Climate Change Advisory Council Secretariat

CB WG Meeting 5

27th July 2023

Agenda

Time	Agenda Item
13:30	1. Opening of Meeting
13:35	2. Focused discussion on Methane
14:40	3. Ethics of Methane Emissions and Climate Change
15:15	4. Scoping of Modelling Work
16:00	5. Carbon Budgets Work Plan
16:25	6. Next Steps and Agenda for next meeting
16:30	7. AOB
16:30	Meeting Close

1. Opening of Meeting

Action Number	Date Raised	Description	Owner	Due	Status
3	20/04/23	Expand discussion of macroeconomic inputs/ drivers	CCAC Secretariat and relevant CB WG Members	Q3 2023	Ongoing – Update to be provided at CB WG Meeting 4
5	20/04/23	Further develop the approach and preparation for topical discussions	CCAC Secretariat	Q3 2023	Ongoing – Secretariat to provide an update on the approach and preparation for upcoming topical discussions at each meeting.

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2. Scoping of Modelling Work

Scoping the potential for additional modelling and testing of results by;

1. **FERs Ltd** modelling key parameters for Ireland's forestry matrix, and
2. **NTA Framework** – Regional Modelling System modelling key aspects of the transport sector.

    - Model Overview
    - Key questions to ask the model
    - Model Inputs (assumptions / variables / constraints)
    - Model Outputs
    - Sensitivities

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5. Carbon Budgets Work Plan: Topics for Meetings

CB WG Meeting No.	Proposed Date and Time	Topic(s) for Consideration
1	Thursday 9th March 2023 10:00 – 13:00	Carbon Budgets Methodology
2	Thursday 20th April 2023 13:30 – 16:30	Carbon Budgets Methodology / Scoping of modelling work
3	Wednesday 31st May 2023 10:30 – 13:30	Vision for 2050 and Beyond/ Scoping of modelling work/
4	Thursday 29th June 2023 13:30 – 16:30	Climate Justice and 'Paris Test'/ Scoping of modelling work/ Macroeconomic Impacts of carbon budgets/
5	Thursday 27th July 2023 13:30 – 16:30	Focused discussion on methane/ Scoping of modelling work/
6	Friday 8th September 2023 13:30 – 16:30	Populations Projections/ Socioeconomic considerations
CB WG Workshop 1	Wednesday 13th September 2023 13:30 – 16:30	Input model parameters for 2030 starting points, scenario development and assumptions
7	Thursday 19th October 2023 13:30 – 16:30	Landuse Review (TBC)/ Biodiversity Considerations/ 2024 Projections Process (EPA, SEAI & ESRI)
8	Thursday 23rd November 2023 10:30 – 13:30	Role of Negative Emissions/ International approaches to carbon budgets
9	Friday 15th December 2023 13:30 – 16:30	*COP28 – Global Stocktake (TBC)/* *ESAB 2040 Target (TBC)*

5. Carbon Budgets Work Plan: Meeting No. 6: 8th Sept. 13:30 – 16:30

1. Socioeconomic Considerations (NESC)

- Overview of the NESC report on exploring a Just Transition on Agriculture and Land use

➢ *Discussion of the Act requirement to take account of "a just transition to a climate neutral economy which endeavours, in so far as is practicable, to maximise employment opportunities, and support persons and communities that may be negatively affected by the transition" and approach for the second programme*

2. Populations Projections

- CSO (Cathal Doherty) to present on their population projections process
- ESRI (Adele Bergin) to present on their plans for the next round of modelling feeding into the National Planning Framework Review
- DHLGH (Alma Walsh and Colin Fulcher) to present on the National Planning Framework Review

5. Carbon Budgets Work Plan: Workshop 13th September 13:30 – 16:30

Proposed Agenda

1. **Building Blocks for scenarios for CB3 and CB4**
   - 2030 starting points: staying within carbon budget 1 and 2, underperformance (EPA WAM), overperformance (sensitivity)
   - Targets for 2050: based on an emissions trajectory consistent with specific temperature outcomes and based on an emissions trajectory towards net zero greenhouse gas emissions in 2050
   - Considering the ESAB recommendation for an EU 2040 climate target
2. **Scenario development for 2nd Carbon Budget Programme**
   - Shared understandings to inform scenario development by Teagasc (FAPRI), NUIG (GOBLIN), UCC (TIM) and SEAI (NEMF)
   - Discussion of potential for integration and discrepancies
   - Anticipated outcomes
3. **Competing Land Use Requirements**
   - Land use and model representations of biodiversity constraints
   - Afforestation, Biomethane, Nitrogen demand (water quality/air quality)
4. **Timeline for Modelling/ Analysis Iteration 1**

Objective: Develop a shared understanding of model inputs and expected outputs

Post Workshop

- Secretariat to prepare an outcome report for CCAC meeting on 28th Sept.
- Modelling/Analysis Iteration 1 Commences following CB WG meeting No. 7 19th Oct.

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6. AOB

AOB?

Irish Carbon Budgets: Methane

Kian Mintz-Woo

University College Cork (Ireland) / International Institute for Applied Systems Analysis (Austria)

July 27, 2023

PREFACE

- Philosophers tell us that we need to be wary of arguments that advance our own interests in uncertain contexts, since the dearth of theory might lead us towards "moral corruption" (Gardiner, 2010, 10.1093/oso/9780195399622.003.0012)
- Carbon budgets depend on "irreducibly normative" assumptions (Dooley et al., 2021, 10.1038/s41558-021-01015-8; Schulen et al., 2023, 10.1002/wcc.847)
- Permissions to emit are not themselves morally important—they only allow us to access morally important things (capabilities/welfare)

OUTLINE

1. The stock/flow accounting problem
2. Three responses
3. Conclusion and further resources

THE PROBLEM

- Carbon dioxide (CO_2) is a stock pollutant: warming potential is (basically) insensitive to the timing of emissions, just to the entire long-lived stock of carbon (physical accident)
- Methane (CH_4) is a flow pollutant: warming potential is highly sensitive to the timing of emissions, since it decays more rapidly
- The Stock/Flow Accounting Problem is: how or should CO_2 and CH_4 be compared?
- Context: In most countries, less material than in Ireland
- Despite the fact that this is not discussed in the philosophical literature, we can tackle it in the same argument-/justification-based way

FIRST: ALLOW SUBSTITUTION USING GWP-100

- Standard accounting practices allow for comparison with CO_2 using GWP-100 (i.e. global warming potential over a hundred year period)
  - Pro: This is standard practice, both across the IPCC and across most peer countries (e.g. EU countries, stocktaking comparisons)
  - Pro: Very straightforward, both for modelling (e.g. 2030 and 2050 targets) and for various stakeholders (e.g. public or decision-makers)
  - Con: Highly sensitive to the period (100 years is an arbitrary temporal timeline and much greater with smaller timelines)
  - Con: Subject to some conversion factor updates

SECOND: ALLOW SUBSTITUTION USING GWP*

- Newer research, especially from Myles Allen, allows for comparison with CO_2 using GWP* (i.e. global warming potential given constant emission flows)
  - Pro: This more accurately connects CH_4 with actual warming effects (e.g. avoids long-term warming associated with increasing stocks while reducing flows)
  - Pro: [EPA] Can be implemented with the CCAC Paris Test (as has been shown by Paul Price and others)
  - Con: Very complex to explain to a variety of stakeholders (sectoral, public, decision-makers); highly unintuitive
  - Con: Could grandfather in previous high methane flows; potentially unfair

THIRD: SPLIT-GAS ACCOUNTING

- Some countries have separate budgets (and/or targets) for CO_2 and CO_4 (e.g. New Zealand)
  - Pro: This avoids having to determine conversion factors—reduces types of value judgement
  - Pro: Very straightforward to explain to stakeholders (easier to avoid double-(ac)counting tricks)
  - Con: Requires a parallel debate to CO_2—doubles the existing types of value judgment
  - Con: [EPA] Given that our brief is to give a carbon budget (one?) to CCAC, this would require (at least two) budgets and then potentially combining them

TAKEAWAYS

- My personal view is that split-gas accounting is more justifiable, since it reduces the type of value judgments
- One focal point is PA reductions in CH_4 (on an EPC basis). Note that this is still very conservative, in the sense that it effectively grandfathers Ireland's historically high CH_4 emissions

A Couple Resources

1. For discussions about philosophical equity principles (or burden-sharing principles): Polluter Pays, Beneficiary Pays, Ability to Pay, Polluter Pays, Then Receives, see my attached (Mintz-Woo, 2023);
2. For details on philosophical approaches to population ethics, cf. Cafaro (2012, doi:10.1002/wcc.153; 2022; doi:10.1002/wcc.748) [All citations are hyperlinks]

Methane policy targets

Joe Wheatley

“The [Long Term] Strategy is consistent with achieving net zero emissions for long-lived greenhouse gases (CO2 and N2O) and a significant reduction in methane emissions by 2050, thus establishing a climate neutral economy.“-DECC 2023

CBWG 27 July 2023

Advantages of Simple Climate Models

- Central tool for IPCC global policy analysis since TAR (2001, MAGICC)
- Rich information compared to metrics
- Simple, fast, intuitive
- Calibrated to latest ESM outputs CMIP6
- National-level contributions to climate change
- Uncertainty analysis
- Multi-model approach

MAGICC, FaIR, Hector, Oscar,..

Climate Targets

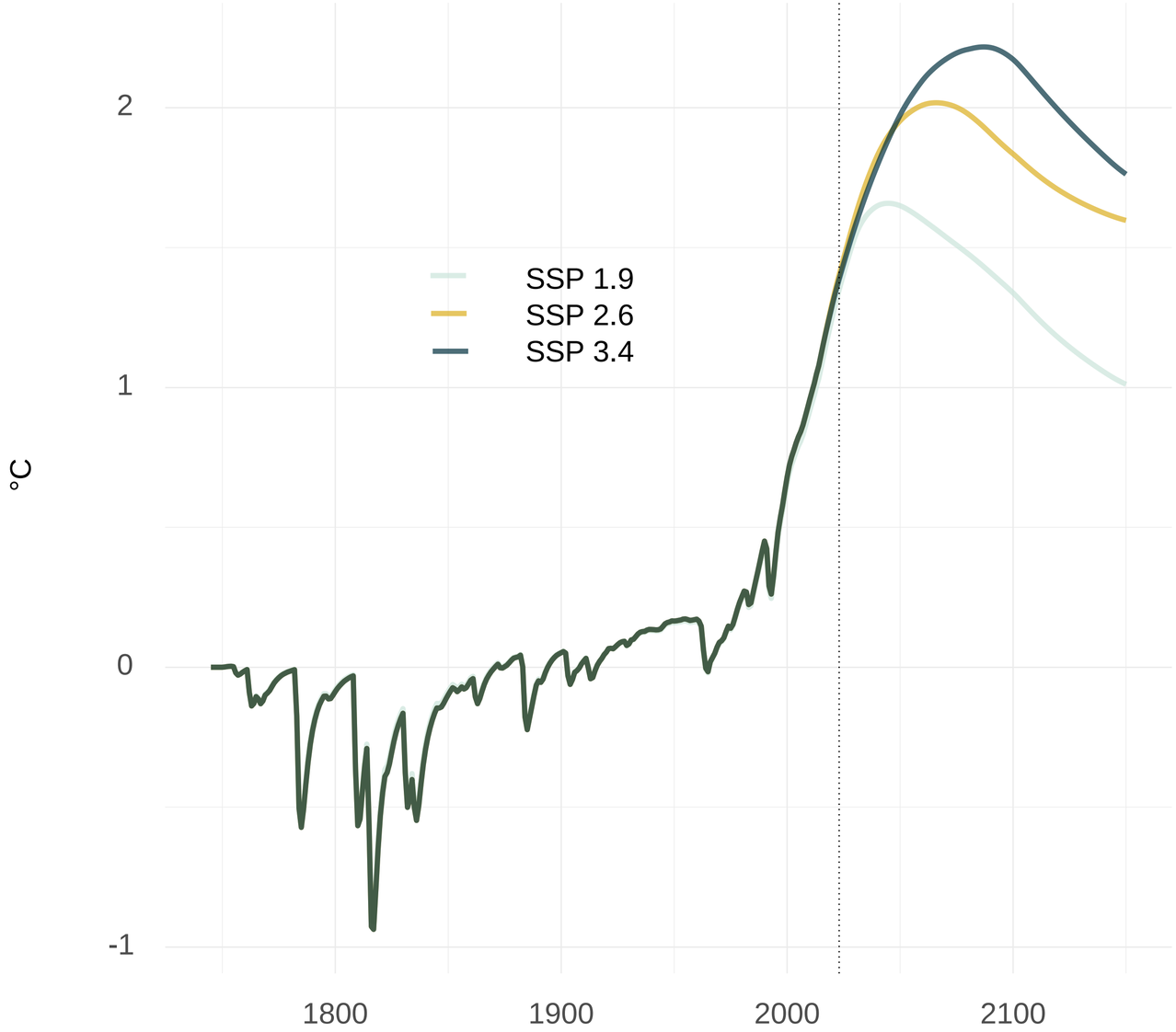
Alternative frameworks

- Temperature
- Carbon Neutrality
- Net Zero
- Temperature Neutrality
- Climate Neutrality

Climate Targets

Alternative frameworks

- **Temperature e.g. Paris Article 2.1(a)**
- Carbon Neutrality
- Net Zero
- Temperature Neutrality
- Climate Neutrality

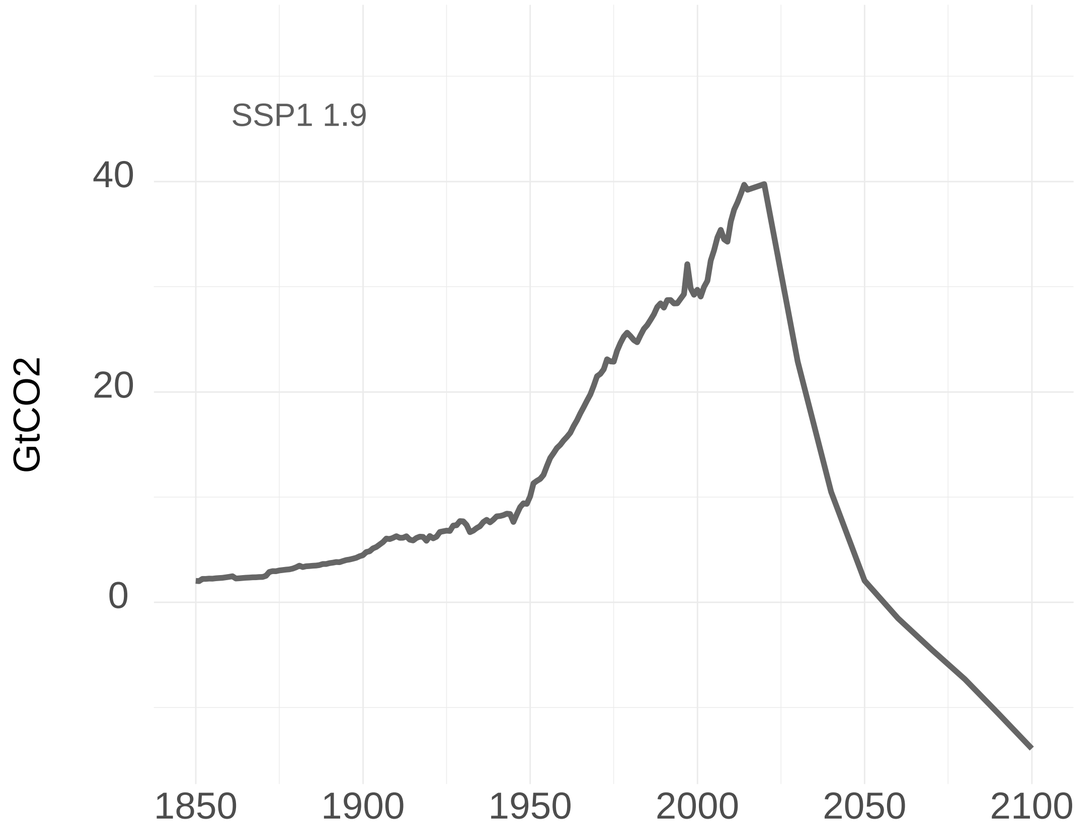


Hectorv3.1

Climate Targets

Alternative frameworks

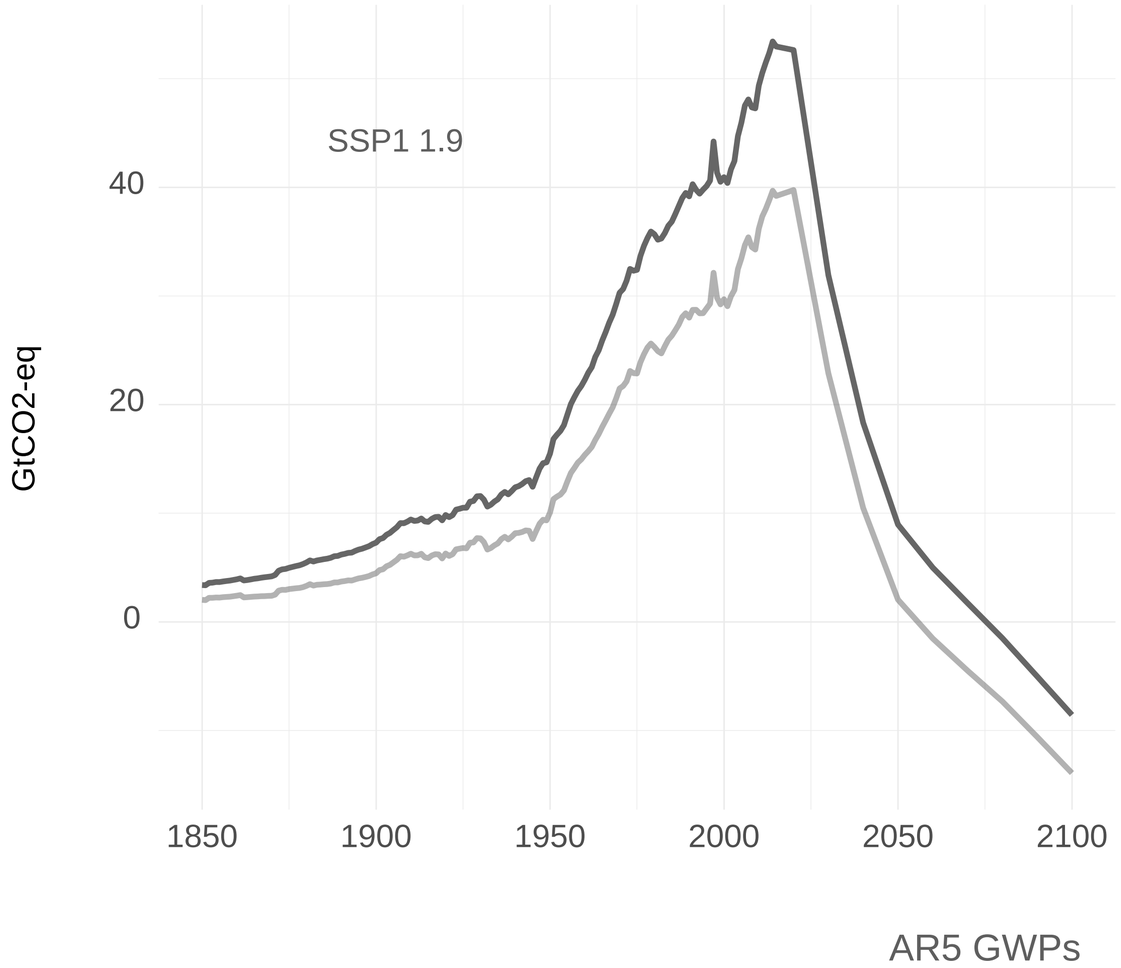
- Temperature
- **Carbon Neutrality e.g. 2056 in SSP1.9**
- Net Zero
- Temperature Neutrality
- Climate Neutrality



