



# REM

**Road Emissions Model**  
Transport Infrastructure Ireland

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31<sup>st</sup> May 2023



# Overview of the REM

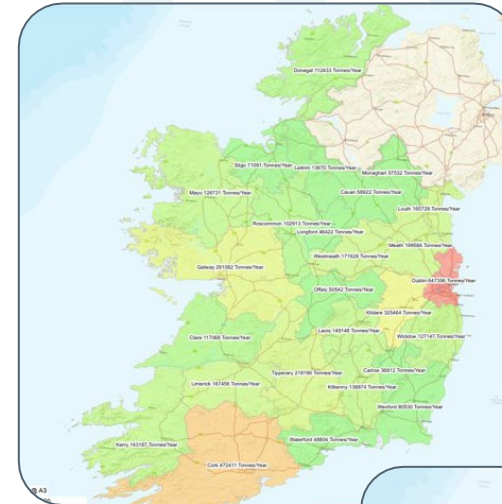
The REM calculates the GHG and non GHG emissions (e.g. Nitrogen Dioxide and Particulates) generated from vehicles on a modelled road network.

Can be used for assessing the impact of projects at a local scale or policy assessment at a regional or national scale on such emissions.

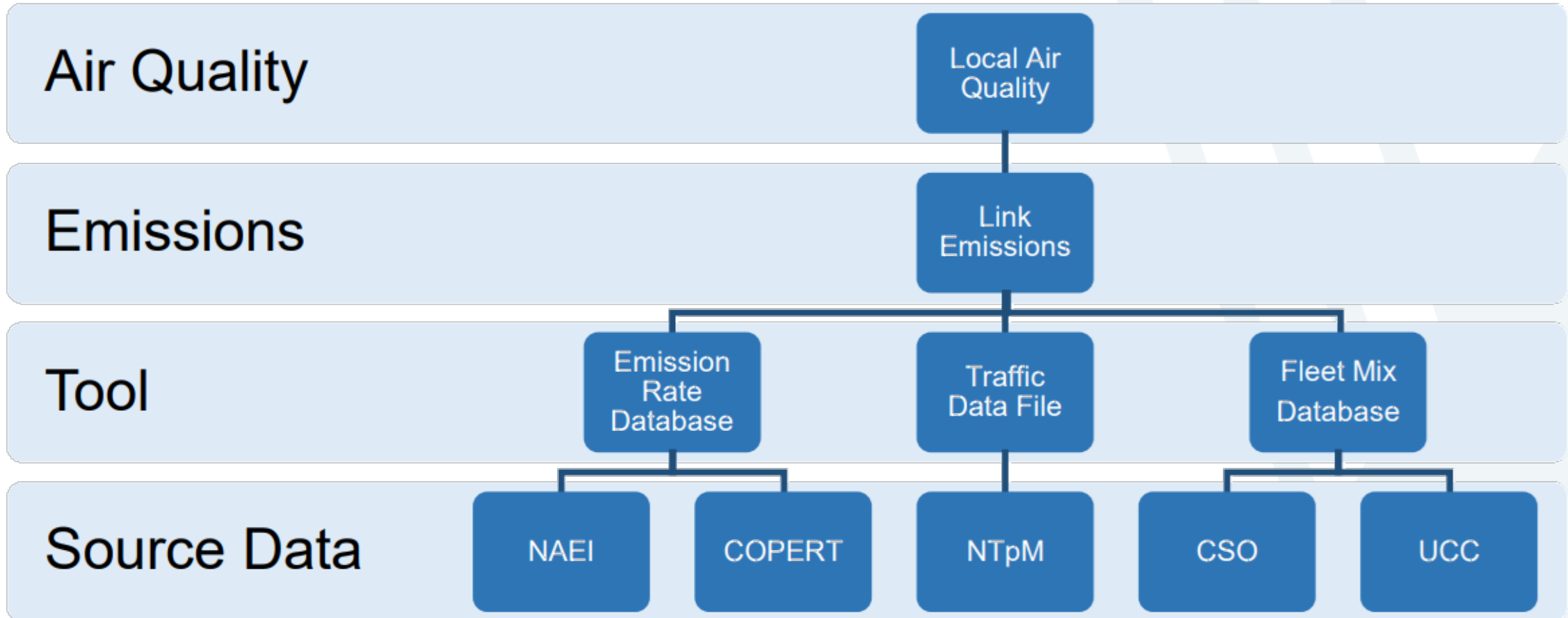
Provides outputs to quantify climate impacts of projects for both the EIA and Project Appraisal processes

A link based tool which is crucial for understanding emission variations with speed on a network

Consistent source of impacts from project level right up to national reporting of vehicle emissions



