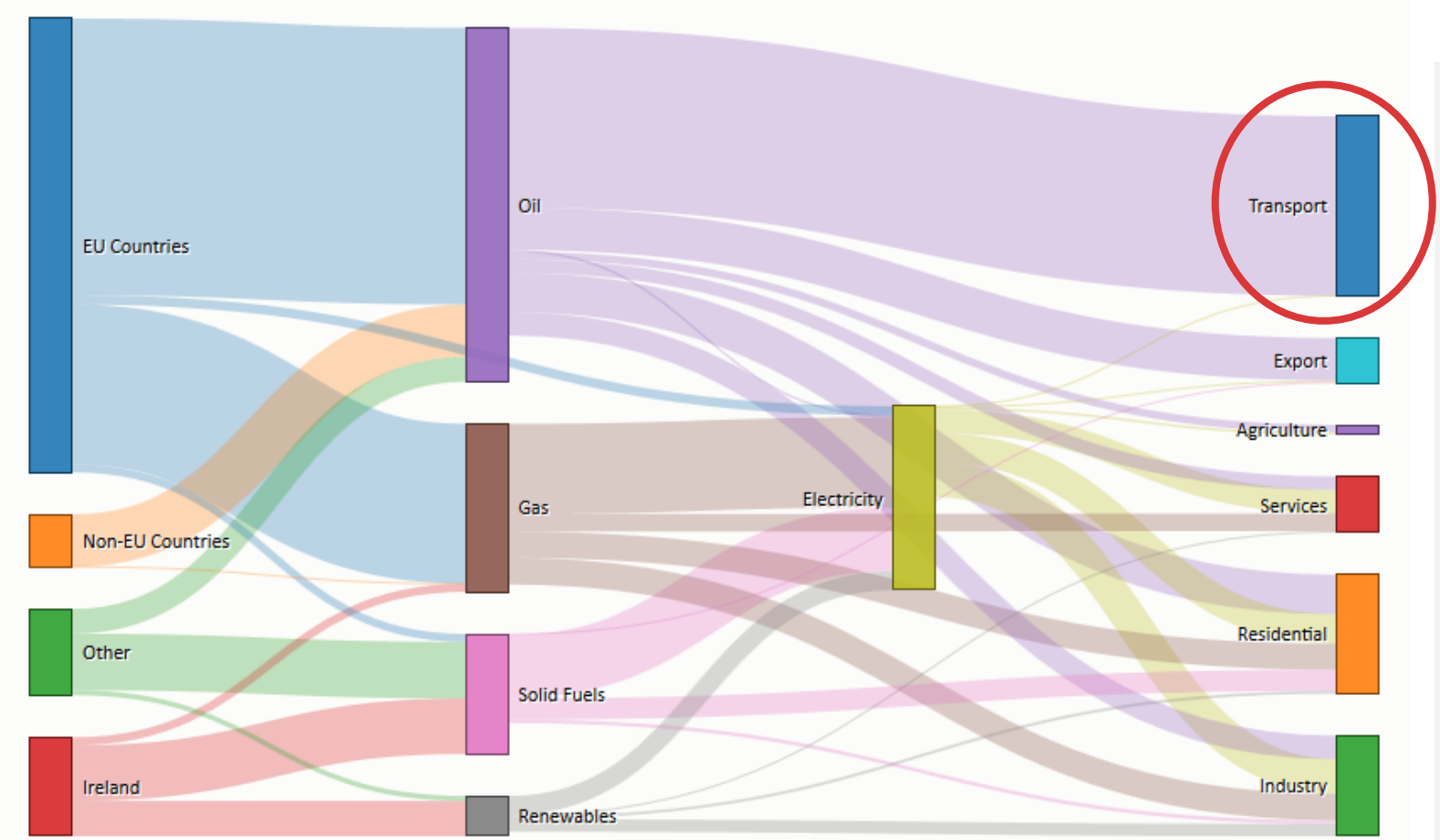
# Energy Flow Diagram of Ireland - 2013

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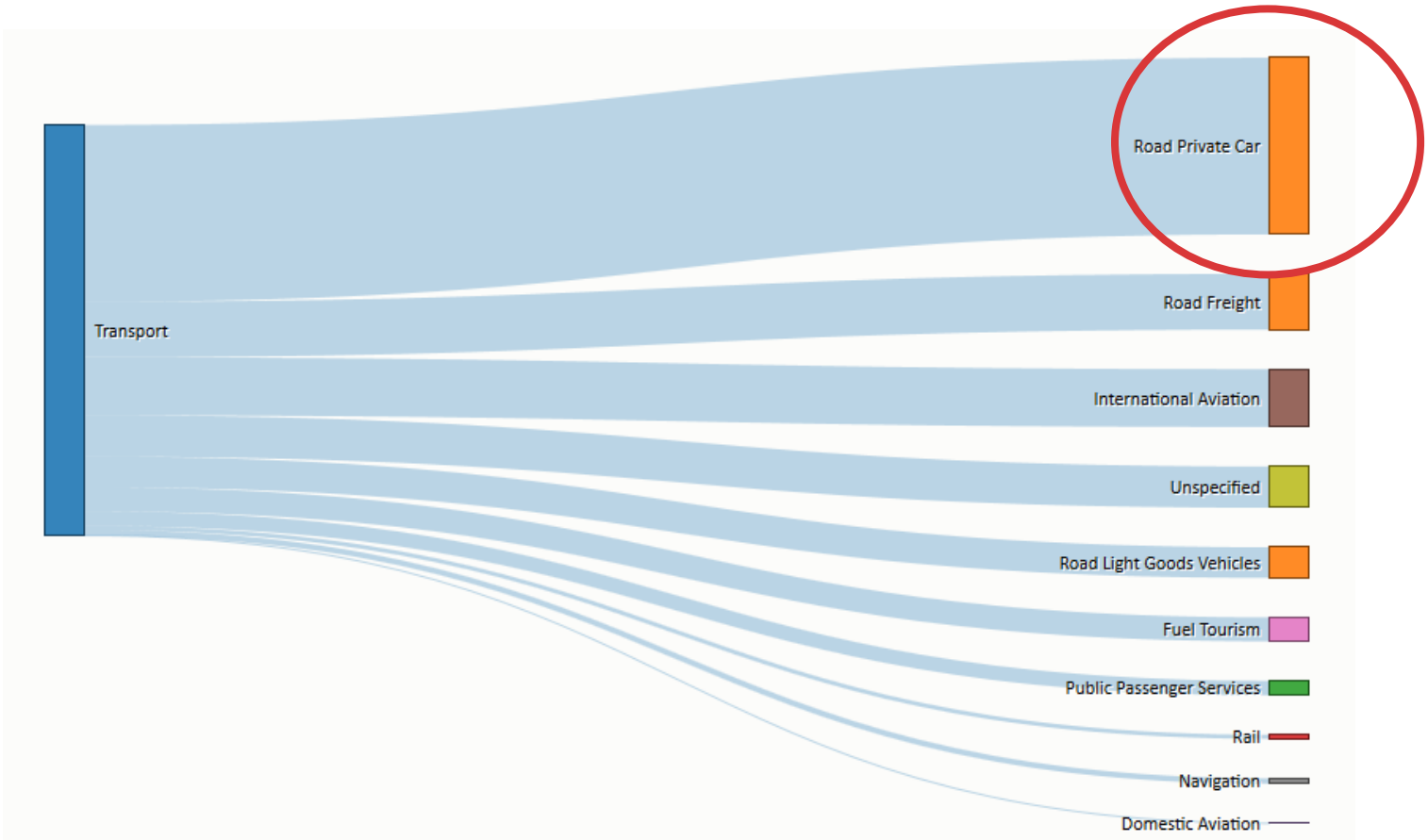
# Transport Sector in Ireland - 2013