Climate Targets

Alternative frameworks

- Temperature
- Carbon Neutrality
- **GWP100 Net Zero e.g. 2075 in SSP1.9**
- Temperature Neutrality
- Climate Neutrality



"*achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century*"- Paris Article 4.1

Climate Targets

Alternative frameworks

- Temperature
- Carbon Neutrality
- Net Zero
- **Temperature Neutrality**
- Climate Neutrality

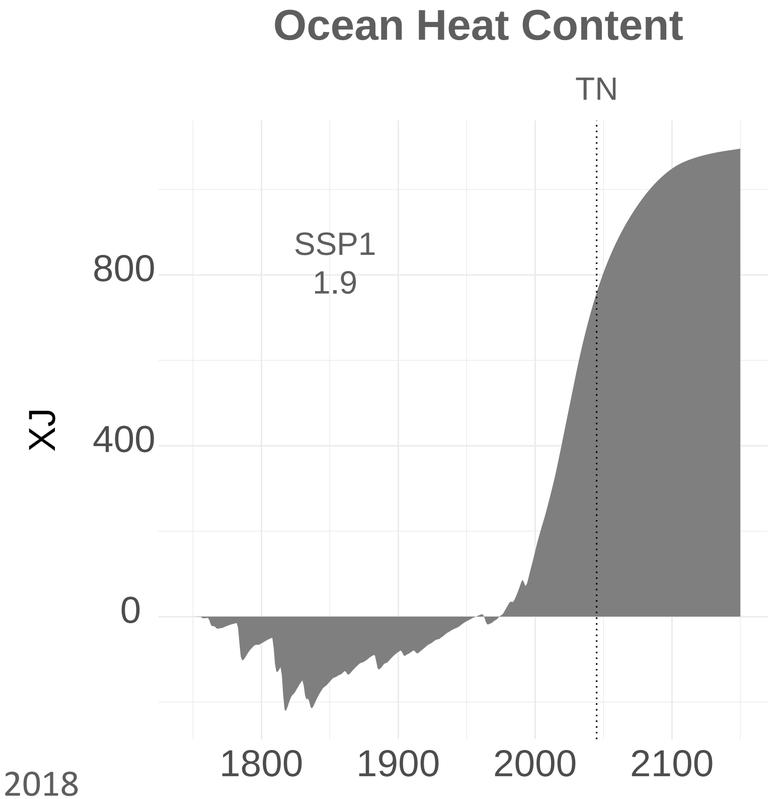
scenario	TN year	°C
SSP 1.9	2045	1.66
SSP 2.6	2066	2.02
SSP 3.4	2087	2.22

Hectorv3.1

Climate Targets

Alternative frameworks

- Temperature
- Carbon Neutrality
- Net Zero
- Temperature Neutrality
- **Climate Neutrality (Climate Laws)**



"A state in which human activities result in no net effect on the climate system"- IPCC 2018

"Reaching climate neutrality will mean that Ireland will have no further negative impacts on the climate system by mid-century." Long Term Strategy 2023

"Climate neutrality is considered to mean a cessation of further warming of the Earth's climate system by atmospheric greenhouse gases."- Climate Neutrality Forum 2021

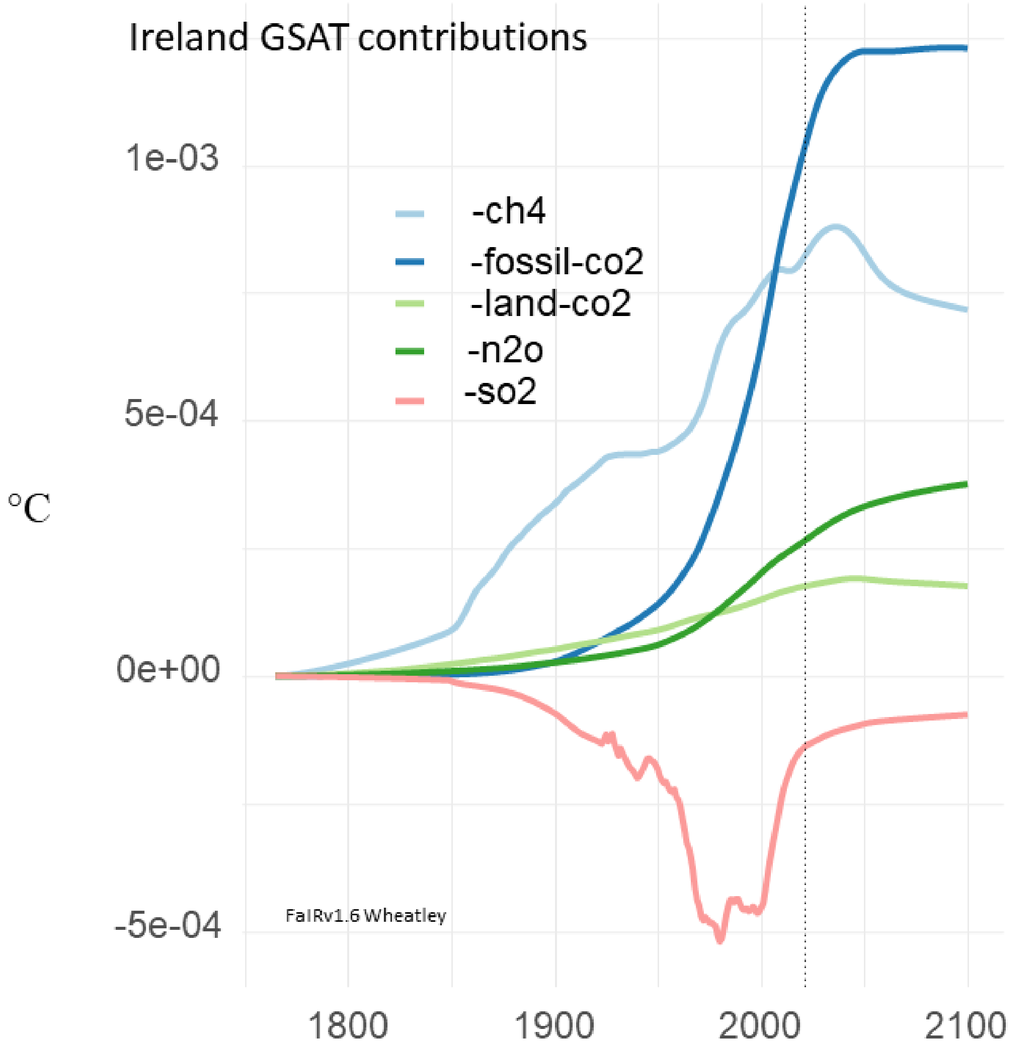
National contribution to warming in SCM

exclude Irish territorial emissions

- Historical climate forcers
  https://zenodo.org/record/7004406#.ZHR-2HbMK3A
- Future scenarios e.g.

IE-C					
2025	2030	2035	2050	2100	gas
85	49	35	0	-7	fossil-CO_2
95	90	85	60	50	CH_4
95	90	85	60	50	N_2O
95	85	80	-10	-20	land-CO_2
85	49	35	0	0	SO_2
60.1	44.3	37.4	13.6	8.0	$MtCO_2e$

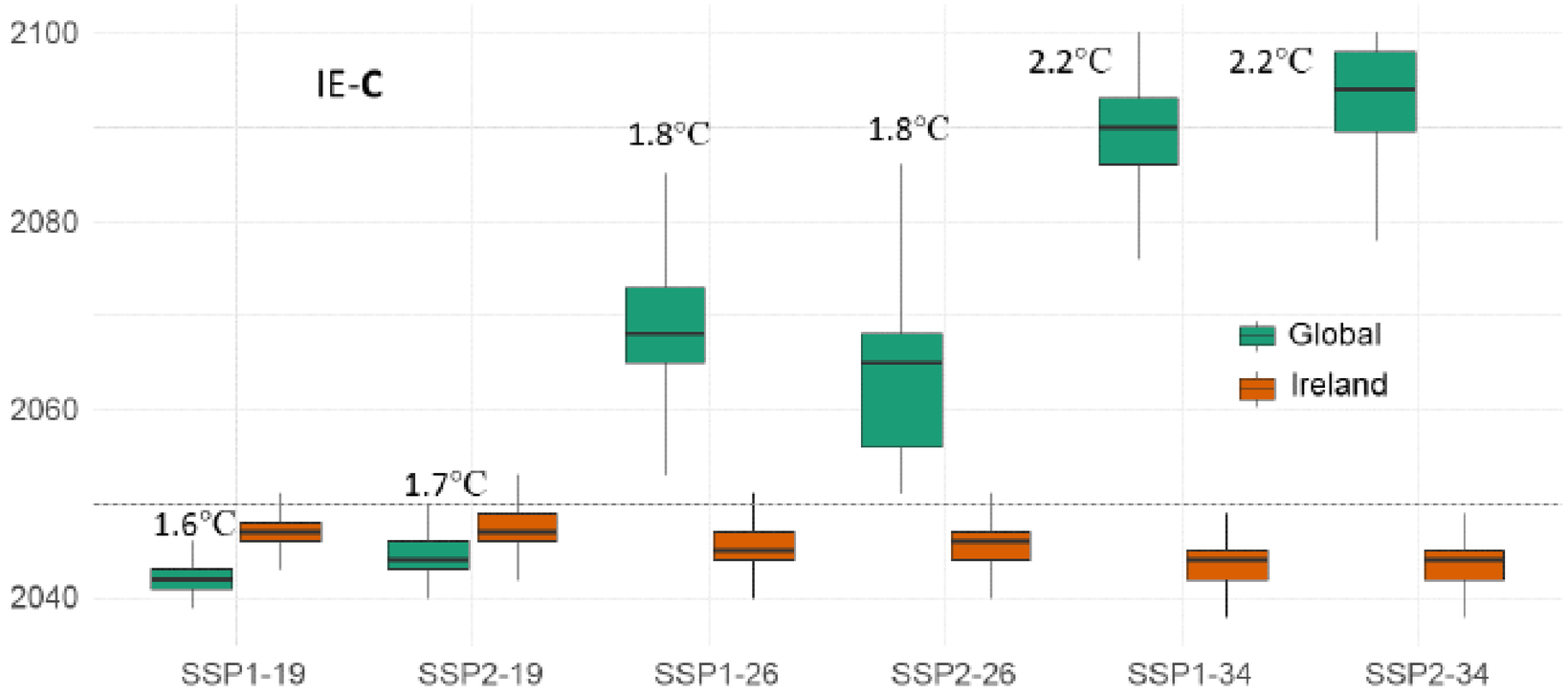
Emissions as % of 2018



Gutschow, J., Gunther, A., & Pfluger, M. (2021). The PRIMAP-HIST national historical emissions time series (1750-2019) v2. 3.1.

National vs Global Temperature Neutral Year

Ireland scenario: carbon neutral in 2050, methane -40%



J Wheatley, Climate Policy 2023

FaIRv1.6 1000-member ensemble

Methane impact depends on future atmosphere

Radiative forcing and lifetime

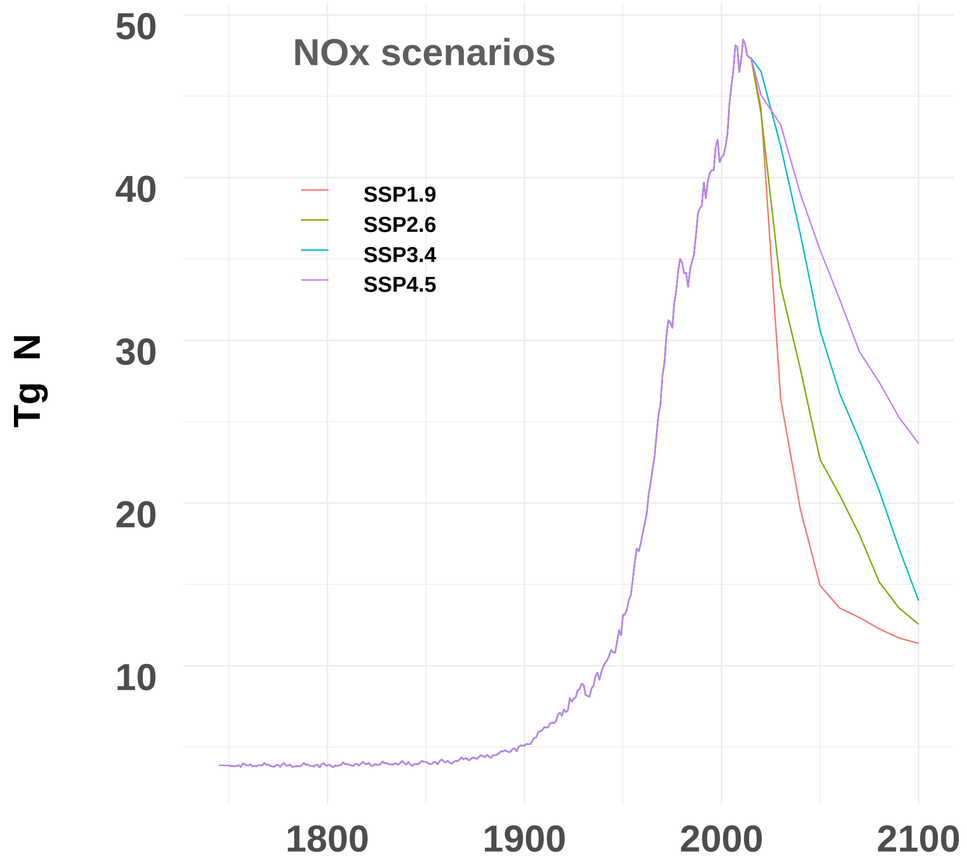
$$RF_{CH_4} \propto \sqrt{M} - \sqrt{M_0}$$

M methane concentration (~1900 ppb)

N_2O absorption band overlaps

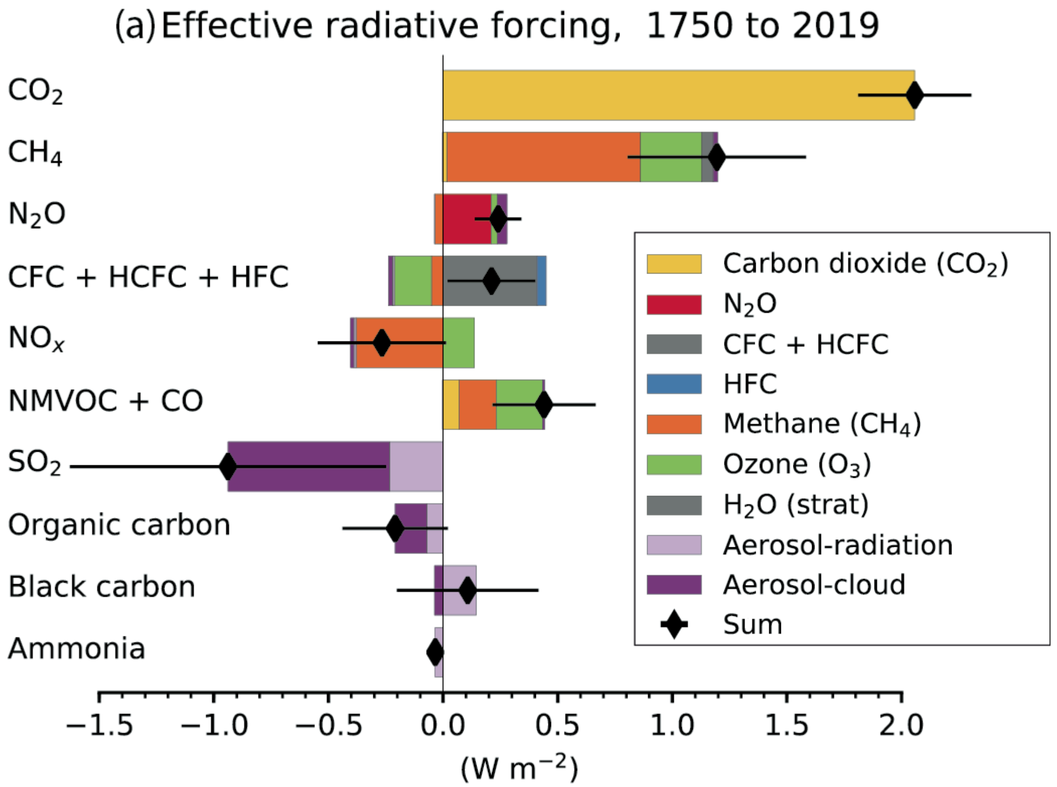
$$\tau_{CH_4}^{-1} \propto [OH]$$

NOx : $[OH] \uparrow$ NMVOC : $[OH] \downarrow$ CO : $[OH] \downarrow$



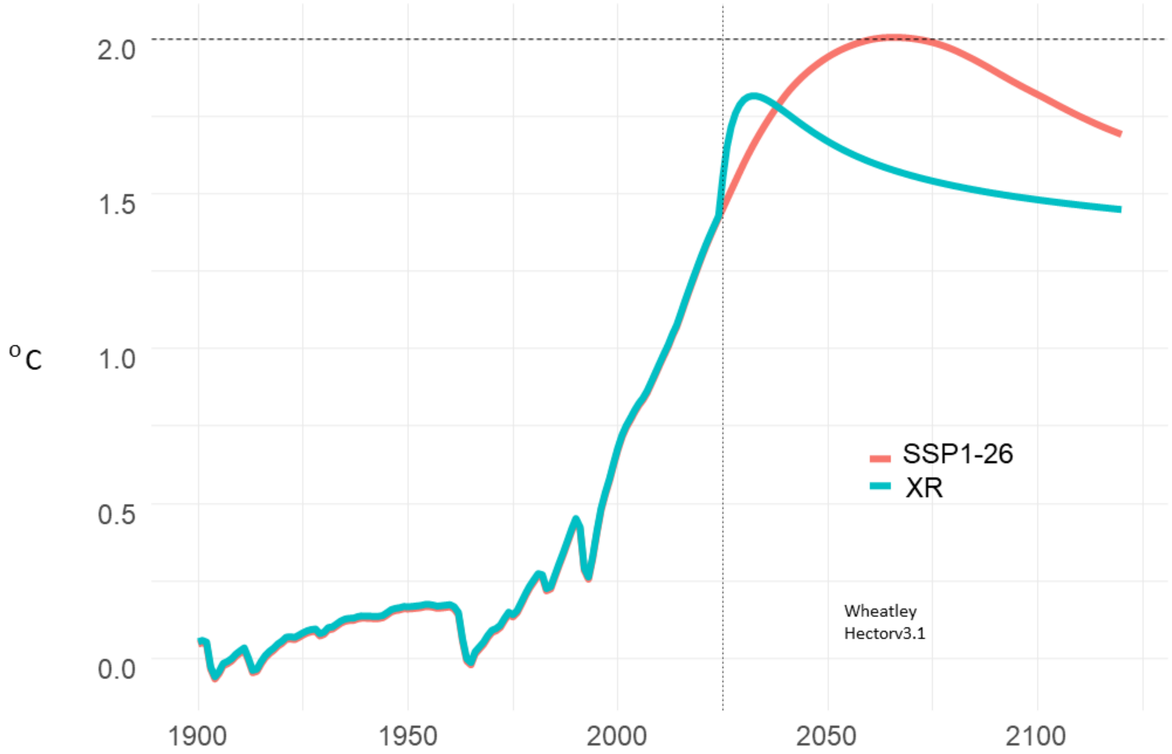
Short-lived air pollutants

Relevant for temperature neutrality



IPCC_AR6_WGI_Figure_6_12

2025 termination shock



Conclusions

- SCMs: useful tools for national policy analysis
- Split-gas approach needed to assess warming impacts
- Methane warming reflects future atmospheric CH_4 concentration, NOx ..
- Temperature neutrality in 2040s consistent with 1.5°C target