# Components of REM



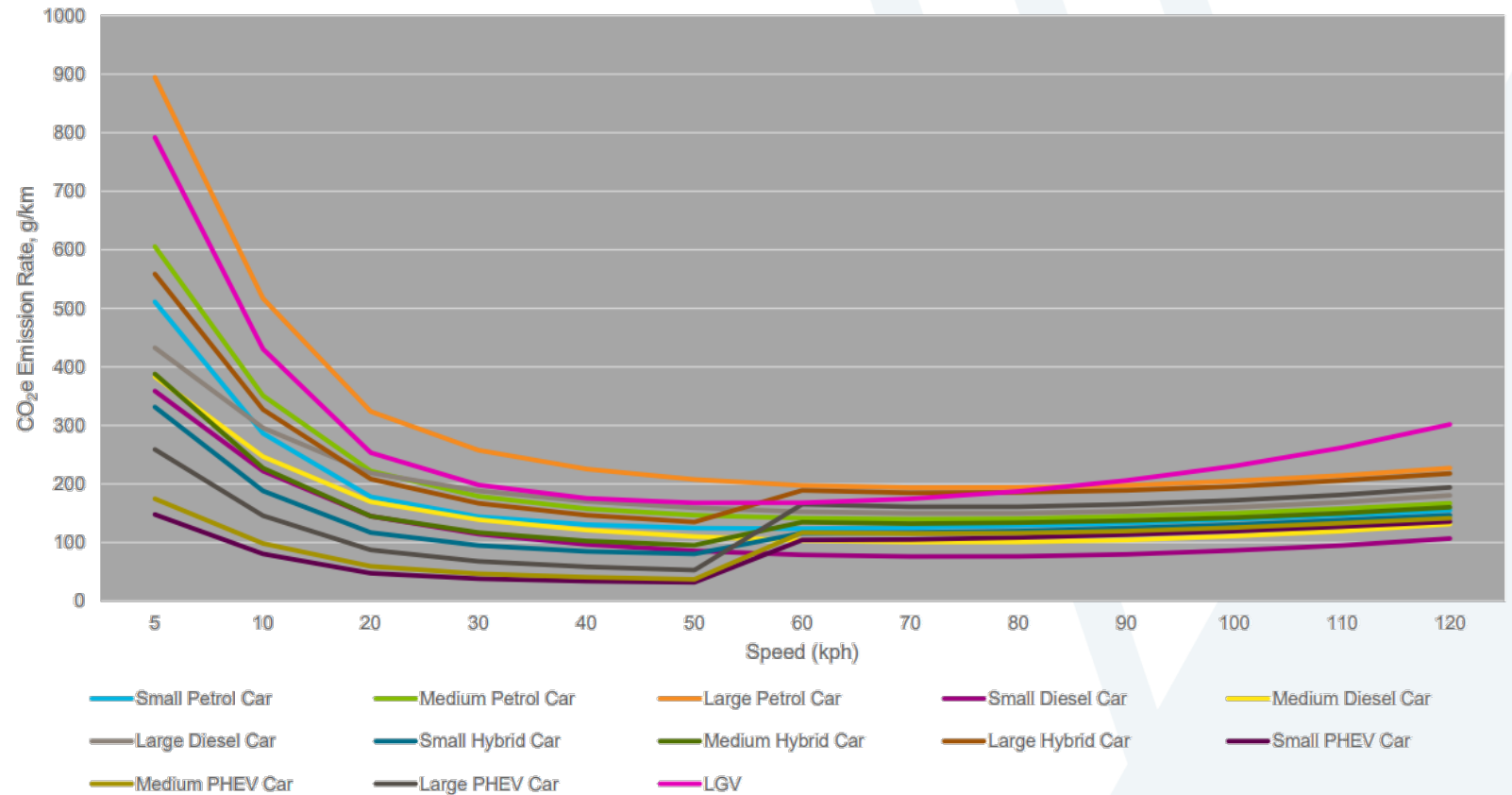
# Emissions Rates

copert 

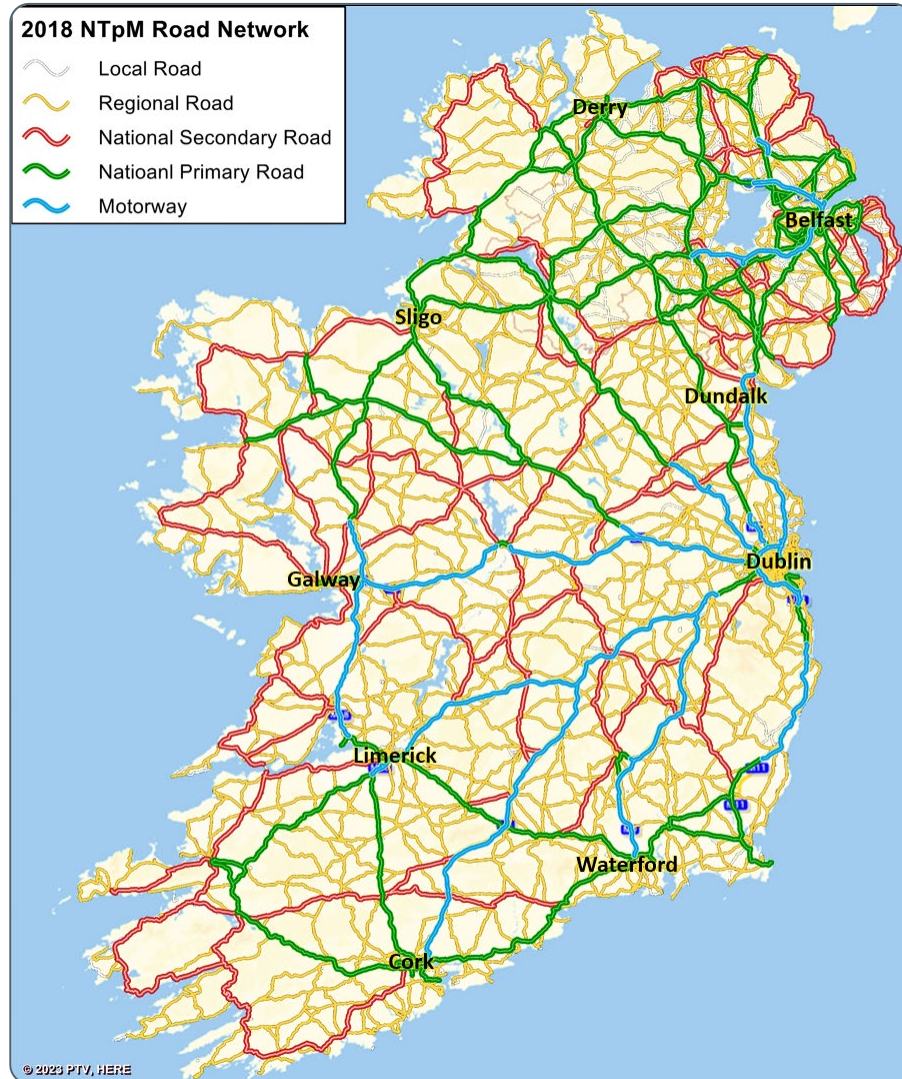
 National Atmospheric Emissions Inventory

 Department for Environment Food & Rural Affairs

Emissions Factors Toolkit v10.1



# Road Traffic Network



The REM reads in link based traffic data

Inputs can be a very simple, local network.  
Or full information on all roads in Ireland

Requires data on average daily traffic  
volumes (light vehicles & heavy vehicles)

Requires data on average hourly vehicle  
speeds (free-flow and congested)

Data from transport model can be used as  
an input to the REM. Observed data can also  
be used

# Existing Vehicle Fleet Mix



## Fuel Technology

- Petrol
- Diesel
- PHEV / HEV / BEV

## Engine Size

- Car
- LDV analogous



## Vehicle Type

- Car