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# Overview

- Top-down policy model:
  - Technology Roadmaps
  - Targets
  - Optimisation Model

- Bottom-up policy models:
  - Policy Roadmaps
  - Measures
  - Simulation

- Multi-model approach to informing on policy decisions

# Top-Down Policy Model (TIMES)

- Irish TIMES is a least-cost optimisation model of the Irish Energy System

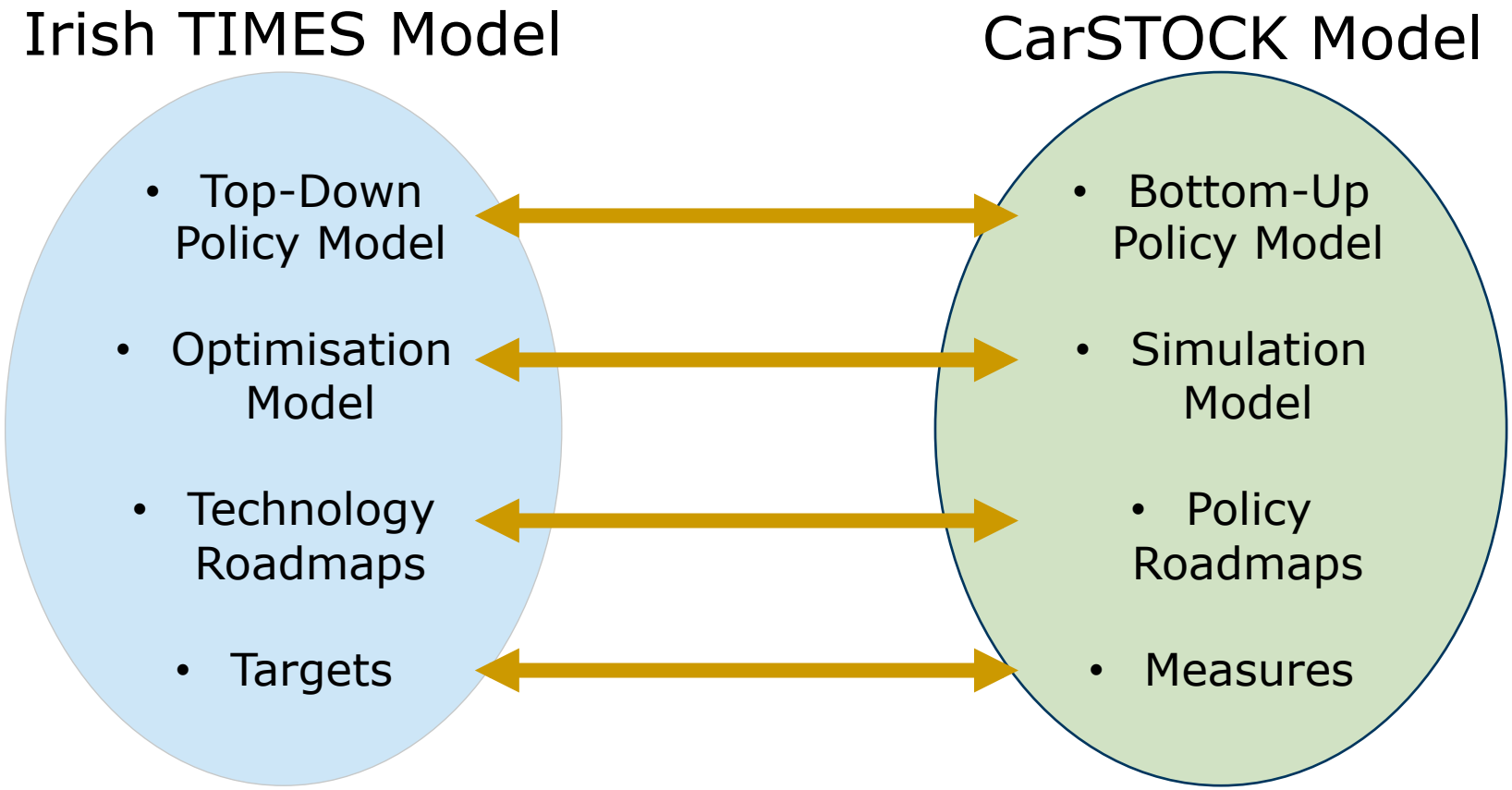
- The model minimises total system cost subject to imposed constraints for the Irish energy system

- The model runs a scenario and highlights the level of effort required by sector (e.g. transport, residential, etc.) to reach an overall goal

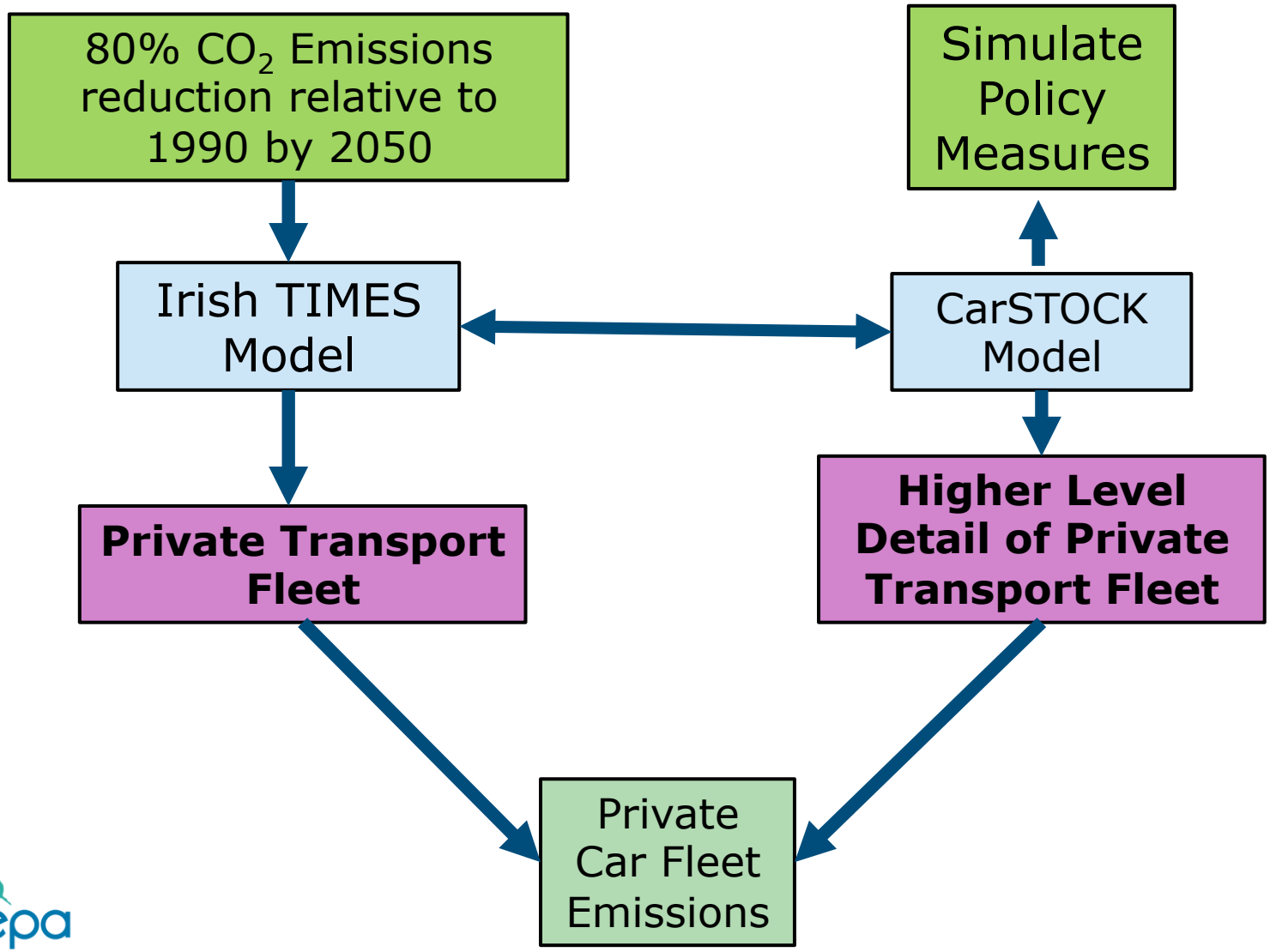
# Bottom-Up Policy Model (CarSTOCK)