Allen, M. R., Peters, G. P., Shine, K. P., Azar, C., Balcombe, P., Boucher, O., . . . others (2022). Indicate separate contributions of long-lived and short-lived greenhouse gases in emission targets. npj Climate and Atmospheric Science, 5 (1), 1{4

Regional Modelling System (RMS)

CCAC Carbon Budgets Working Group

Peadar Ó Súilleabháin and Karen Whitaker on behalf of Barry Colleary

1. Model Overview
2. Key questions to ask the model
3. Model Inputs (assumptions/variables/constraints)
4. Model Outputs
5. Sensitivities

27th July 2023

NTA Transport Modelling Division

The Team

Barry Colleary
Head Of Transport Modelling

David Conlon
Senior Transport Modeller

Peadar Ó Súilleabháin, PhD
Senior Transport Modeller

William Brazil, PhD
Transport Modeller- Grade 2

Wen Zhang
Transport Modeller Grade 2

Warren Whitney, PhD
Transport Modeller- Grade 3

Karen Whitaker
Transport Modeller- Grade 2

Brendan Meskell
Transport Modeller- Grade 3

Niamh Kennedy
Environmental & Sustainability Manager

Experience and Expertise

- Estimating and Forecasting Transport Demand using forecasts from Planning (CSO)
- Multi-Modal Model Development
- Survey design & Statistical analysis
  - National Household Travel Surveys
- Data Collection, Analysis and GIS mapping
- Multi-Modal Scheme Appraisal (PAG Stages 1-4)
- Preparation of EIAs
- Assisting Preparation of Transport Assessments
- Economic Appraisal & Business Case Preparation
- Local Area Models + Micro-Simulation
- All details in between

Introduction

What is the Transport Modelling Suite?

Údarás Náisiúnta Iompair
National Transport Authority

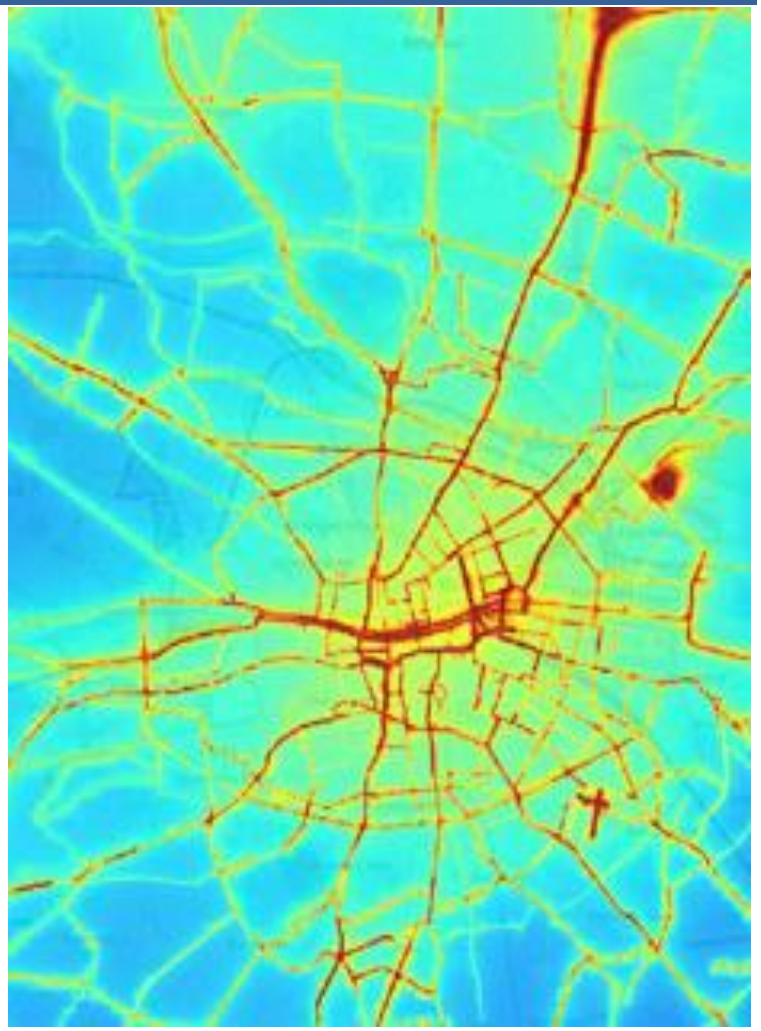
Overview

A suite of computer models to mimic our transport systems, networks and behaviours

Developed to support **strategic planning** and **project appraisal**

Includes the **RMS** and **stand-alone processing tools**

Used to **inform policy** and answer important **transport questions**

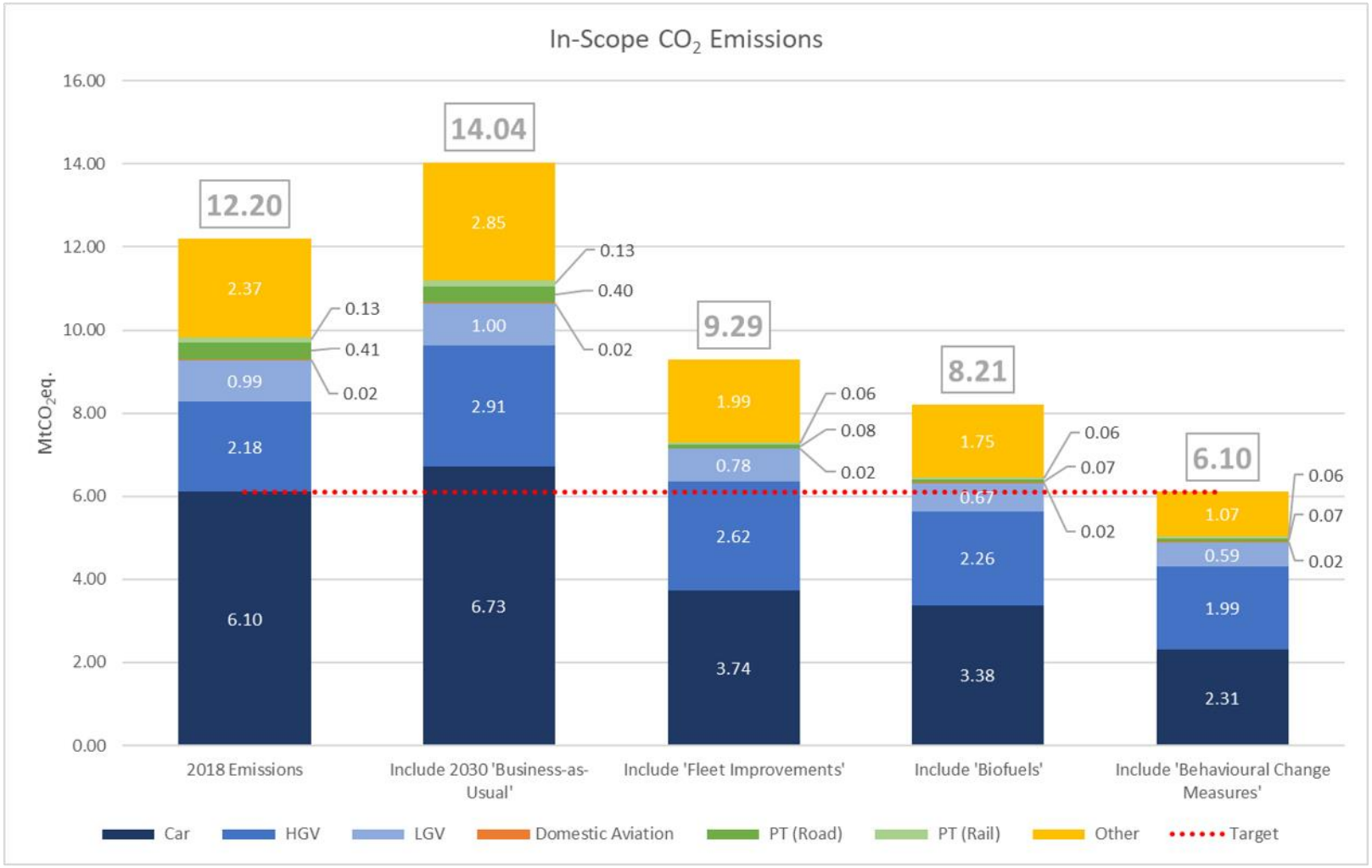


Introduction
RMS Application Examples

Introduction

Questions the RMS can help answer

What carbon emissions reductions can be achieved through transport measures?

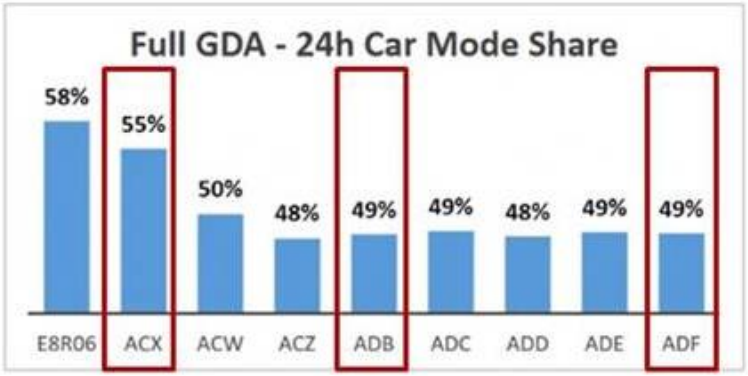


Introduction

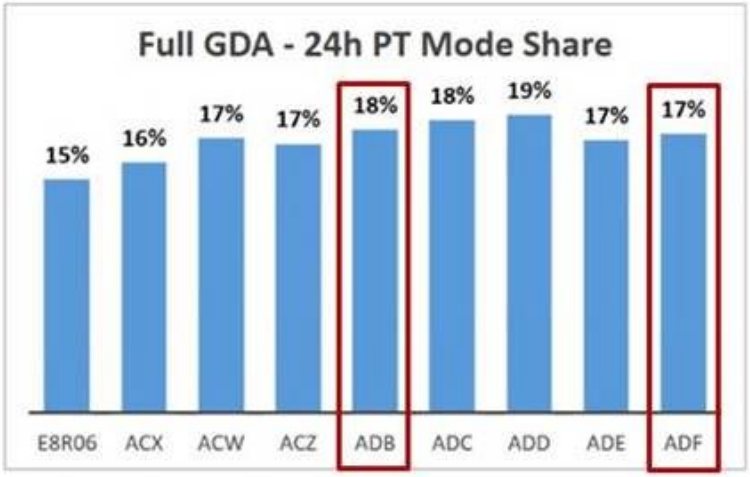
Questions the RMS can help answer

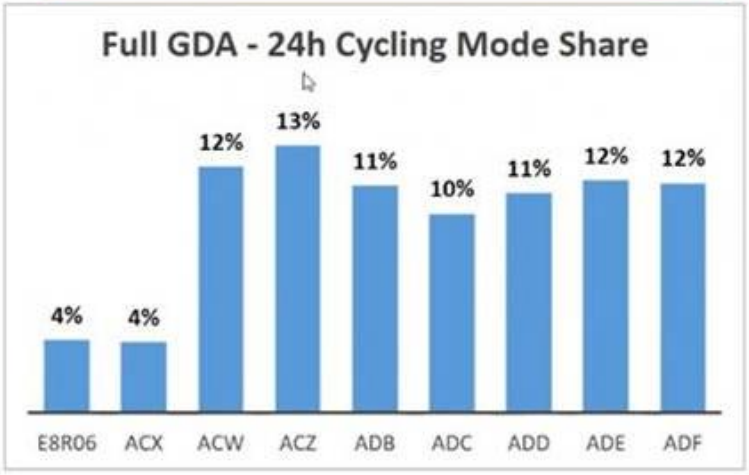
How will the implementation of a strategy influence travel behaviours?

GDA 24h Mode share



Run ID	Name
E8R06	2016 Base
ACX	DoMin D4
ACW	Cycle Prop + No Pking Mgmt + Tolls
ACZ	Strategy Hardcoded BusSpeed
ADB	Strategy
ADC	Strategy 60% Cyc. Prop.
ADD	Strategy + IVT reduction
ADE	Strategy Without Bus Speed hardcoded
ADF	Strategy Without DART UG



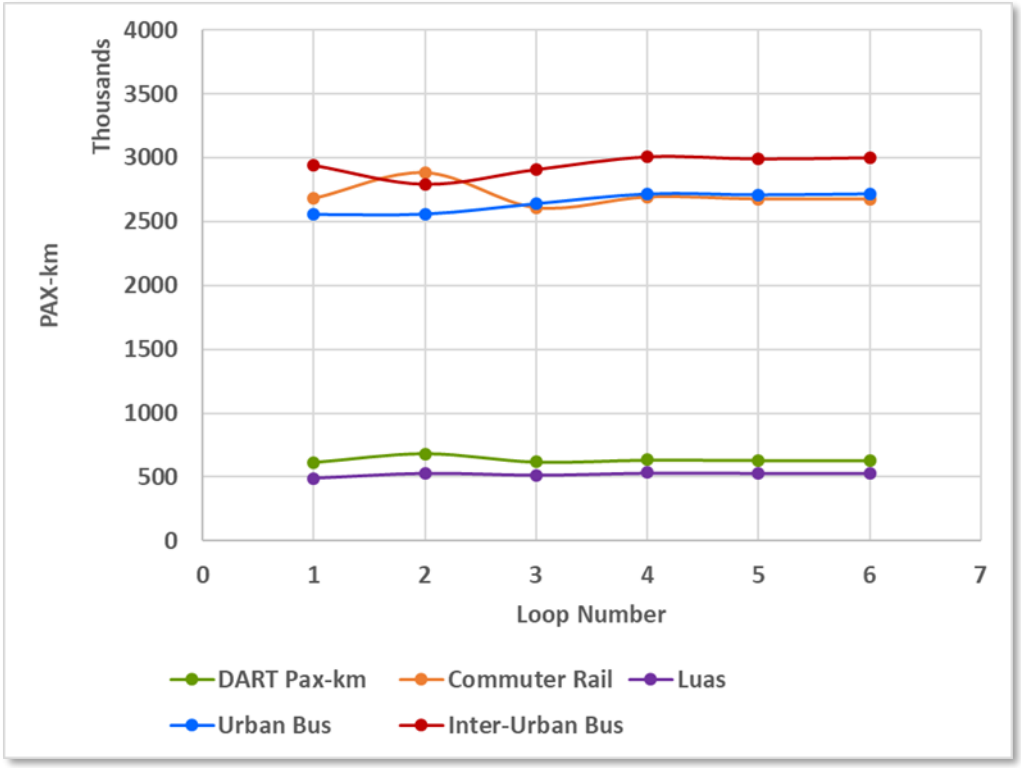


Introduction

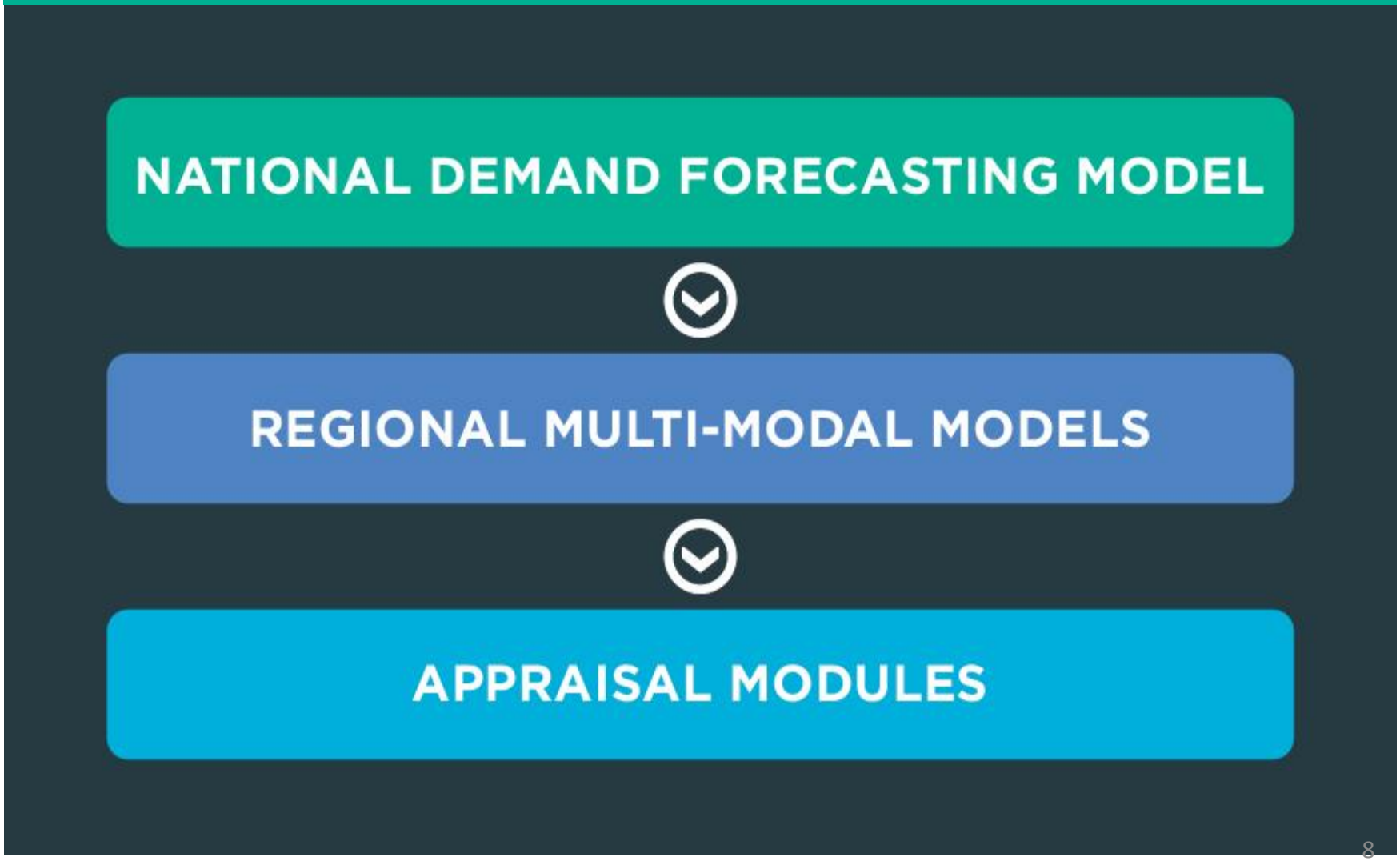
Questions the RMS can help answer

How will reducing public transport fares influence mode shares and distances travelled?