- LGV
- HGV

## Weight

- Heavy freight
- Articulated / Rigid
- Light freight
- LGV class

## Age Profile

- Euro Class
- Cat / DPF fails adjustment
- Abatement retrofit

# Future Fleet Scenarios



## Car Fleet Scenarios

### Business As Usual

A continuation of current trends in relation to consumer and market behaviour around the purchasing of vehicles

### Climate Action Plan

An interpretation by UCC MaREI of increased number of electric vehicles in the fleet by 2030. Informed by “bottom-up” modelling of consumer behaviour

### Intermediate

A linear interpolation of the above two scenarios to assist in sensitivity analysis



## HGV Fleet Scenarios

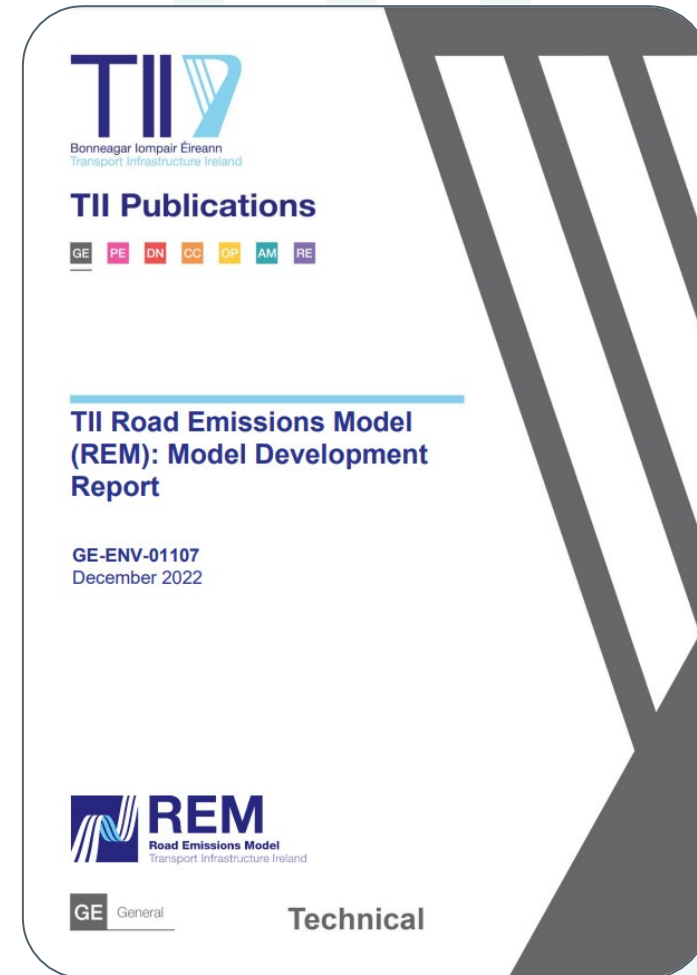
Extrapolation of existing trends regarding the purchasing and use of Heavy Goods Vehicles developed by AECOM