- The CarSTOCK model is a simulation model of the private car fleet in Ireland projected forwards to 2050
- The model allows for the introduction of scenarios which can give an insight into policies which can be introduced on a lower end (e.g. efficiency improvements in cars)
- Vehicles are disaggregated into a range of variables with given specific energy consumption for each type
- This allows for the calculation of total energy and emissions in the private transport sector

# Methodology

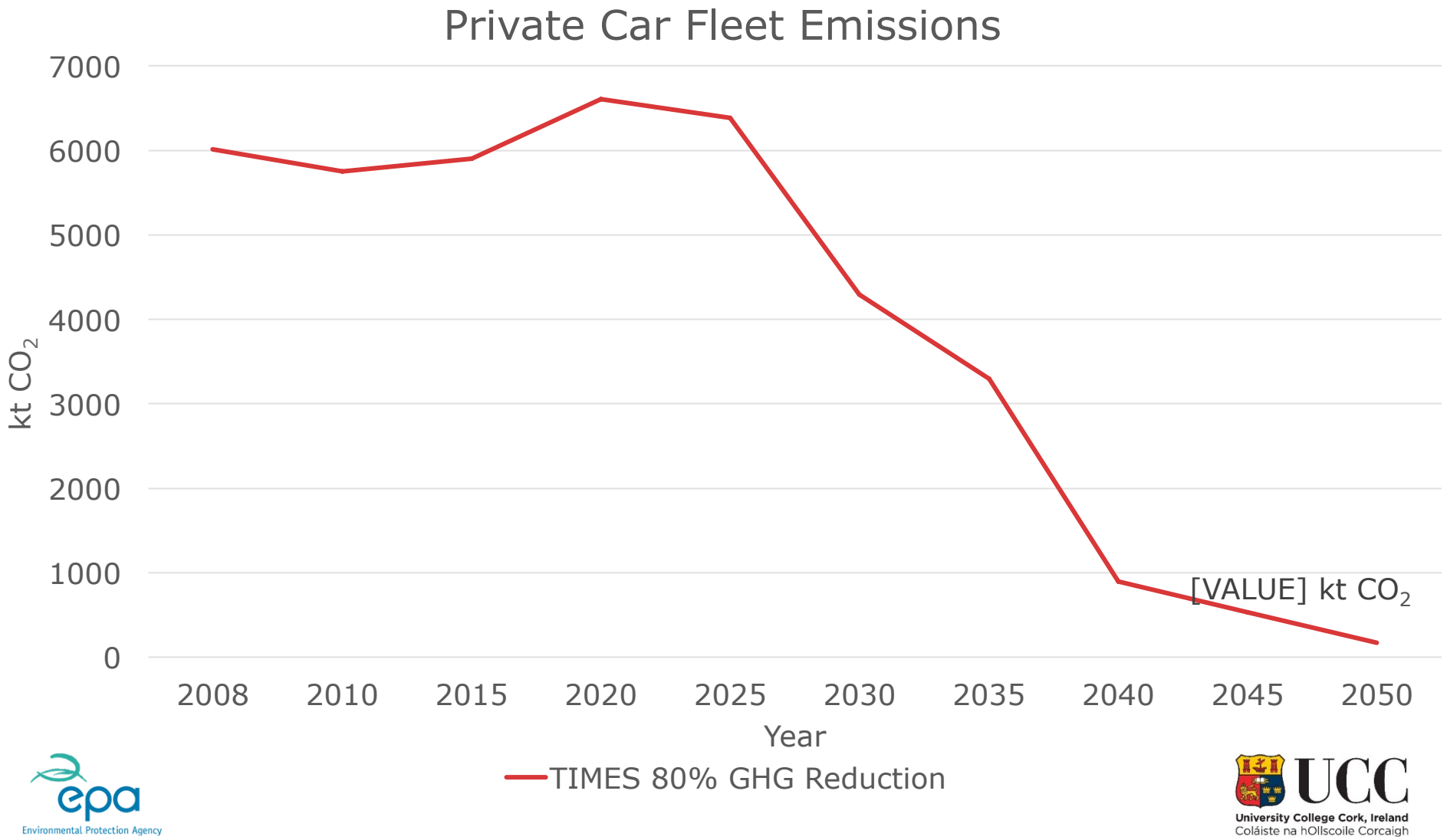


# Process


80% $CO_2$ Emissions reduction relative to 1990 by 2050
Simulate Policy Measures
Irish TIMES Model
CarSTOCK Model
Private Transport Fleet
Higher Level Detail of Private Transport Fleet
Private Car Fleet Emissions

# The Low Carbon Roadmap – Irish TIMES
# Private Transport

(80% overall $CO_2$ Emissions Reduction by 2050 relative to 1990)

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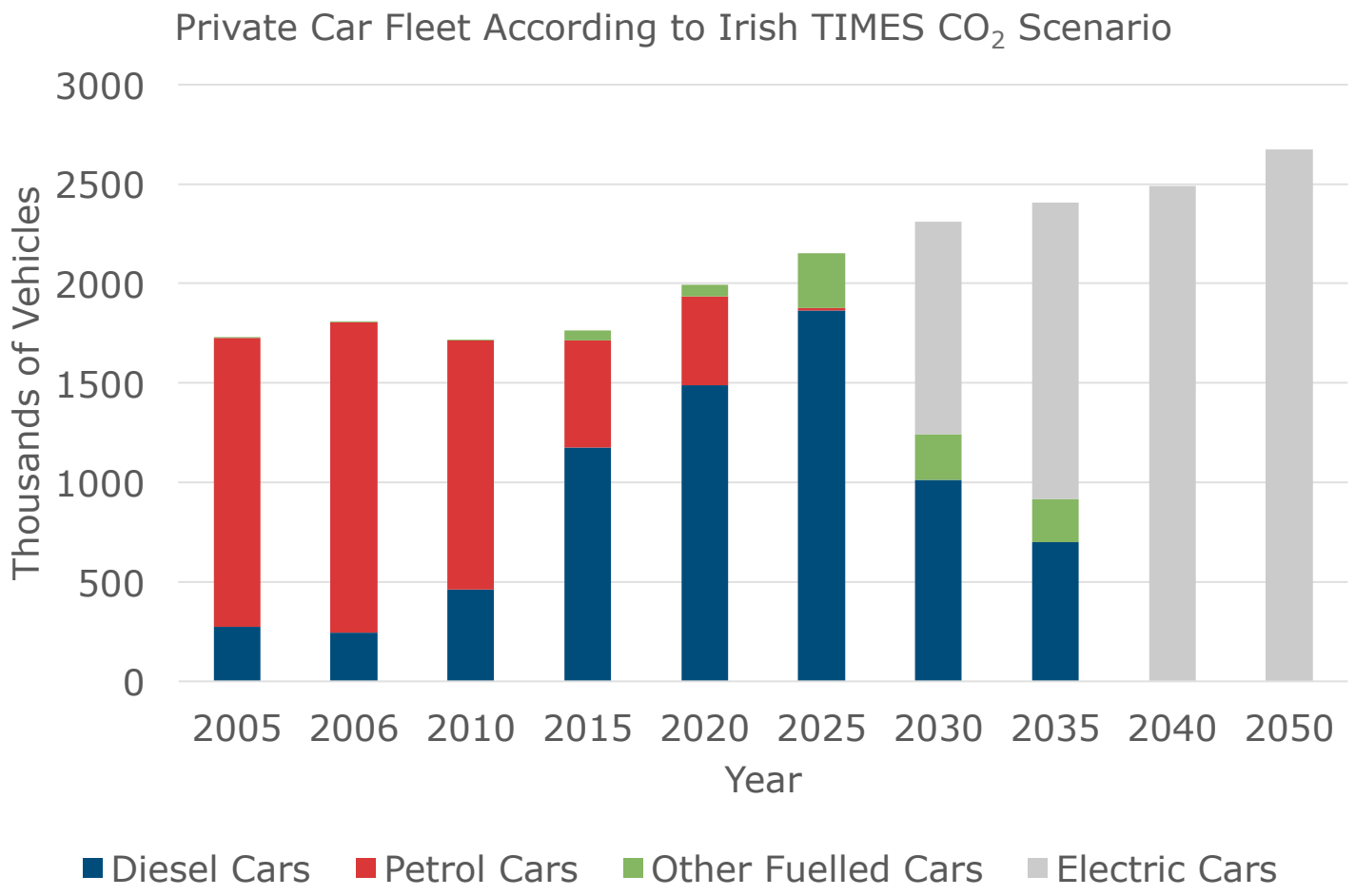
# The Low Carbon Roadmap
# Private Car Fleet