CHANGES	Fares Reduced by 100%	Fares Reduced by 50%
Passenger Distance (km)	24-Hour Sum	24-Hour Sum
PT MODES		
DART	129,000 (+22.7%)	48,800 (+8.6%)
Commuter Rail	**736,600** (+31.5%)	291,700 (+12.5%)
LUAS	120,600 (+26.9%)	62,800 (+14.0%)
Urban / Town Bus	289,300 (+12.0%)	288,100 (+11.9%)
Inter-Urban Bus	**420,500** (+16.4%)	**407,900** (+15.9%)
Grand Totals	1,696,000 (+20.3%)	1,099,200 (+13.2%)



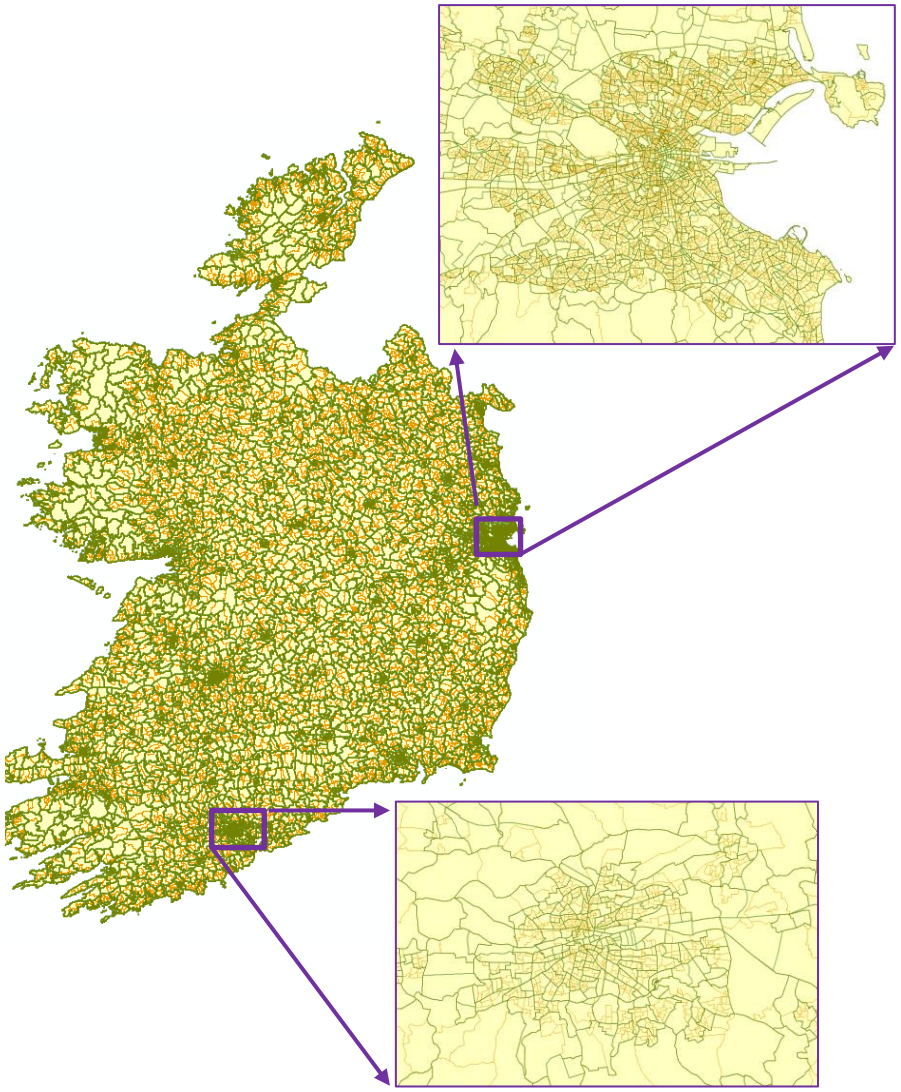
Model Overview
Regional Modelling System



Model Overview

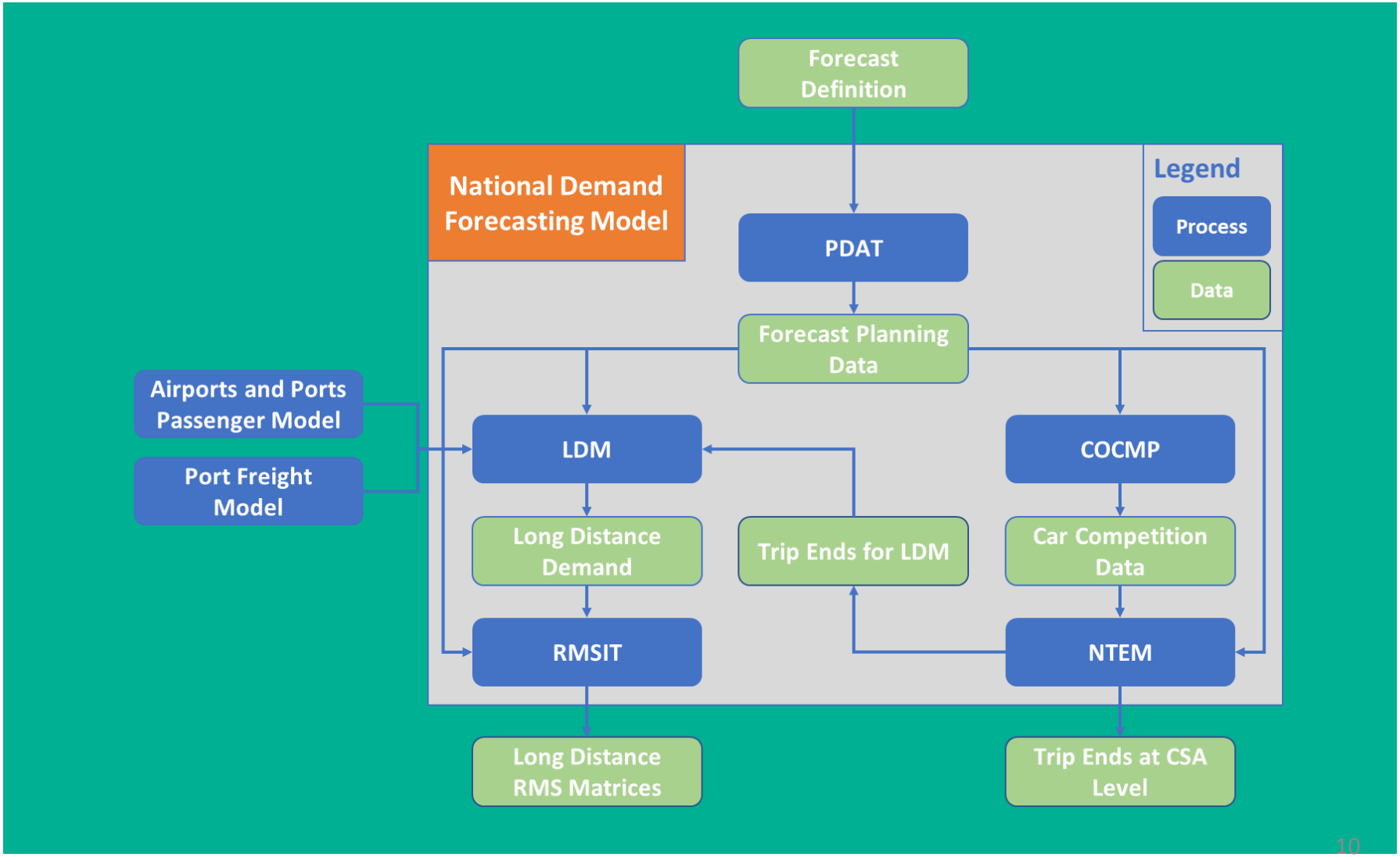
NTA Zones and Census Small Areas

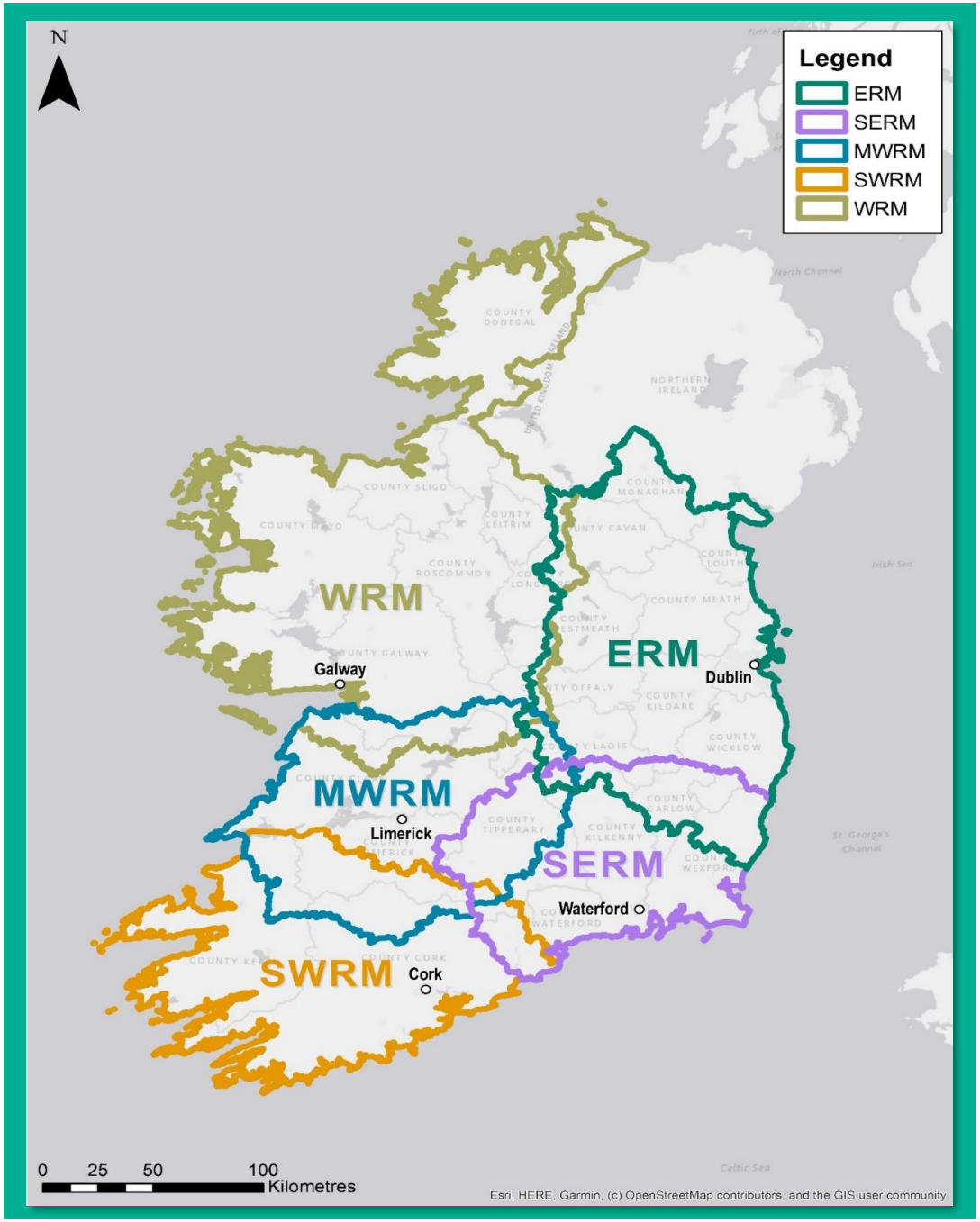
- NTA zonal systems
- Consistent national system used for each Regional Model
- Related to CSA/ED system used but coarser for computational requirements
- **4,770 zones in 2016 model** sitting on top of **18,641 Census Small Areas** in 2016 census
- Currently updating to 2022 data and PT timetables



Model Overview

National Demand Forecasting Model (NDFM)





Údarás Náisiúnta Iompair
National Transport Authority

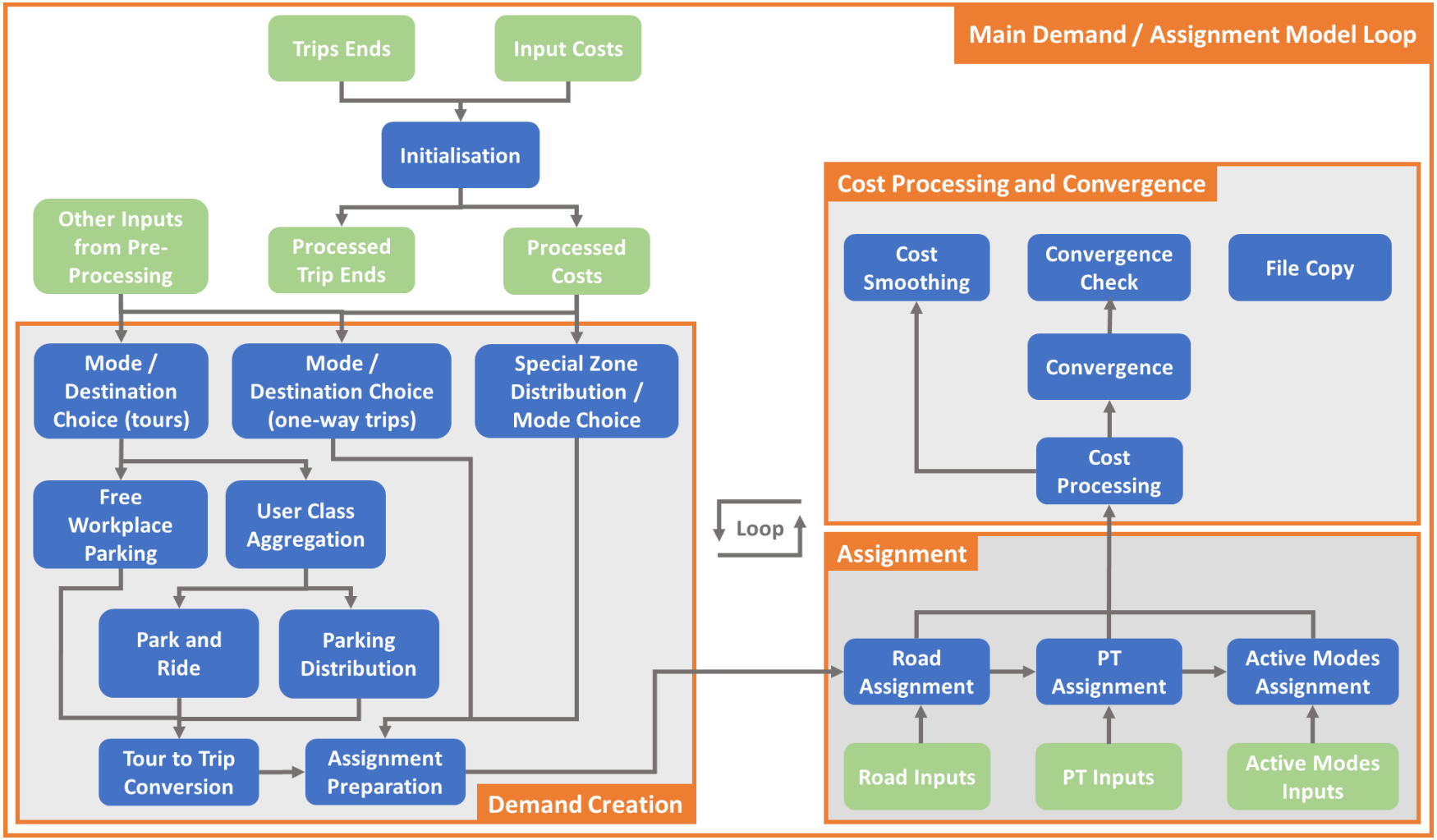
Model Overview

Regional Models

- Multi modal assignment: public transport, highway, walking, and cycling
- Mode and destination choice influenced by parking availability and supply (e.g., Park-and-Ride)
- Key outputs: distance travelled, trips, and mode share