Car stock modelling and projections by UCC MaREI is open source data available at <https://github.com/vor115384876/Irish-Car-Stock-Model>

# REM Report

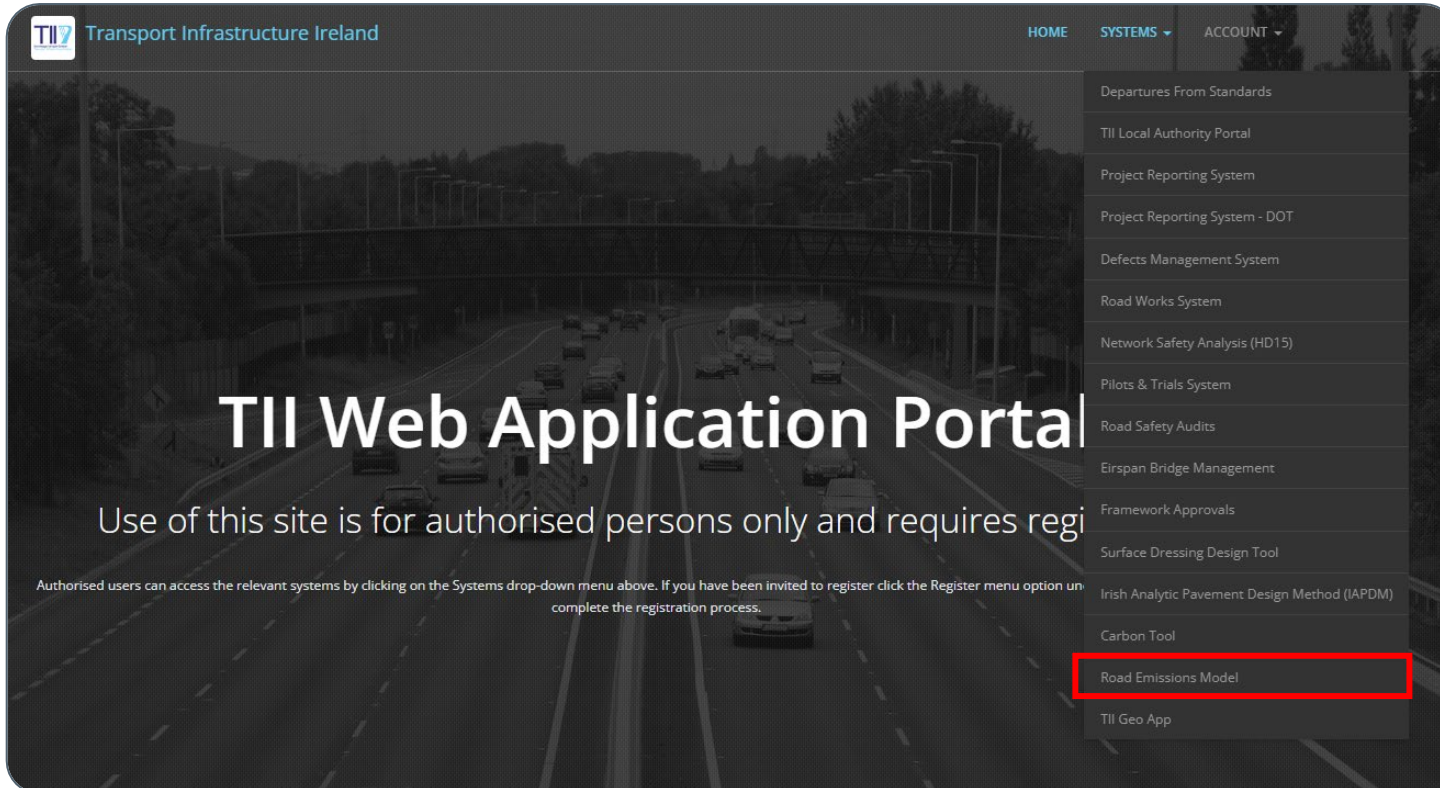
**TII Road Emissions Model (REM): Model Development Report (GE-ENV-01107)** published on the TII Publications website