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# CarSTOCK Scenarios

1. **BaU -** Business as Usual

2. **Improved Efficiency –** Increasing the efficiency of petrol and diesel cars

3. **Improved Efficiency + Further Measures –** Increasing efficiency, incorporates modal shifting

4. **Improved Efficiency + Further Measures + EV -** Increasing efficiency, incorporates modal shifting, includes gearshift indicator and has sales of only electric vehicles from 2030 onwards

# CarSTOCK Scenarios

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4. **Improved Efficiency + SmTr + Eco + EV -** Increasing efficiency, incorporates modal shifting, includes gearshift indicator and has sales of only electric vehicles from 2030 onwards

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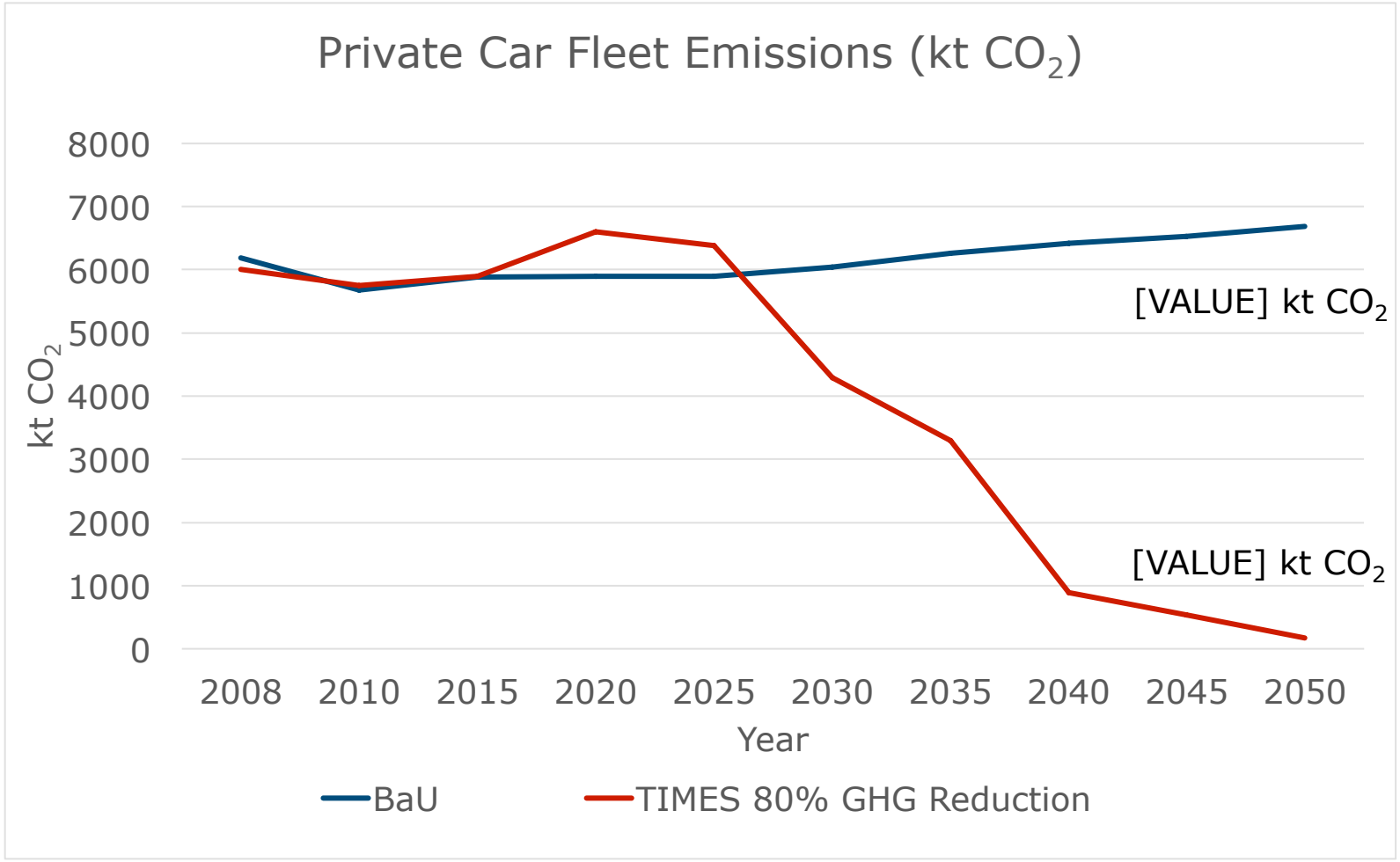
# CarSTOCK BaU