Model Overview

Regional Model Demand Components



Model Inputs
Trip Demand

Inputs

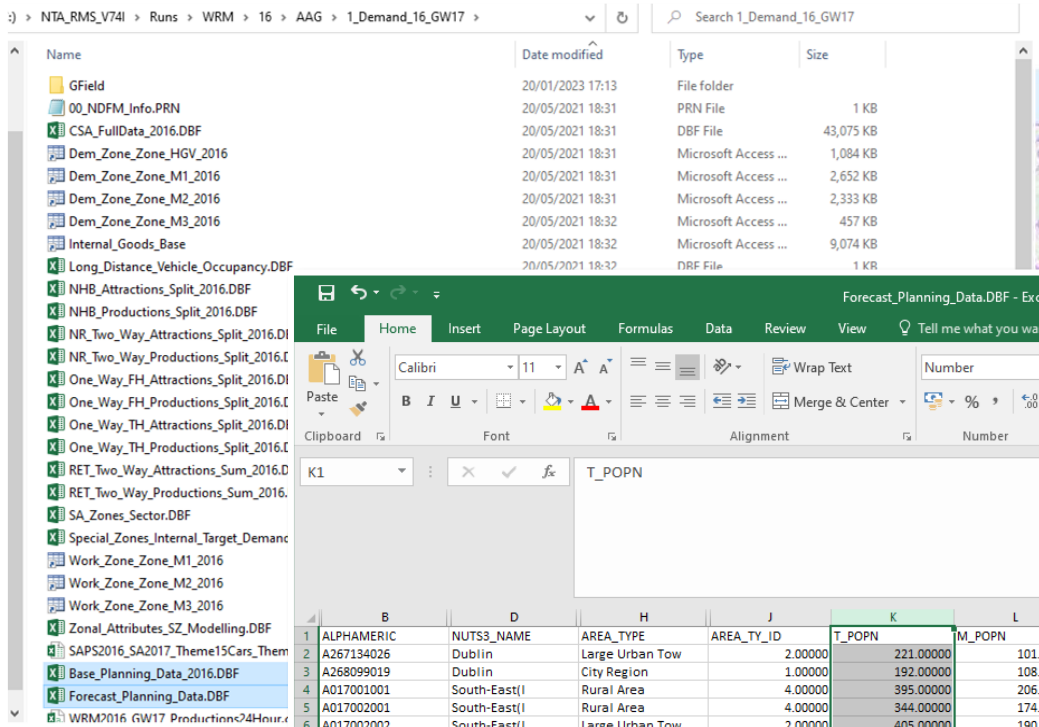
- **Planning Sheet for Forecast Year**
- **Road and PT networks (proposed schemes)**
- **Forecast Car Ownership**
- **Proposed policies**

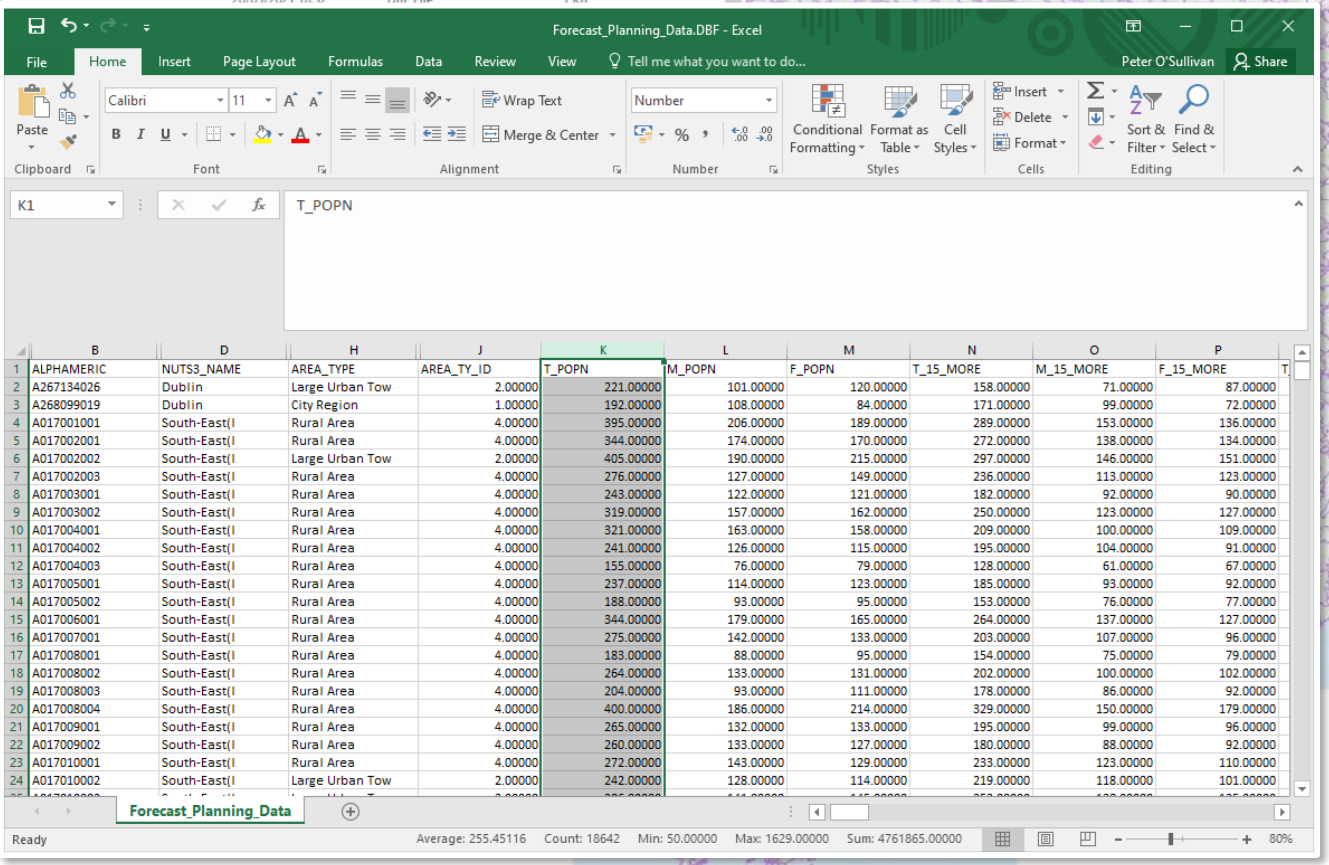
Parameters

- **Vehicle Operating Costs "PPK"**
- **Values of Time (VoT)**
- **GenCost parameters→ Responses/sensitivities to changes in GenCost based on 2016 data such as POWSCAR & NHTS**

Model Inputs

Trip Demand





	B	D	H	J	K	L	M	N	O	P
1	ALPHAMERIC	NUTS3_NAME	AREA_TYPE	AREA_TY_ID	T_POPN	M_POPN	F_POPN	T_15_MORE	M_15_MORE	F_15_MORE
2	A267134026	Dublin	Large Urban Tow	2.00000	221.00000	101.00000	120.00000	158.00000	71.00000	87.00000
3	A268099019	Dublin	City Region	1.00000	192.00000	108.00000	84.00000	171.00000	99.00000	72.00000
4	A017001001	South-East(I	Rural Area	4.00000	395.00000	206.00000	189.00000	289.00000	153.00000	136.00000
5	A017002001	South-East(I	Rural Area	4.00000	344.00000	174.00000	170.00000	272.00000	138.00000	134.00000
6	A017002002	South-East(I	Large Urban Tow	2.00000	405.00000	190.00000	215.00000	297.00000	146.00000	151.00000
7	A017002003	South-East(I	Rural Area	4.00000	276.00000	127.00000	149.00000	236.00000	113.00000	123.00000
8	A017003001	South-East(I	Rural Area	4.00000	243.00000	122.00000	121.00000	182.00000	92.00000	90.00000
9	A017003002	South-East(I	Rural Area	4.00000	319.00000	157.00000	162.00000	250.00000	123.00000	127.00000
10	A017004001	South-East(I	Rural Area	4.00000	321.00000	163.00000	158.00000	209.00000	100.00000	109.00000
11	A017004002	South-East(I	Rural Area	4.00000	241.00000	126.00000	115.00000	195.00000	104.00000	91.00000
12	A017004003	South-East(I	Rural Area	4.00000	155.00000	76.00000	79.00000	128.00000	61.00000	67.00000
13	A017005001	South-East(I	Rural Area	4.00000	237.00000	114.00000	123.00000	185.00000	93.00000	92.00000
14	A017005002	South-East(I	Rural Area	4.00000	188.00000	93.00000	95.00000	153.00000	76.00000	77.00000
15	A017006001	South-East(I	Rural Area	4.00000	344.00000	179.00000	165.00000	264.00000	137.00000	127.00000
16	A017007001	South-East(I	Rural Area	4.00000	275.00000	142.00000	133.00000	203.00000	107.00000	96.00000
17	A017008001	South-East(I	Rural Area	4.00000	183.00000	88.00000	95.00000	154.00000	75.00000	79.00000
18	A017008002	South-East(I	Rural Area	4.00000	264.00000	133.00000	131.00000	202.00000	100.00000	102.00000
19	A017008003	South-East(I	Rural Area	4.00000	204.00000	93.00000	111.00000	178.00000	86.00000	92.00000
20	A017008004	South-East(I	Rural Area	4.00000	400.00000	186.00000	214.00000	329.00000	150.00000	179.00000
21	A017009001	South-East(I	Rural Area	4.00000	265.00000	132.00000	133.00000	195.00000	99.00000	96.00000
22	A017009002	South-East(I	Rural Area	4.00000	260.00000	133.00000	127.00000	180.00000	88.00000	92.00000
23	A017010001	South-East(I	Rural Area	4.00000	272.00000	143.00000	129.00000	233.00000	123.00000	110.00000
24	A017010002	South-East(I	Large Urban Tow	2.00000	242.00000	128.00000	114.00000	219.00000	118.00000	101.00000

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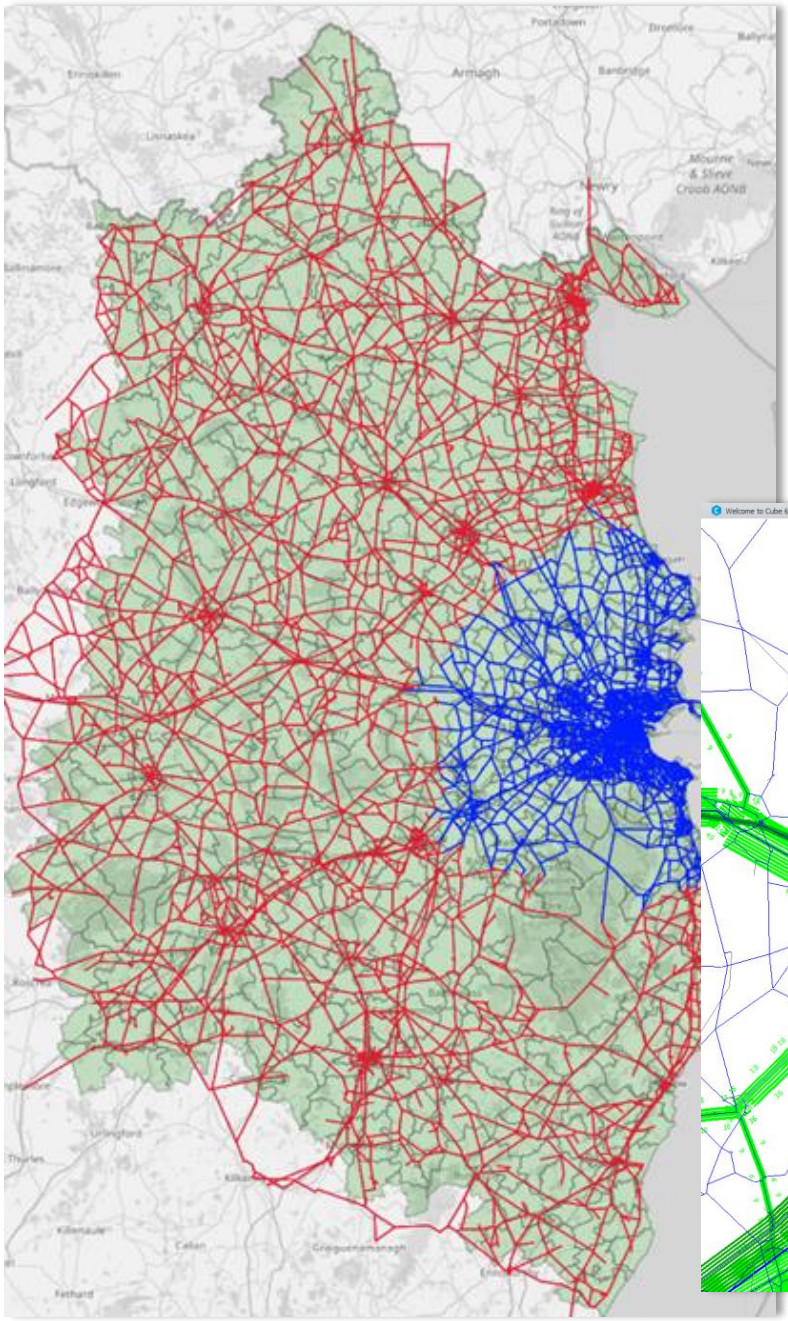
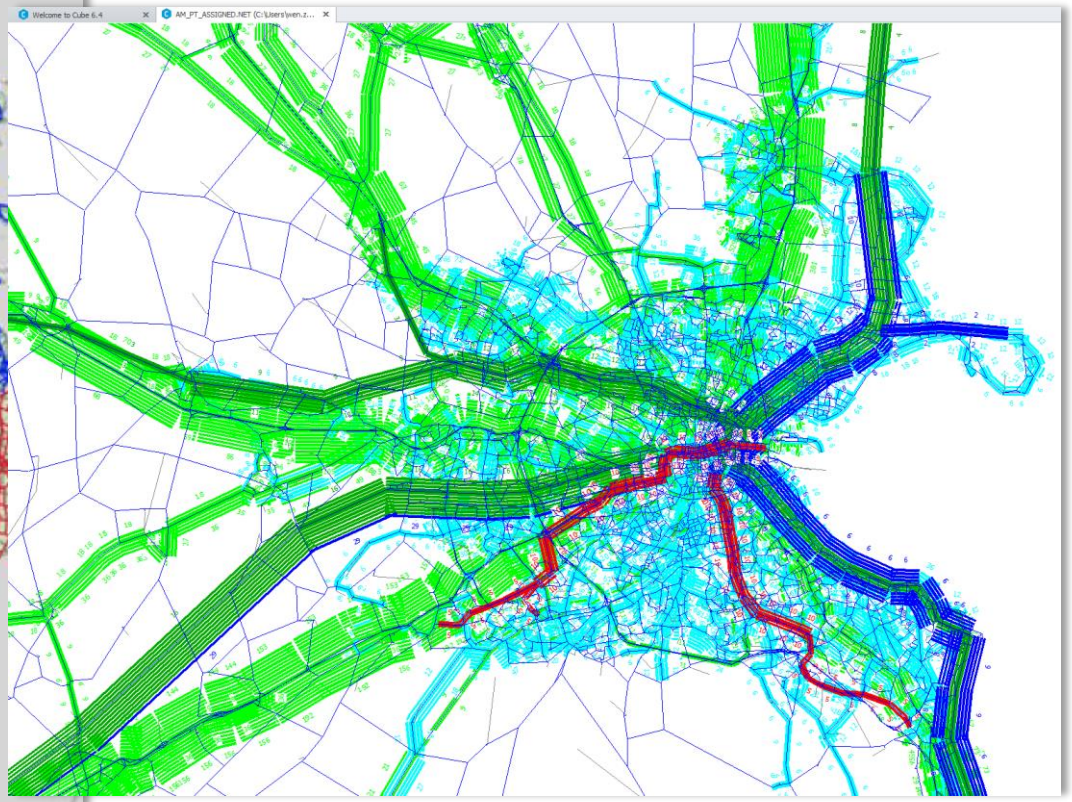
Model Inputs