<https://www.tiipublications.ie/library/GE-ENV-01107-01.pdf>





# Access to the REM



The screenshot shows the TII Web Application Portal. The header includes the TII logo and 'Transport Infrastructure Ireland' on the left, and navigation links for 'HOME', 'SYSTEMS', and 'ACCOUNT' on the right. A 'SYSTEMS' dropdown menu is open, listing various tools and systems. The 'Road Emissions Model' option is highlighted with a red box. Below the menu, there is a large heading 'TII Web Application Portal' and a sub-heading 'Use of this site is for authorised persons only and requires registration'. A small text block below that states: 'Authorised users can access the relevant systems by clicking on the Systems drop-down menu above. If you have been invited to register click the Register menu option and complete the registration process.'

1. Request Approval by emailing [climatetools@tii.ie](mailto:climatetools@tii.ie)
2. Provide information on use case / project, region where REM will be accessed from and email addresses of users
3. Access provided by TII IT Support to the REM via the TII Web Apps Portal at <https://web.tii.ie/>

# REM Interface

**TIIV AECOM**

Introduction

**Input Parameters**

Outputs

Downloads

Guides and Templates

Outputs

Quick User Guide

Run

## Inputs Home

### Standard Input Options

These are the basic parameters required to run the model.

**Enter Project Name**

e.g 'Road Project 1'

**Select Emission Year**

2018

**Select Fleet Mix**

Default

**Select Pollutants**

NOx PM10 CO2

**Navigate to Traffic Data Input file**

Browse... 2030 VDM Reference Scenario\_inputs.csv

Upload complete

Clear Traffic File Preview Traffic File

Include catalyst fails

### Advanced Input Options

Advanced model parameters can be configured in the collapsible boxes below.

**Fleet Database Selection**

Select fleet database to use in calculations. More information on these fleet databases are provided in the user guide.

**Select Fleet Database**

Business as Usual

Intermediate Case

Climate Action Plan

**Origin Data Selection**

Include the origin data in run

View Origin Data

**Euro Class Selection**

**Receptor File Input**

**Bus Flow Input**

# Advanced Features

## Origin data selection

The user can incorporate origin data to adjust the fleet profile within counties based on a predefined origin breakdown. This is based on the origin data in the TII National Transport Model (NTpM).

## Euro Class Selection

By changing Euro Class the user can adjust and exclude specific Euro classes for tests such as Clean Air Zones.

## Bus Flows and Fleet

The ability to add bus fleet is also an advanced option

### Euro Class Selection

The input boxes below can be used to select euro classes to remove from the fleet for the calculation. More information on these options are provided in the user guide. Note that this is optional, leaving the inputs blank will include all euro classes in the calculation.

**Select LDV Petrol Euro Classes to Remove**

**Select LDV Diesel Euro Classes to Remove**

**Select HDV Euro Classes to Remove**

### Bus Flow Input

Input bus traffic input file and euro splits data to include pollutant concentrations from buses within the calculation. Note that this is optional, the bus traffic input file can be downloaded from the downloads menu.

Include bus emissions in run

**Navigate to bus traffic input file**

No file selected

Euro Category	NO <sub>x</sub> Fraction	PM <sub>10</sub> / CO <sub>2</sub> Fraction
Pre-Euro	0	0
Euro I	0	0
Euro II	0	0
Euro III	0	0
Euro IV	0	0
Euro V EGR	0	0
Euro V SCR	0	0