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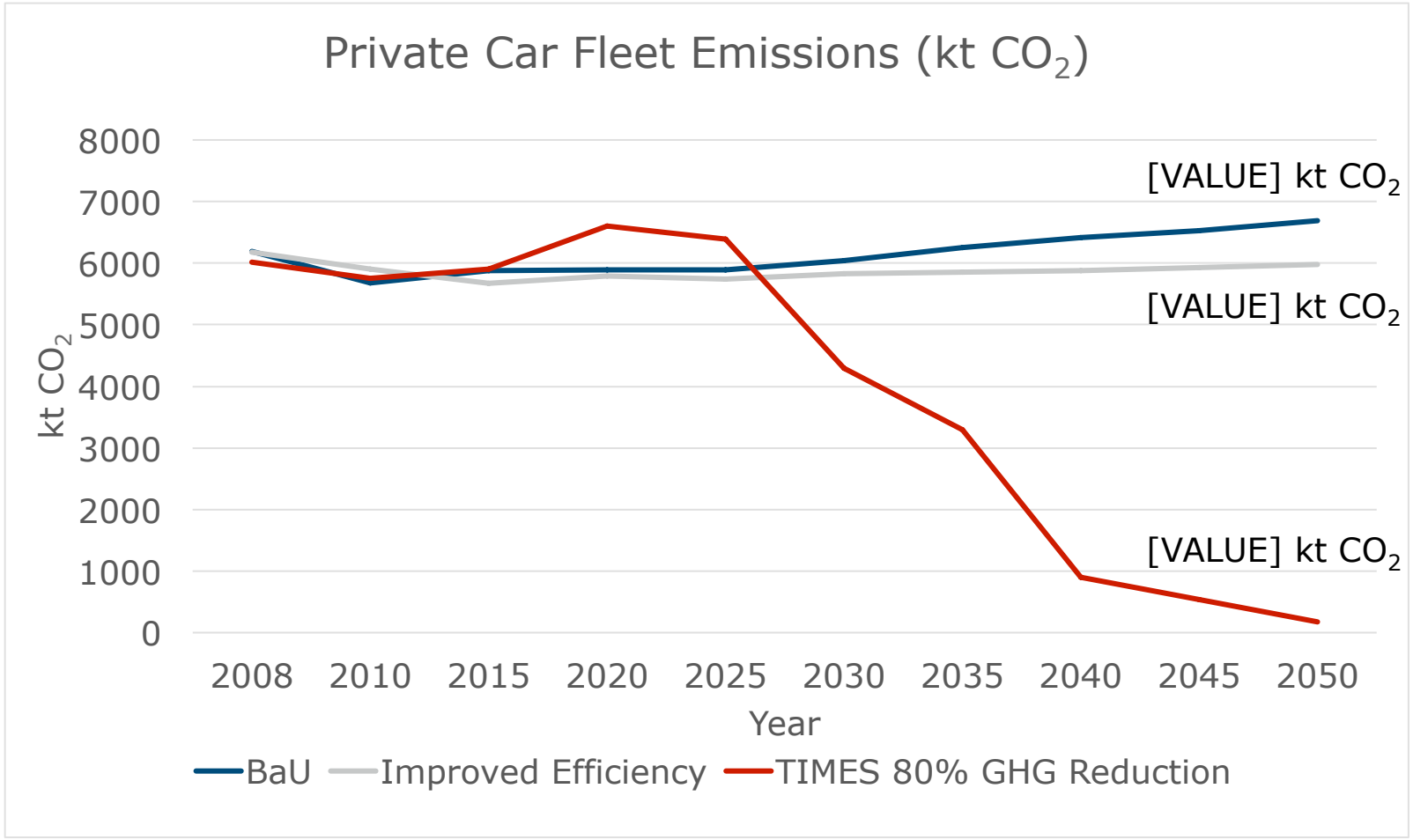
# CarSTOCK – Improved Efficiency

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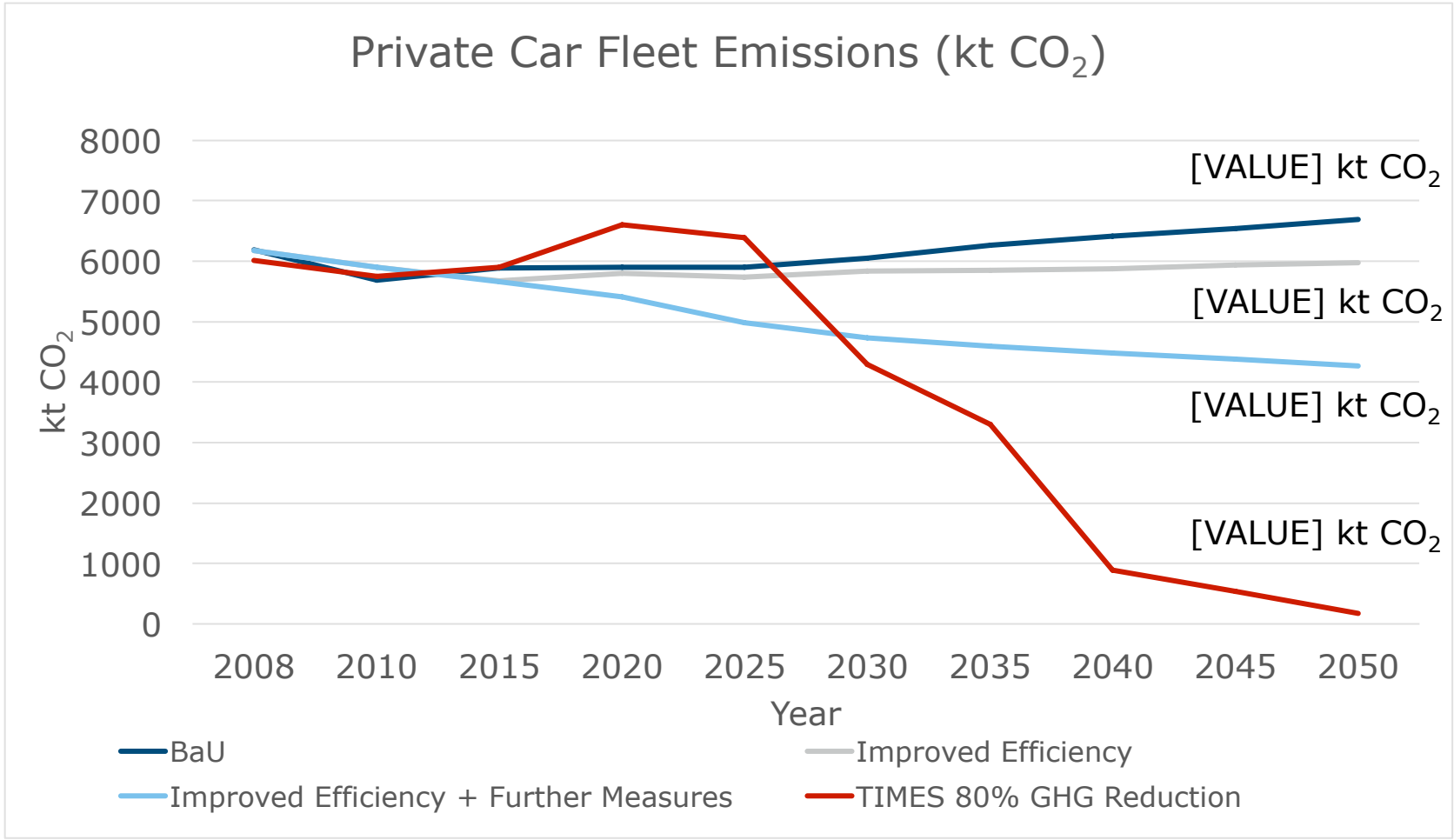
# CarSTOCK – Further Measures