Networks: main roads & tolls, scheduled public transport and cycle networks





ERM Network Coverage

Model Inputs

Parking spaces and charges

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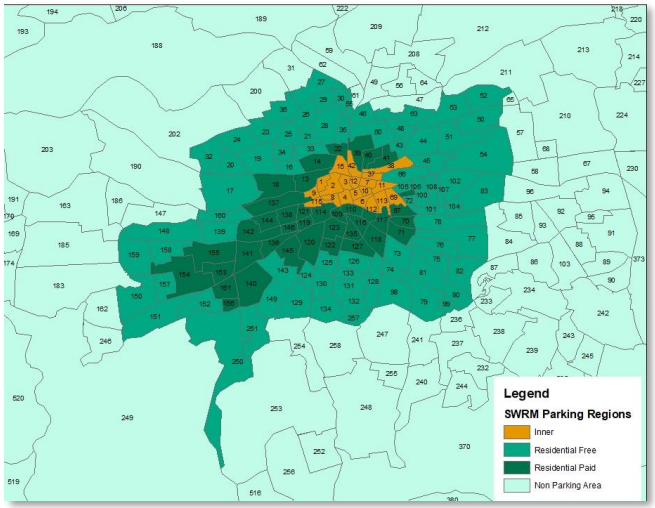
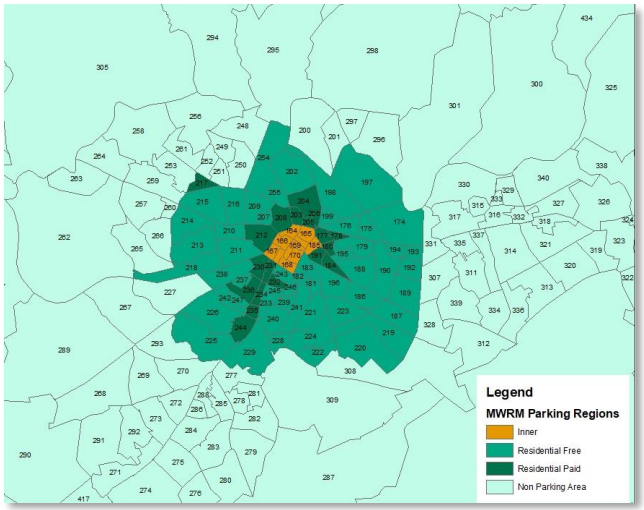
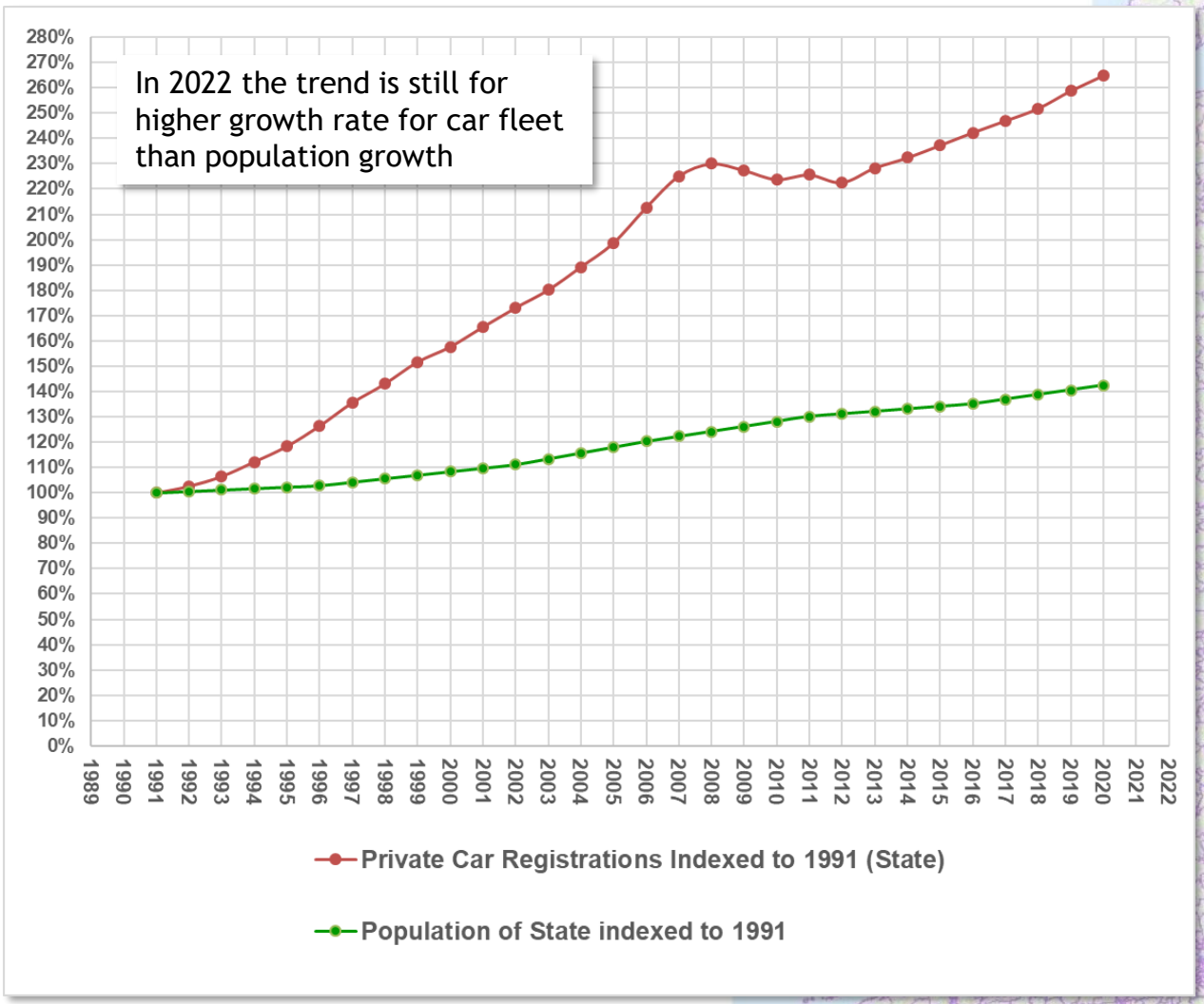




Model Inputs

National Car Ownership Trend

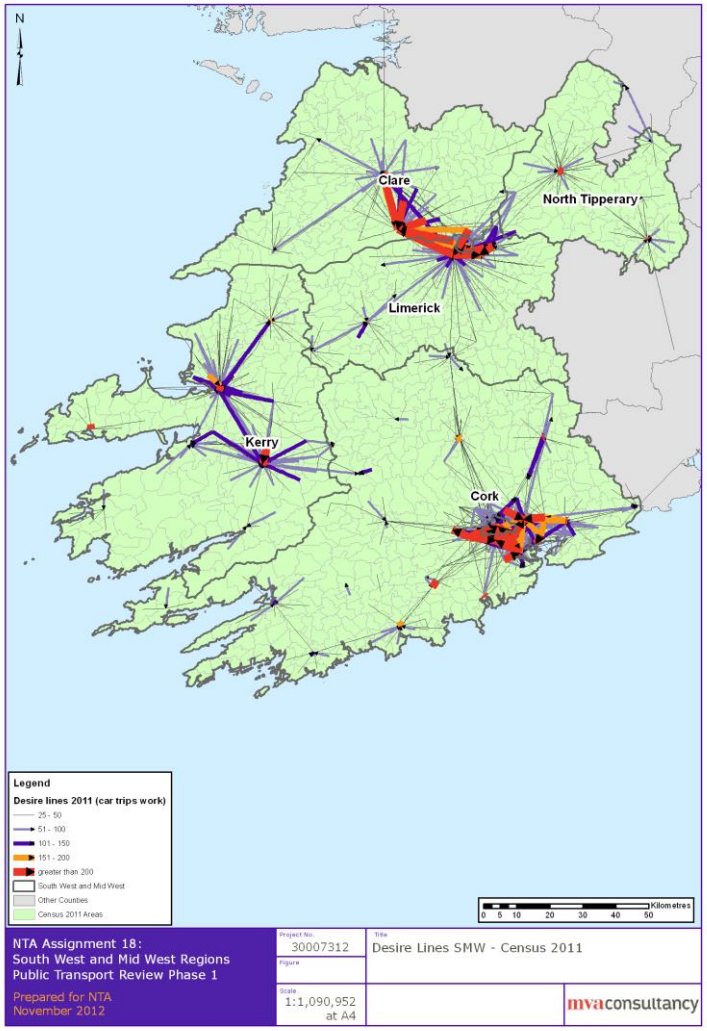


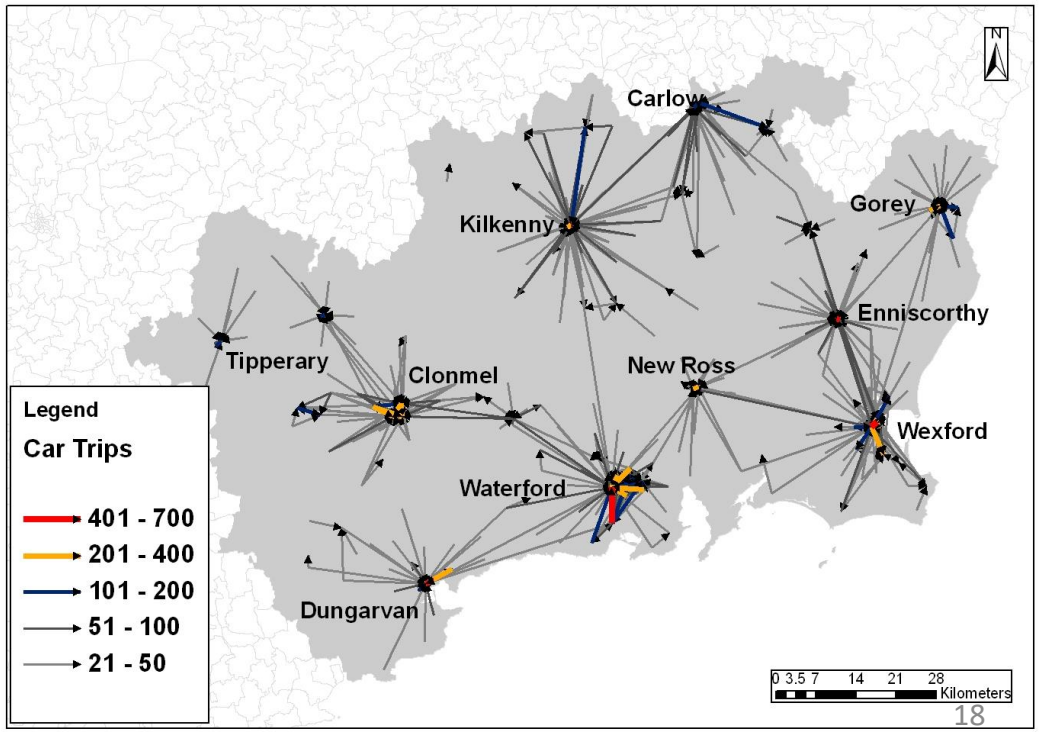
Model Inputs

Existing Patterns of Car Travel

Facilitated by better roads and lower housing costs in more remote locations.

As specified in the planning sheet / POWSCAR data + NPF forecast





Red lines = high car flow (24-hour);

Blue lines = LOW bus flow (24-hour)

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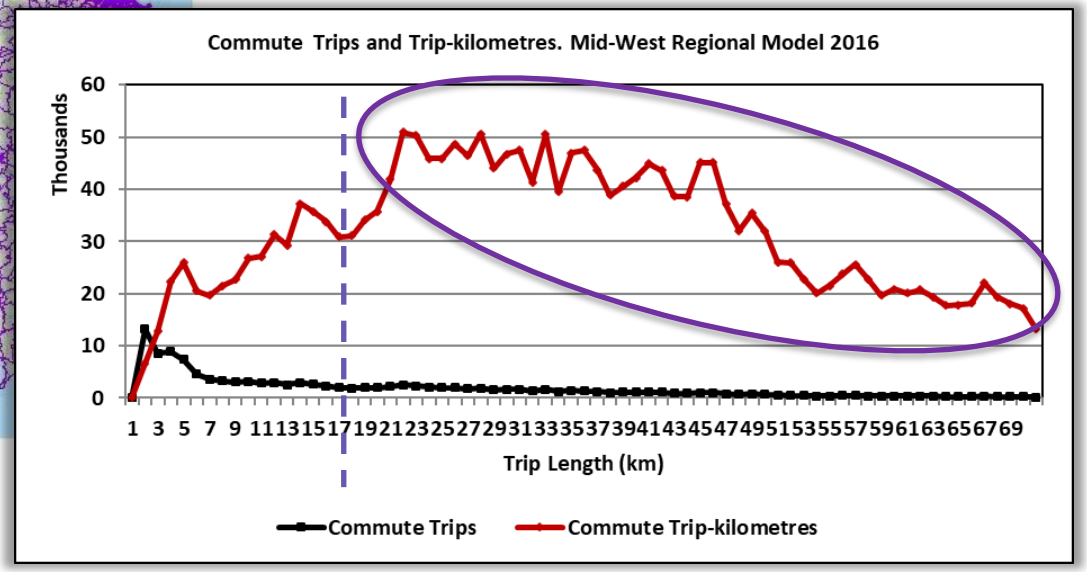
Model Outputs

Bus Service Planning (PT Gap Analysis)



Model Outputs

GHG/particulate emissions sources/Noise mapping

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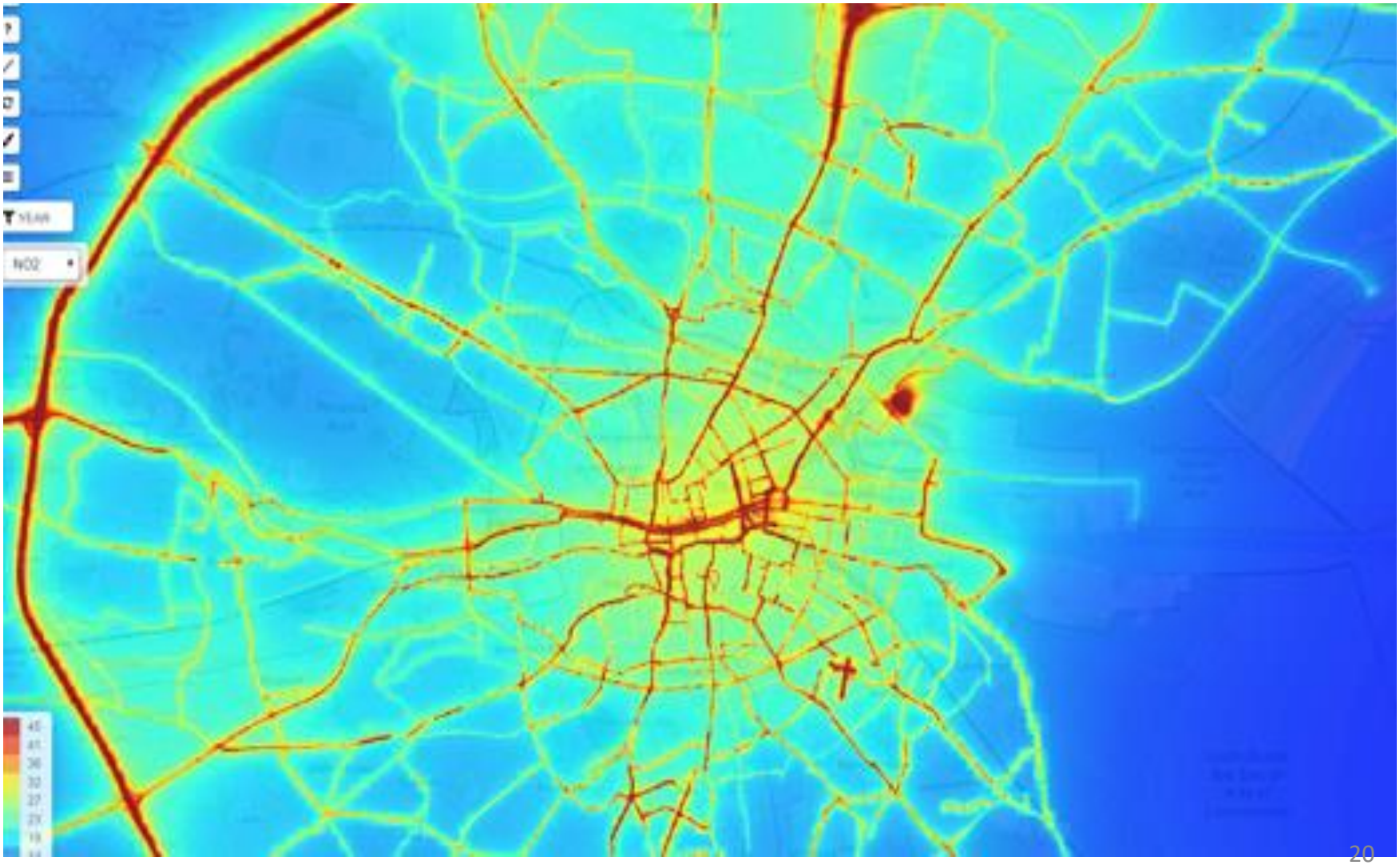
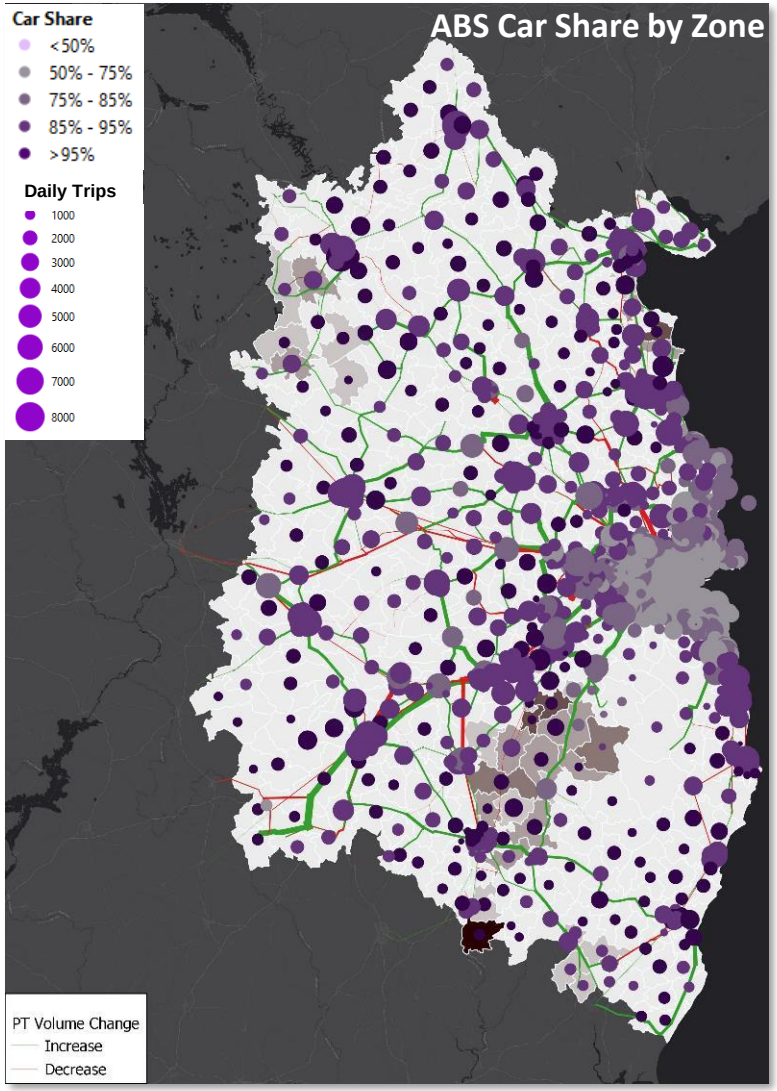
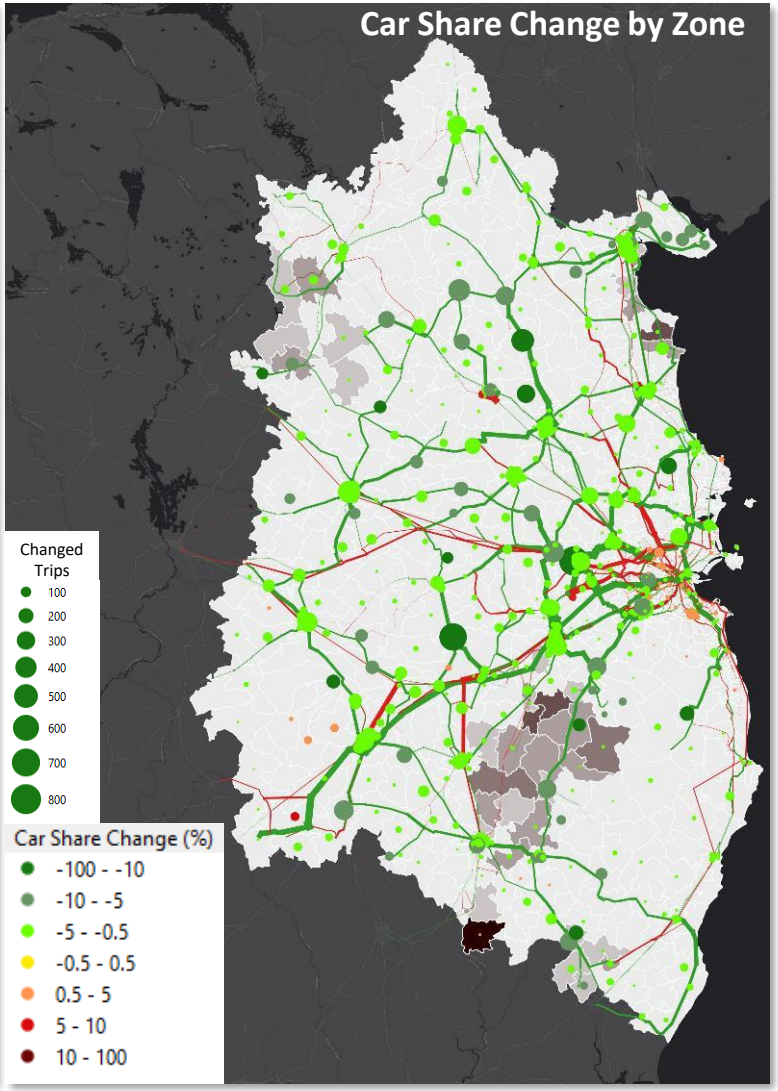