# Outputs – Emissions impacts of projects

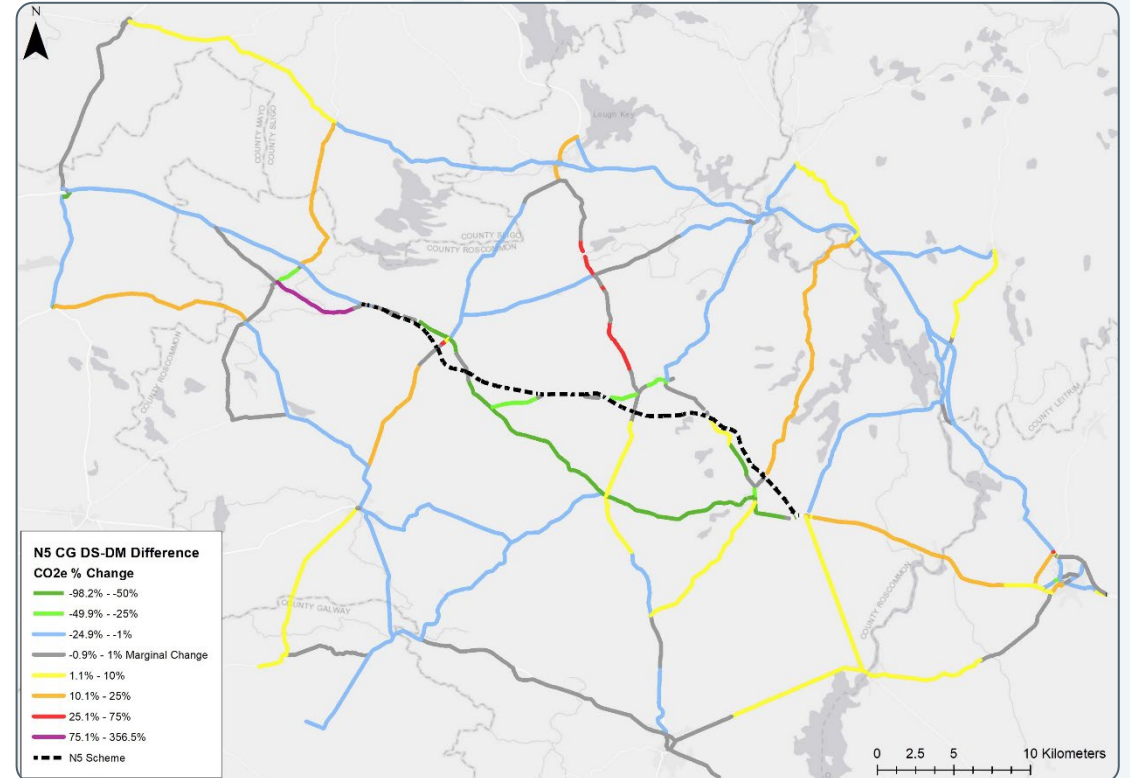
## Tabular summaries

	Total NOx (kg/yr)	Total PM10 (kg/yr)	Total PM2.5 (kg/yr)	Total CO2 (tonnes/yr)	Total CH4 (kg/yr)	Total N2O (kg/yr)	Total CO2e (tonnes/yr)
<b>Business as Usual Scenario</b>	73219	-3064	-1551	217	331	-51	210
	0.29%	-0.26%	-0.23%	0.00%	0.26%	-0.02%	0.00%
<b>Intermeditate Case Scenario</b>	70076	-2987	-1473	2597	251	-18	2599
	0.31%	-0.26%	-0.22%	0.04%	0.17%	-0.01%	0.04%
<b>Climate Action Plan Scenario</b>	63495	-2888	-1374	7011	113	22	7022
	0.33%	-0.25%	-0.21%	0.12%	0.07%	0.01%	0.12%

	Total NOx (kg/yr)	Total PM10 (kg/yr)	Total PM2.5 (kg/yr)	Total CO2 (tonnes/yr)	Total CH4 (kg/yr)	Total N2O (kg/yr)	Total CO2e (tonnes/yr)
<b>Business as Usual Scenario - Comments</b>	0.29% <b>increase</b> in Nox.....	0.26% <b>reduction</b> in PM10.....	0.23% <b>reduction</b> in PM2.5.....	Negliblege change in CO2.....	0.26% <b>increase</b> in CH4.....	Negliblege change in NO2.....	Negliblege change in CO2e.....
<b>Intermeditate Case Scenario - Comments</b>	0.31% <b>increase</b> in Nox.....	0.26% <b>reduction</b> in PM10.....	0.22% <b>reduction</b> in PM2.5.....	Negliblege change in CO2.....	0.17% <b>increase</b> in CH4.....	Negliblege change in NO2.....	Negliblege change in CO2e.....
<b>Climate Action Plan Scenario - Comments</b>	0.33% <b>increase</b> in Nox.....	0.25% <b>reduction</b> in PM10.....	0.21% <b>reduction</b> in PM2.5.....	0.12% <b>increase</b> in CO2.....	0.07% <b>increase</b> in CH4.....	Negliblege change in NO2.....	0.12% <b>increase</b> in CO2e.....