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# CarSTOCK Scenarios

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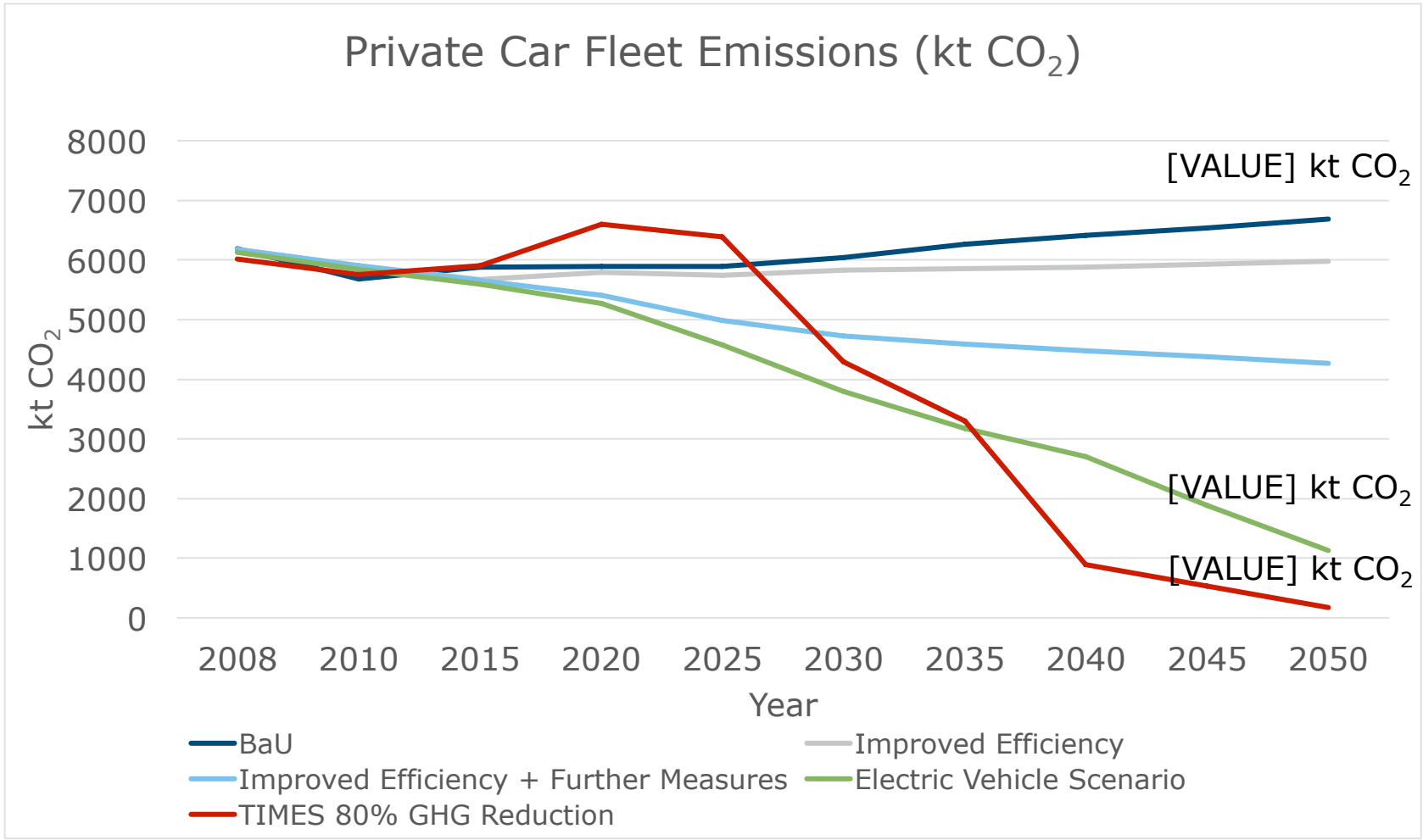
# CarSTOCK – Electric Vehicle Scenario

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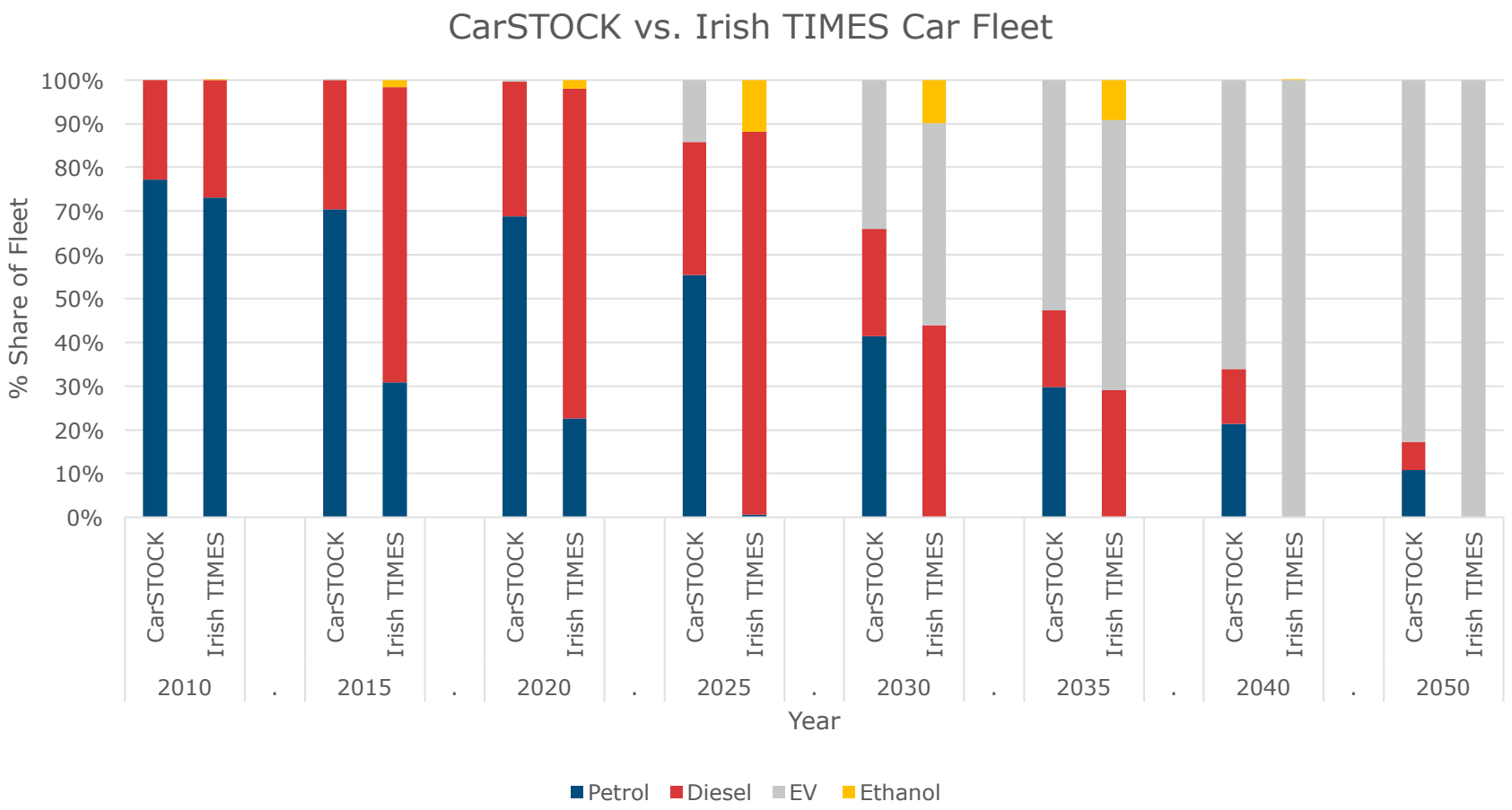
# CarSTOCK and TIMES Private Car Fleet Comparison