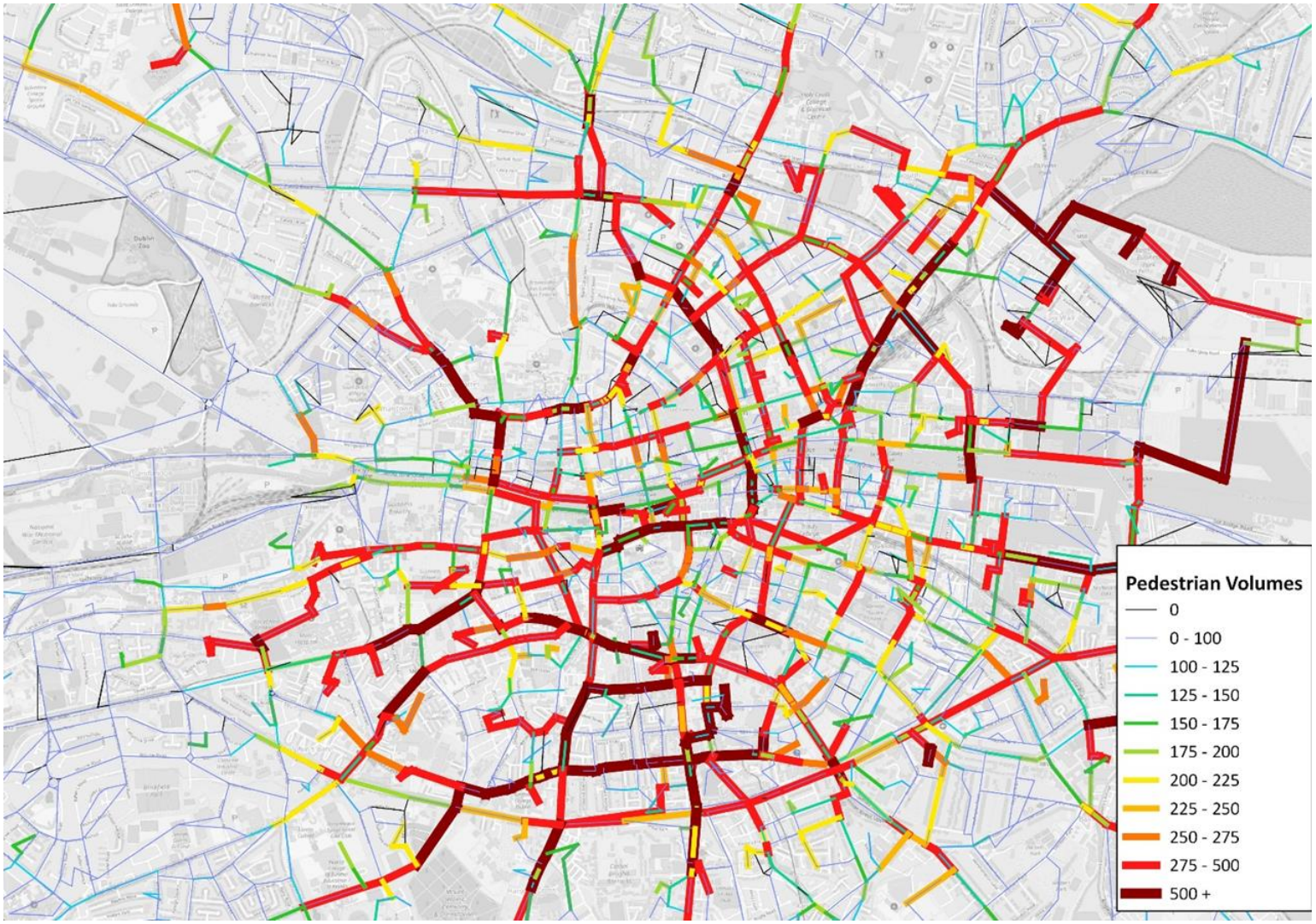
Model Outputs
2042 GDA Strategy modelling



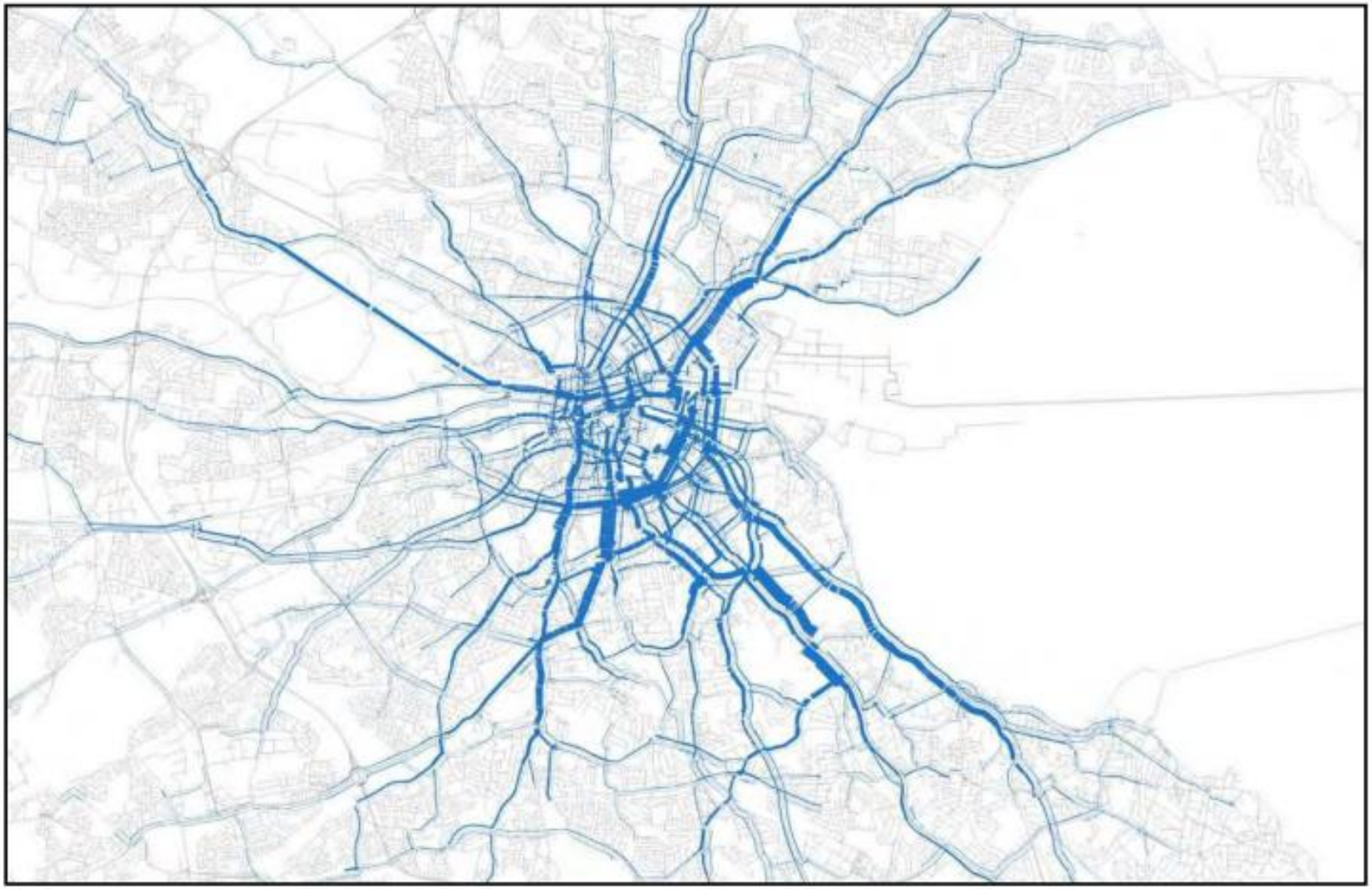


- Car Mode Share reduced in most hinterland zones.
- A few zones have increased car share.
- Zones within M50 have marginally increased car share.

Model Outputs
Assignments: Walking



Model Outputs
Assignments: Cycling



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Climate Action Plan

Modelling Approach

CAP Emissions Modelling

Tools and Output

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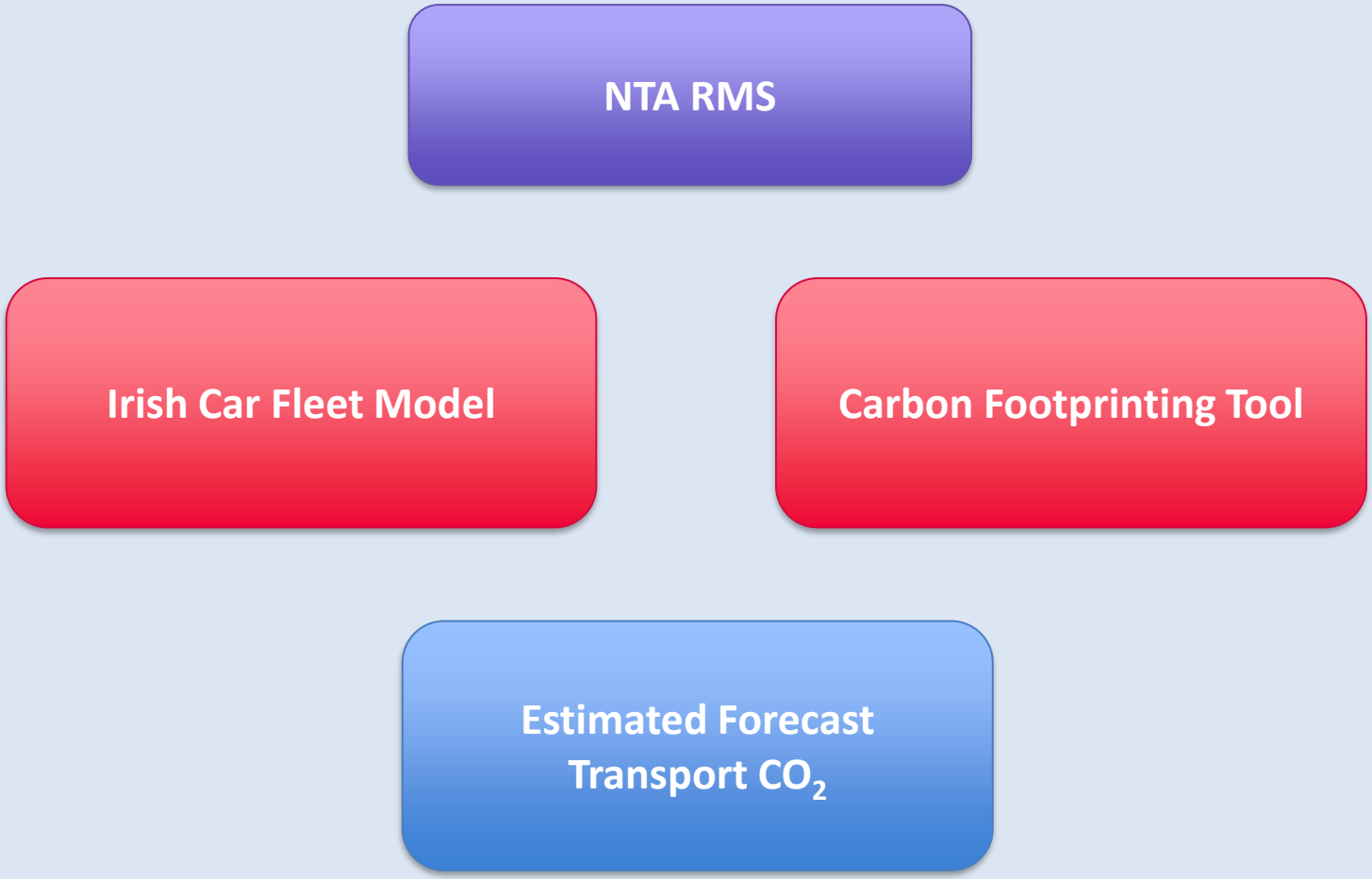

CAP Emissions Modelling

Irish Car Fleet Model

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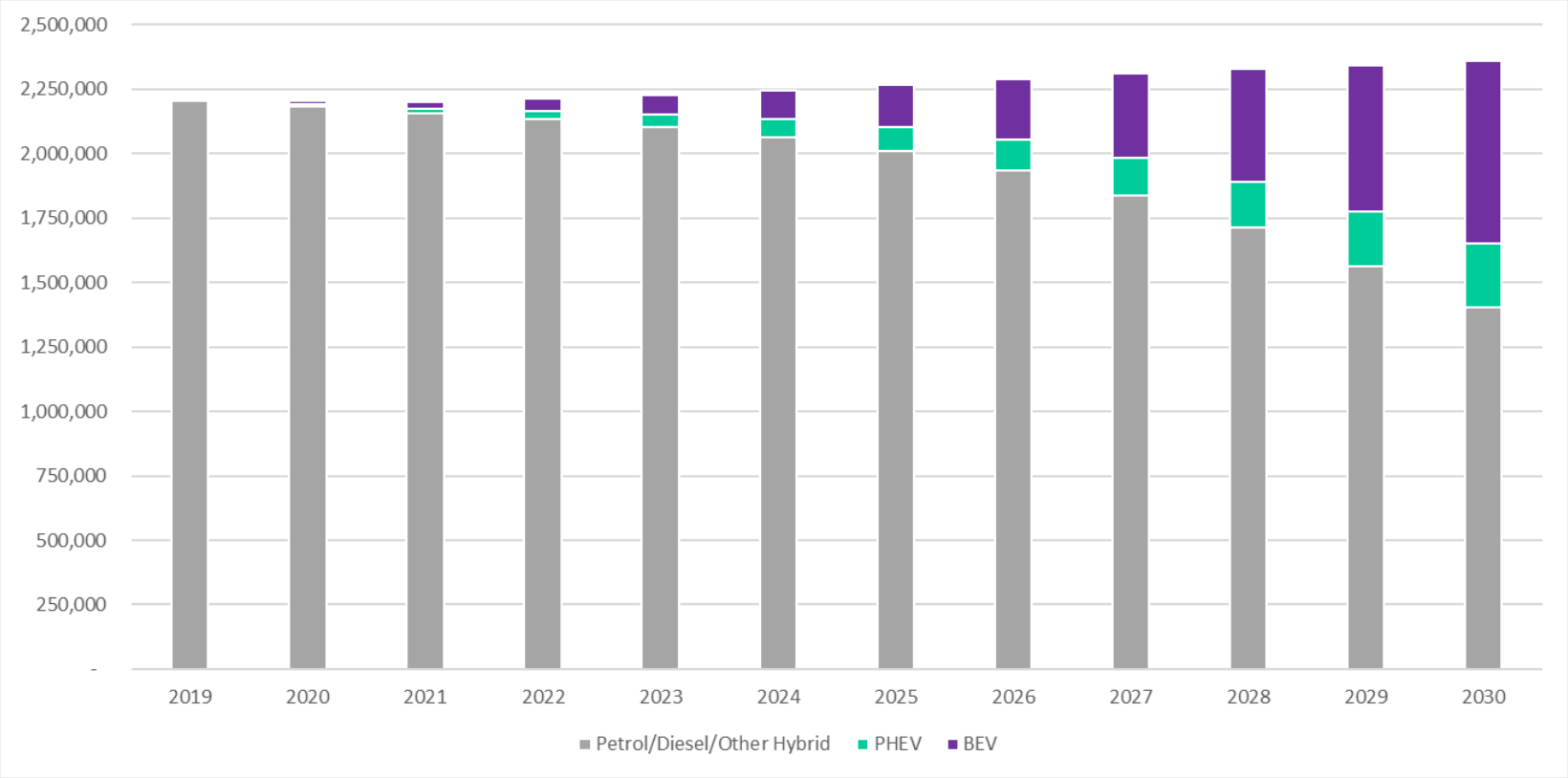
National Transport Authority

Projections: Car Fleet Mix On the Road



Note: NTA predictions are based on CAP23 inputs (dated 24 May 2022). It is estimated that there will be a 6% increase in total cars on the road. **By 2030, 11% of cars on the road will be PHEV and 30% of cars on the road will be BEV.**

CAP Emissions Modelling
Carbon Footprinting Tool (CFT)

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Description

- The CFT estimates the **percentage reduction in carbon emissions from each transport-related measure** and applies these sequentially to the 2025 and 2030 ‘Business-as-Usual' carbon emissions forecasts.
- The **outputs from the CFT are compared to the 2018 baseline level of emissions** to determine how well each package of measures performs against the emissions reduction target.