## Spatial outputs



# Outputs – Analysis of Irish Fleet Emissions

Vehicle Type	5 kph	10 kph	20 kph	30 kph	40 kph	50 kph	60 kph	70 kph	80 kph	90 kph	100 kph	110 kph	120 kph
Small Petrol Car	511.04	286.67	177.47	144.22	130.43	124.77	123.48	124.95	128.37	133.29	139.44	146.65	154.81
Medium Petrol Car	605.56	350.67	221.74	178.55	157.81	146.84	141.43	139.76	140.94	144.46	150.01	157.42	166.54
Large Petrol Car	894.73	516.51	323.71	257.89	225.35	207.38	197.71	193.67	193.93	197.74	204.65	214.38	226.75
Small Diesel Car	358.71	221.95	145.09	113.97	96.14	85.08	78.65	75.90	76.38	79.83	86.09	95.07	106.69
Medium Diesel Car	383.36	246.60	169.74	138.63	120.79	109.74	103.30	100.56	101.04	104.48	110.74	119.72	131.35
Large Diesel Car	432.55	295.78	218.92	187.81	169.98	158.92	152.49	149.74	150.22	153.67	159.93	168.90	180.53
Small Hybrid Car	331.37	187.90	116.97	94.54	84.71	80.27	115.76	116.62	119.62	124.33	130.49	137.96	146.62
Medium Hybrid Car	387.92	226.95	144.70	116.57	102.75	95.26	134.21	132.38	133.46	136.97	142.63	150.26	159.74
Large Hybrid Car	558.62	326.90	208.01	166.89	146.31	134.80	188.77	184.92	185.21	188.97	195.78	205.41	217.67
Small PHEV Car	147.68	80.37	47.61	37.63	33.49	31.80	103.74	105.21	108.63	113.55	119.71	126.92	135.08
Medium PHEV Car	174.49	98.02	59.34	46.39	40.16	36.87	116.55	114.88	116.06	119.58	125.13	132.54	141.66
Large PHEV Car	258.81	145.35	87.51	67.76	58.00	52.61	164.73	160.70	160.95	164.76	171.67	181.41	193.77
LGV	792.02	430.67	252.96	198.14	175.64	167.47	168.02	174.85	187.43	205.77	230.39	261.98	301.67
Small HGV	647.98	541.93	406.96	343.16	314.09	304.21	306.04	317.28	339.38	376.26	-	-	-
Medium HGV	1141.64	925.07	672.22	546.14	479.16	446.98	436.04	439.76	458.47	500.17	-	-	-
Large HGV	2524.17	1892.73	1454.43	1223.04	1039.15	917.27	863.43	862.71	887.91	912.95	-	-	-

# Electric vehicles and emissions

ESTIMATED RANGE  
**349 km**



ë-C4 ELECTRIC

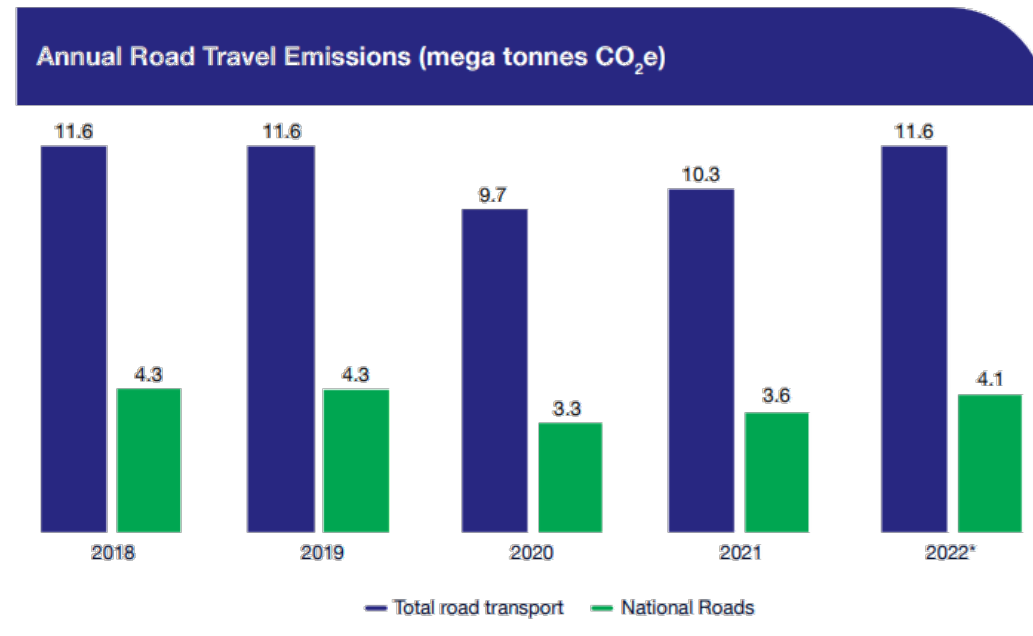
Speed (km/h)	30	40	50	60	70	80	90	100	110	120	130
Range (km)	347	354	350	338	330	302	268	241	216	193	172
Battery capacity (kWh)	50	50	50	50	50	50	50	50	50	50	50
Energy (kWh/km)	0.14	0.14	0.14	0.15	0.15	0.17	0.19	0.21	0.23	0.26	0.29
CO <sub>2</sub> per kWh (g/kWh)	348	348	348	348	348	348	348	348	348	348	348
CO <sub>2</sub> per km (g/km)	50	49	50	51	53	58	65	72	81	90	101

<https://www.citroen.ie/electric-for-all/optimize-your-range.html>

<https://www.seai.ie/data-and-insights/seai-statistics/conversion-factors>).