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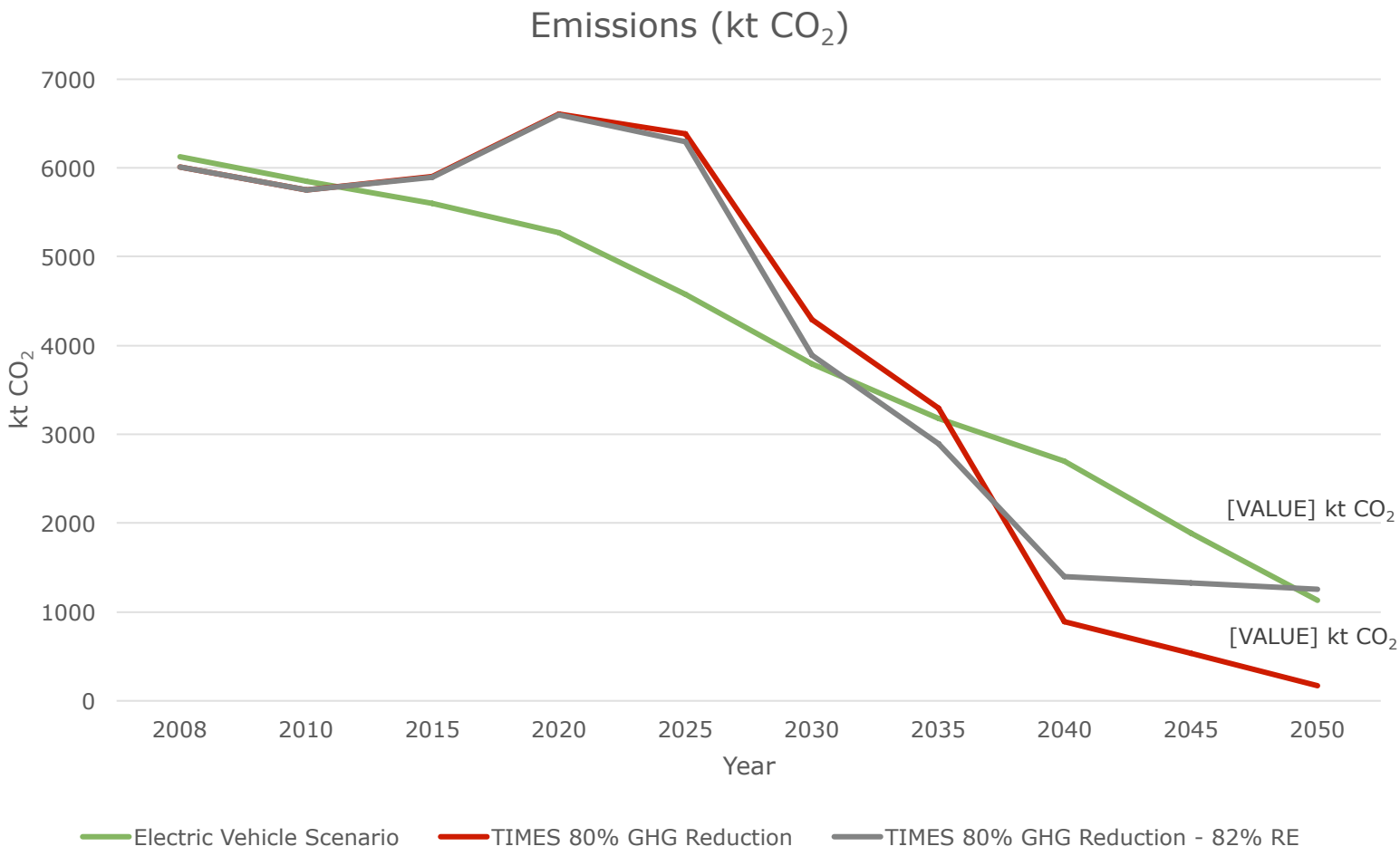
# Insights into Individual Policy Measures

- These results can  be used to give several insights into individual policy measures:
  - Only selling Electric Vehicles from 2030 onwards
  - Introduction of incentives to create a shift towards public transport use or for better bicycle infrastructure
  - After that, introducing a scrappage scheme may be necessary to meet our 80% GHG reduction by 2050 according to TIMES
- Otherwise it may be required to change the inputs for Irish TIMES.

# Second Iteration of the Irish TIMES Scenario

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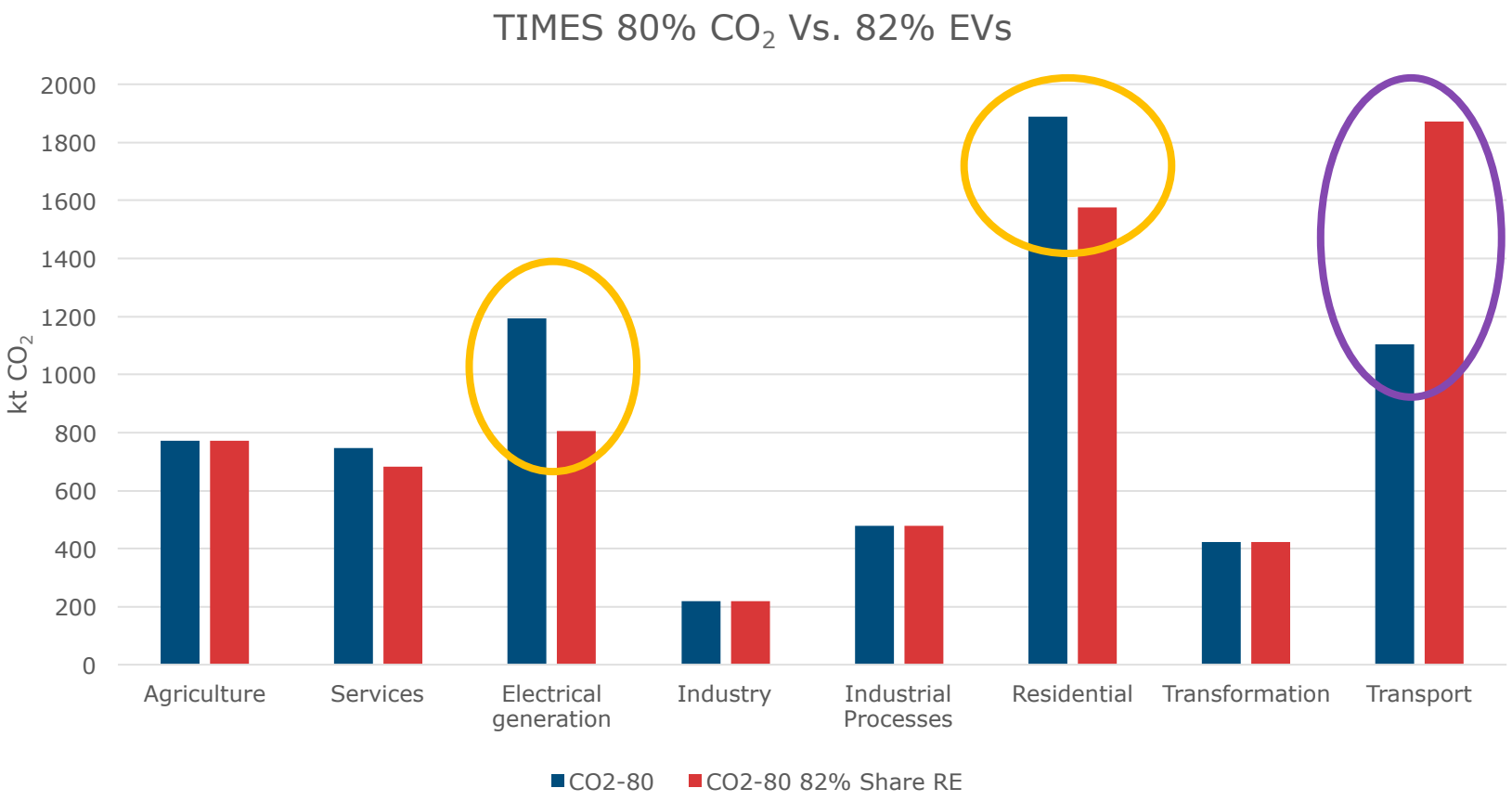
# Irish TIMES 82% EVs Constraint - Results

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# Conclusion

- Creating a soft-link between top-down and bottom-up policy models can provide insights into individual policy measures
- It can test a range of possible policies which could inform on the paths to be taken in reaching given targets
- It also creates an iterative methodology whereby the constraints of the optimisation model can be changed according to the sectoral simulation model
- This soft-linking methodology can be used with any sector in order to create effective policies[1]

[1]Deane, J.P., Dineen, D., Chiodi, A., Gargiulo, P. Gallagher, Ó Gallachóir, B.P., 2013. The Electrification of Residential Heating in Ireland Using Heat Pumps. Working Paper

# Acknowledgements


- Funding – Environmental Protection Agency
- … Modelling on the shoulder of giants
  - Irish TIMES model development – Alessandro Chiodi[2]
  - CarSTOCK model development – Hannah Daly[3,4]


[2] Chiodi, A., Gargiulo, M., Rogan, F., Deane, J.P., Lavigne, D., Rout, U.K., Ó Gallachóir, B.P., 2013. Modelling the impacts of challenging 2050 European climate mitigation targets on Ireland's energy system. Energy Policy 53, 169-189.

[3] **Daly, H.E.** & Ó Gallachóir, B.P. (2011), 'Modelling private car energy demand using a technological car stock model', Transportation Research Part D: Transport and Environment 16(2), 93–101.