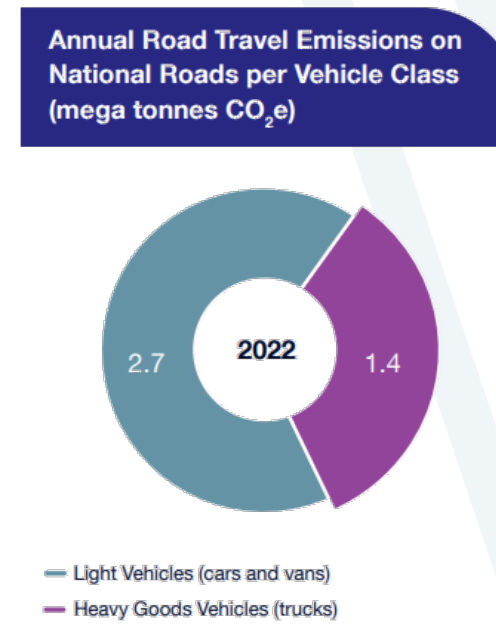
# Outputs – Wider GHG emissions estimates

## A1: Vehicle Emissions on the National Roads Network



Travel on National Roads contributed an average of **35%** of total road transport emissions in 2018-2022.

Sources: 1. EPA, 2022 (estimate of total transport emissions in 2018 was 12.2 mega tonnes, road travel emissions made up 11.6 mega tonnes of this; \*2022 Total road transport emissions is EPA projection and not inventory as per previous years)  
2. TII National Transport Model (NTpM), TII Road Emissions Model (REM), CSO and UCC (2021) Irish Car Stock Model v2.1.



Heavy Goods Vehicles (HGVs) contributed **34%** of National Roads emissions in 2022.

# Upcoming enhancements to the REM

## Monetisation Module

Integration of the REM with PAG Cost-Benefit Analysis requirements on projects. Replacement of high-level monetisation of GHG emissions in TUBA

## Batch Running of Scenarios

New functionality to allow a batch of multiple scenarios to be run at once e.g. multiple future projections, Do-Minimum / Do-Something networks etc.

## Fleet Scenarios

Working towards a set of common fleet scenarios with DoT, NTA and other agencies.

The screenshot displays the 'Monetisation Module' interface. It includes a sidebar with navigation options like 'Introduction', 'Input Parameters', 'Emissions Input', 'Monetisation Input', 'Downloads', and 'Quick User Guide'. The main content area is titled 'Inputs Home' and 'Monetisation Module'. It features 'Basic Input Options' for selecting pollutants (NOx, PM2.5, CO2e) and PM2.5 damage cost options (Rural, City, Metropole). Below this is an 'Emissions Inputs' table with columns for Scenario, Year, DS CO2e (t), DM CO2e (t), ΔCO2e (t), DS NOx (t), DM NOx (t), ΔNOx (t), DS PM2.5 (t), DM PM2.5 (t), and ΔPM2.5 (t). The 'Cost Benefit Analysis Summary' section includes a 'Generate Cost-benefit Analysis Summary' button and two tables: '30-year Timeframe Change' and '60-year Timeframe Change', both showing Year, Change in Emissions (tonnes), % Change, and Monetary Change (€). The '30-year Timeframe Change' table shows: CO2e (+46,500, +7.7, -€2,027,265), NOx (+740, +18.9, -€2,013,113), and PM2.5 (+46, +8.6, -€326,664). The '60-year Timeframe Change' table shows: CO2e (+76,500, +6.2, -€2,993,956), NOx (+890, +13.2, -€2,117,078), and PM2.5 (+76, +7.3, -€386,854). There are also 'Advanced Input Options' for using custom damage costs and a 'Tabulated Outputs' section with a 'Generate Detailed Monetisation Calculations' button.

Scenario	Year	DS CO <sub>2</sub> e (t)	DM CO <sub>2</sub> e (t)	ΔCO <sub>2</sub> e (t)	DS NO <sub>x</sub> (t)	DM NO <sub>x</sub> (t)	ΔNO <sub>x</sub> (t)	DS PM <sub>2.5</sub> (t)	DM PM <sub>2.5</sub> (t)	ΔPM <sub>2.5</sub> (t)
Opening Year	2020	20,000.00	18,000.00	2,000.00	200.00	150.00	50.00	20.00	18.00	2.00
Design Year	2035	21,000.00	19,500.00	1,500.00	150.00	130.00	20.00	19.00	17.50	1.50
Horizon Year	2050	22,000.00	21,000.00	1,000.00	100.00	95.00	5.00	18.00	17.00	1.00

30-year Timeframe Change				60-year Timeframe Change			
Year	Change in Emissions (tonnes)	% Change	Monetary Change (€)	Year	Change in Emissions (tonnes)	% Change	Monetary Change (€)
CO <sub>2</sub> e	+46,500	+7.7	-€2,027,265	CO <sub>2</sub> e	+76,500	+6.2	-€2,993,956
NO <sub>x</sub>	+740	+18.9	-€2,013,113	NO <sub>x</sub>	+890	+13.2	-€2,117,078
PM <sub>2.5</sub>	+46	+8.6	-€326,664	PM <sub>2.5</sub>	+76	+7.3	-€386,854





Bonneagar Iompair Éireann  
Transport Infrastructure Ireland



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