[4] **Daly, H.E.** & Ó Gallachóir, B.P. (2011), 'Modelling future private car energy demand in Ireland', Energy Policy 39, 7815–7824.

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# Thank You


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# Marginal Abatement Costs

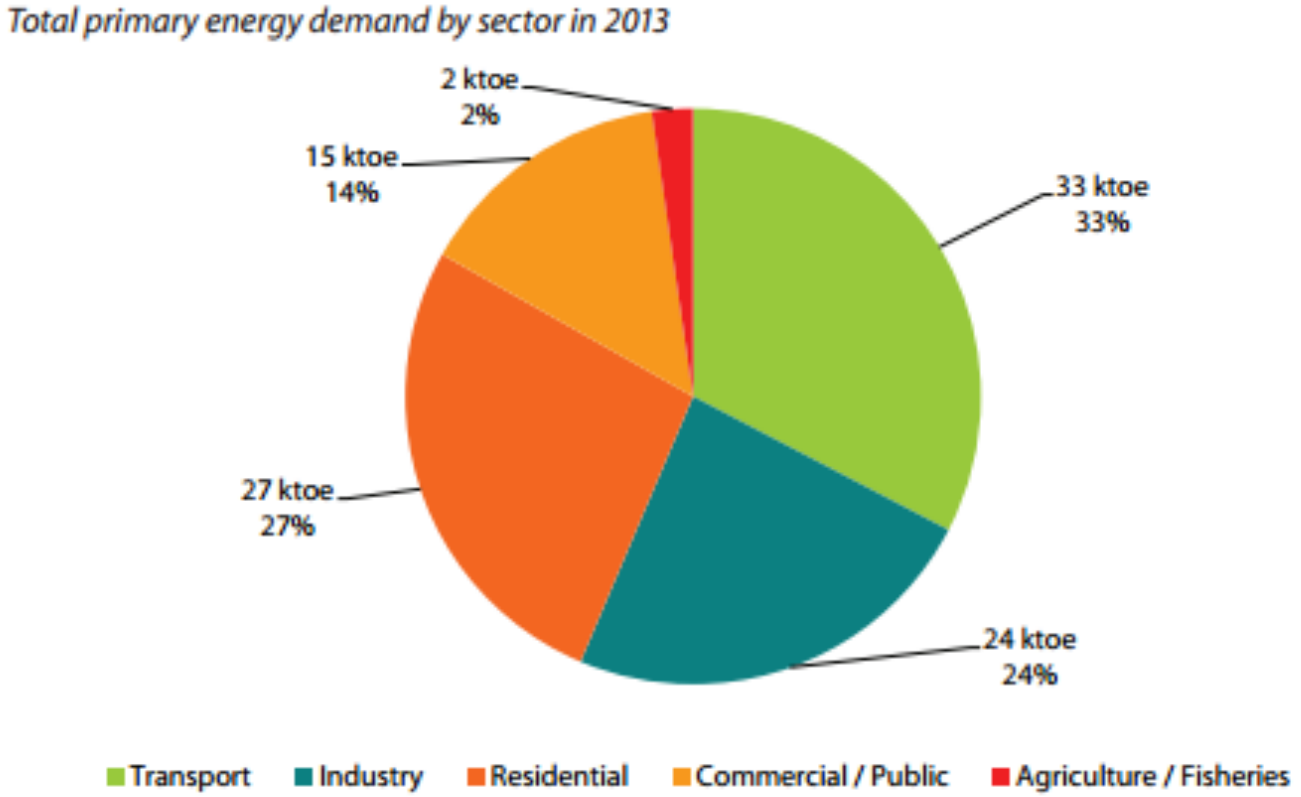
| Commodity | Scenario | 2020 | 2030 | 2040 | 2050 | Unit |
|---|---|---|---|---|---|---|
| All Emissions | CO2-80 | 74.0 | 108.7 | 296.7 | 366.4 | €/tonne |
| All Emissions | CO2-80 82% | 74.0 | 141.9 | 296.7 | 544.4 | €/tonne |

# Survival Rates in CarSTOCK

$$Surv_t(Y-v) = Avg_y\left(\frac{Stock^{y}_{t,y-(Y-v)} - Stock^{y-1}_{t,y-(Y-v)}}{Stock^{y-1}_{t,y-(Y-v)}}\right)$$

$$Stock^{Y}_{t,v} = Stock^{Y-1}_{t,v} \times (Surv_t(Y-v)+1)$$

# TPER in Ireland 2013




Source: SEAI

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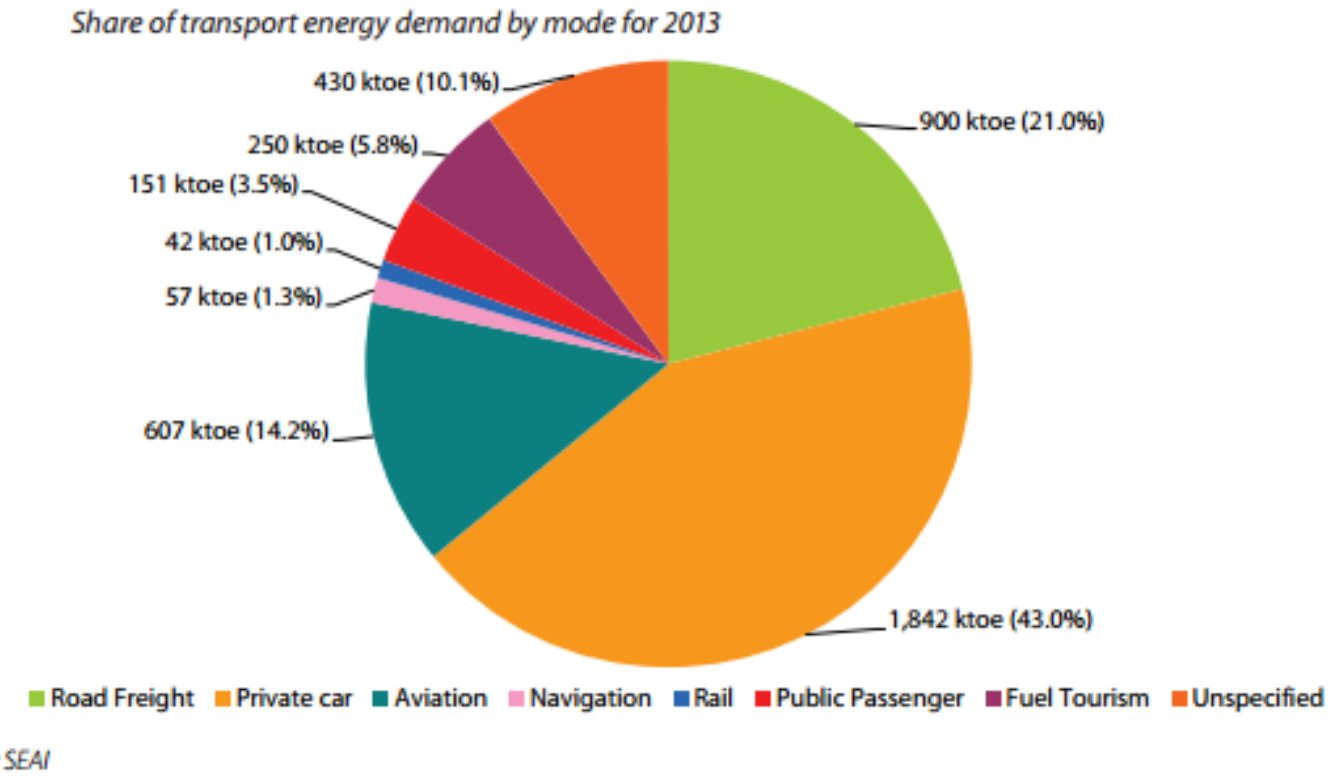
# Transport Energy Demand 2013




*Source: SEAI*

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