CAP Emissions Modelling

Integration of Modelling Tools

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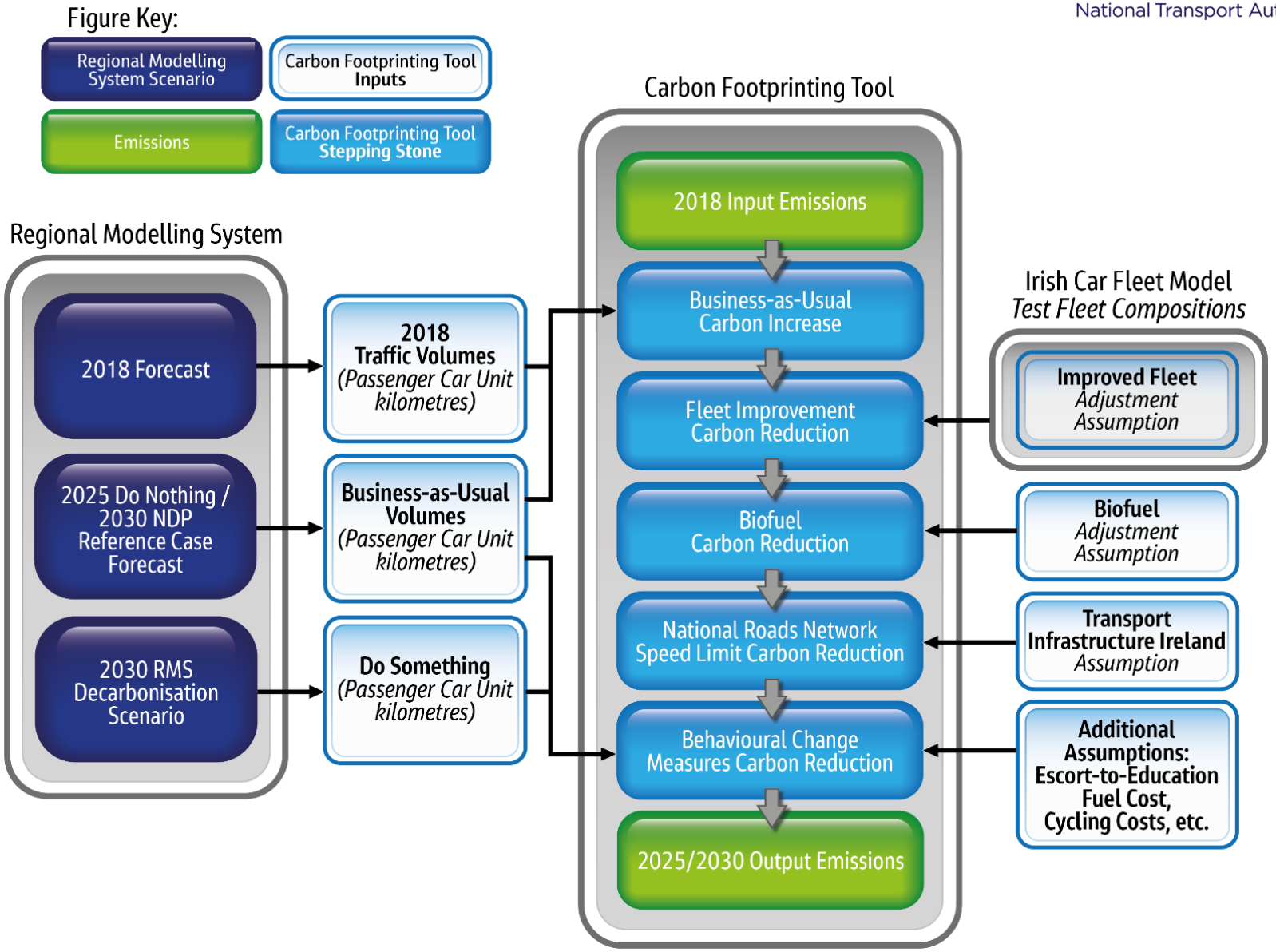

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Summary

Transport and Emissions Modelling Services

Transport Modelling Services

National Climate Modelling Assets – Links to Key Gov / Agency Outputs

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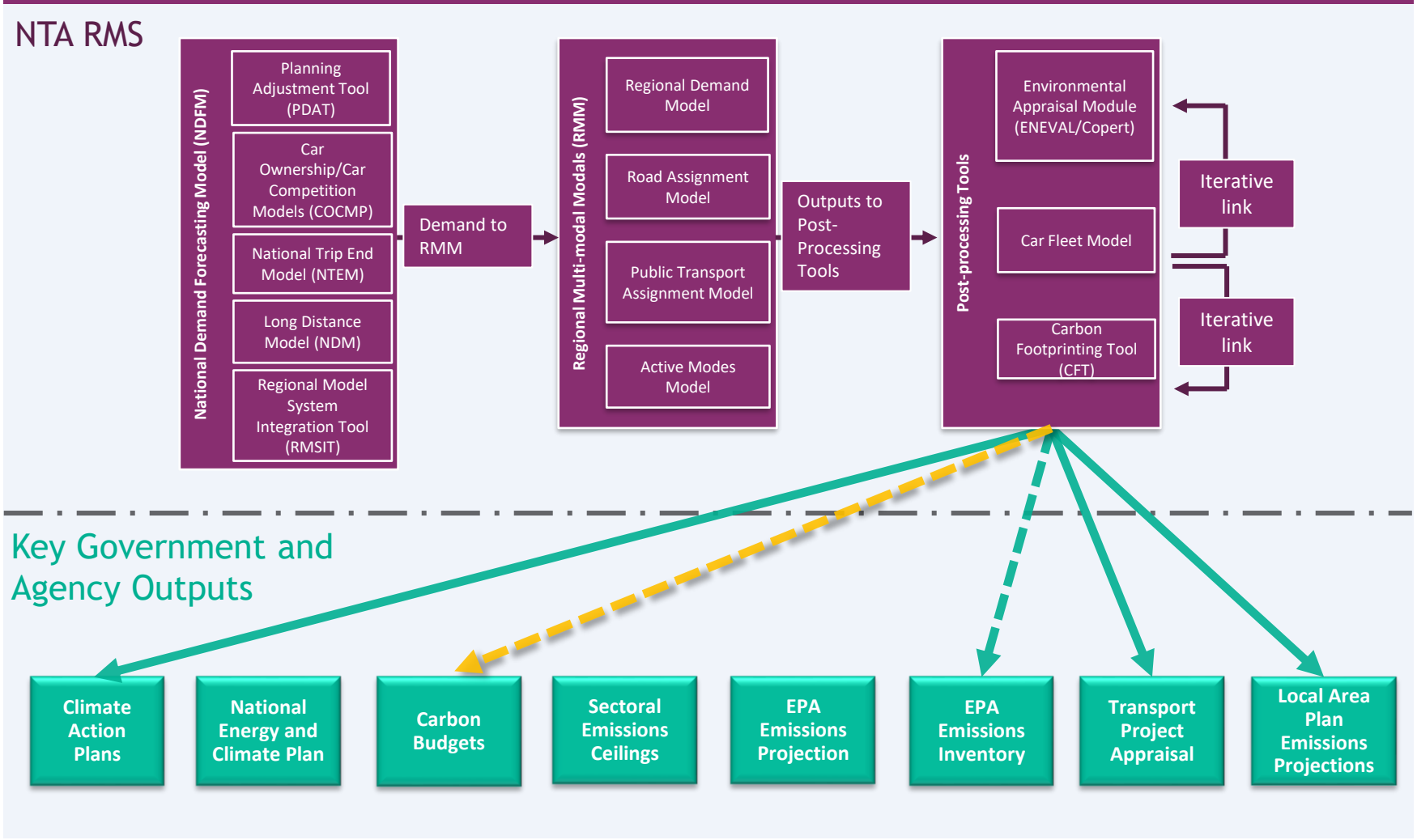


Forestry models

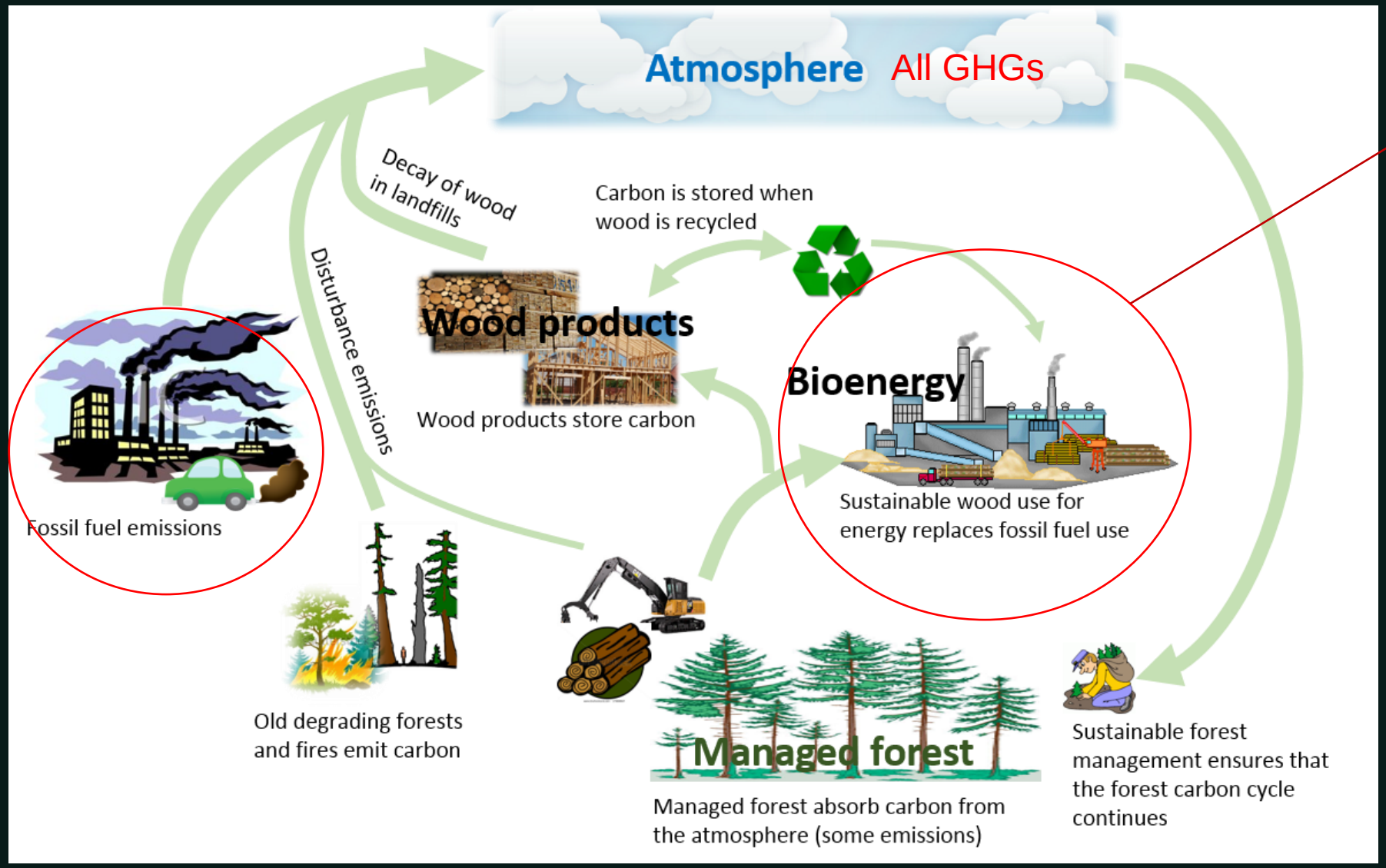
Monitoring and projecting climate change measures for Irish forestry

Outline

- Current uses
- Basic concepts
- What is the model requirement?
- Brief model overview
- Calibration and inputs
- Drivers and trends
- Sensitivities



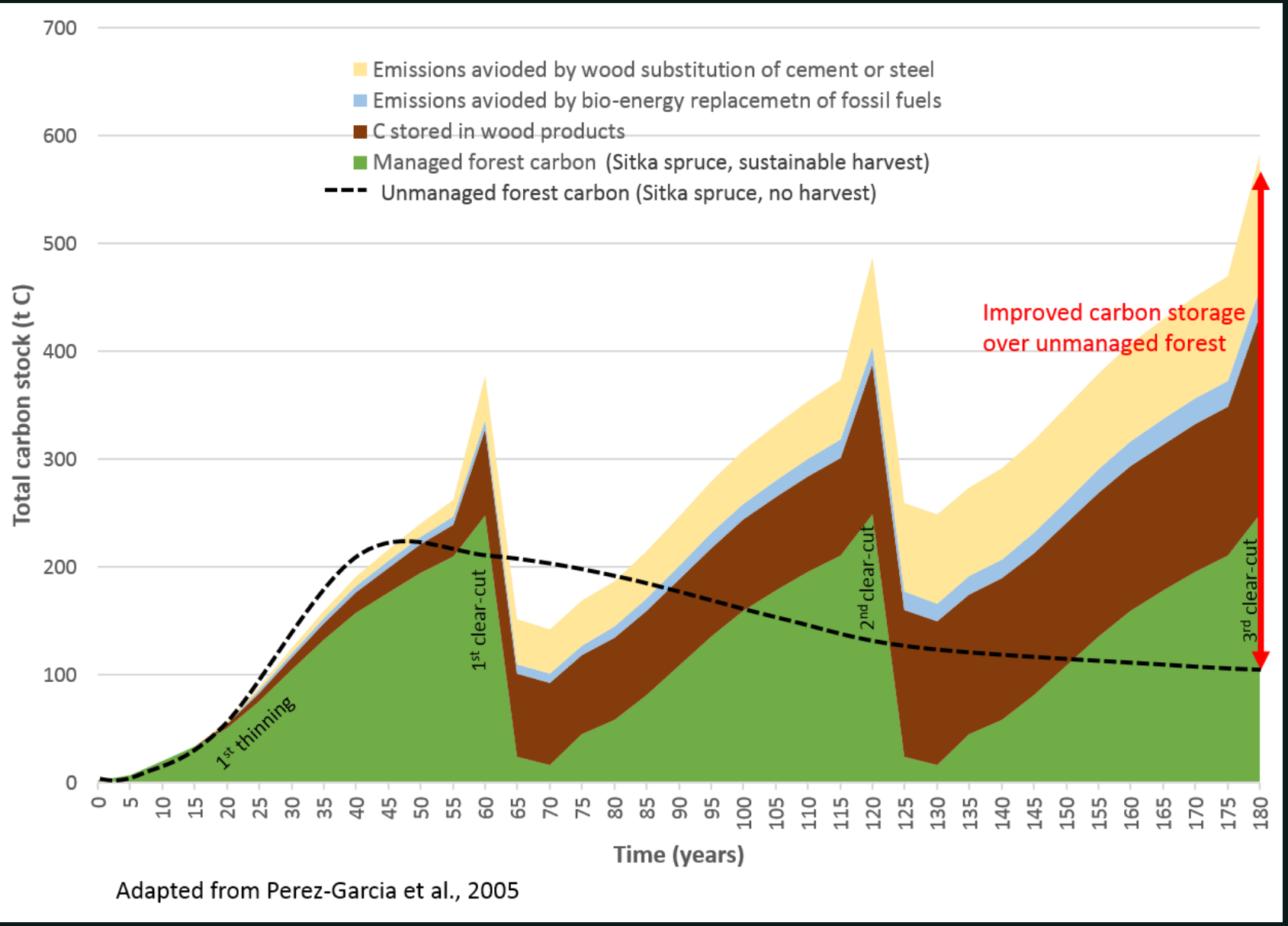

Concepts-system boundary



Outside boundary

- Product and energy substitution
- Grazing shift leakage
  - Livestock numbers?
- Mill sector emissions
- Economic impact on harvest and silviculture
- Land price, farm payments

• Stand cycle



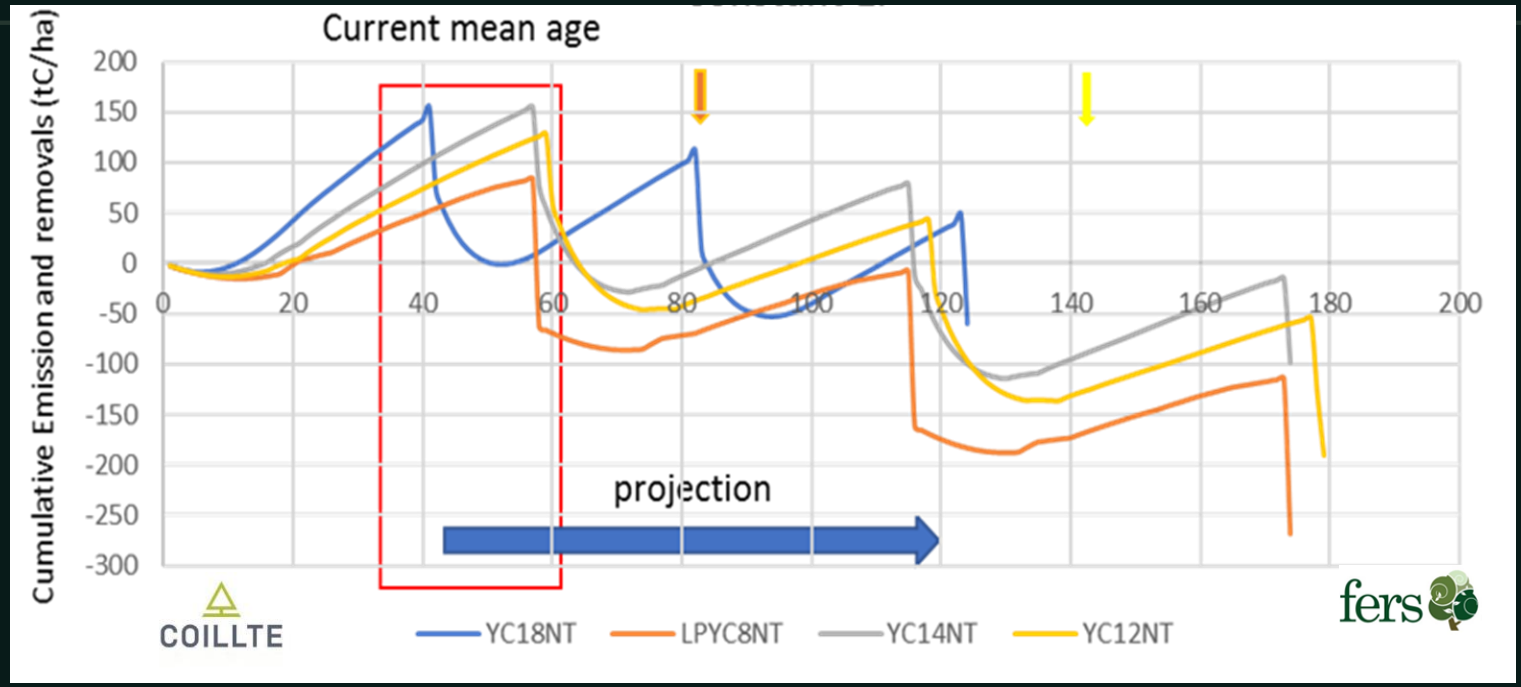
Adapted from Perez-Garcia et al., 2005

- Afforestation results in a slow but saturated sink
- Sustainable management should conserve or enhance the forest sinks
- Product use patways

- Forest are not always sinks

- Over-harvest
- Short rotations
- Age class shifts
- Organic soils
- Natural disturbances

Organic soils



- Most forests are on organic soils (most established before 2000)- highest proportion in EU
- New emission factor 1.68tC/ha/yr~6.2tCO_2 (not in 2018 target)
- Afforestation initially a sink but transitions to net emission after 1-3 rotations (Black et al., 2023, Hargraves et al 2003)

Forest model requirements

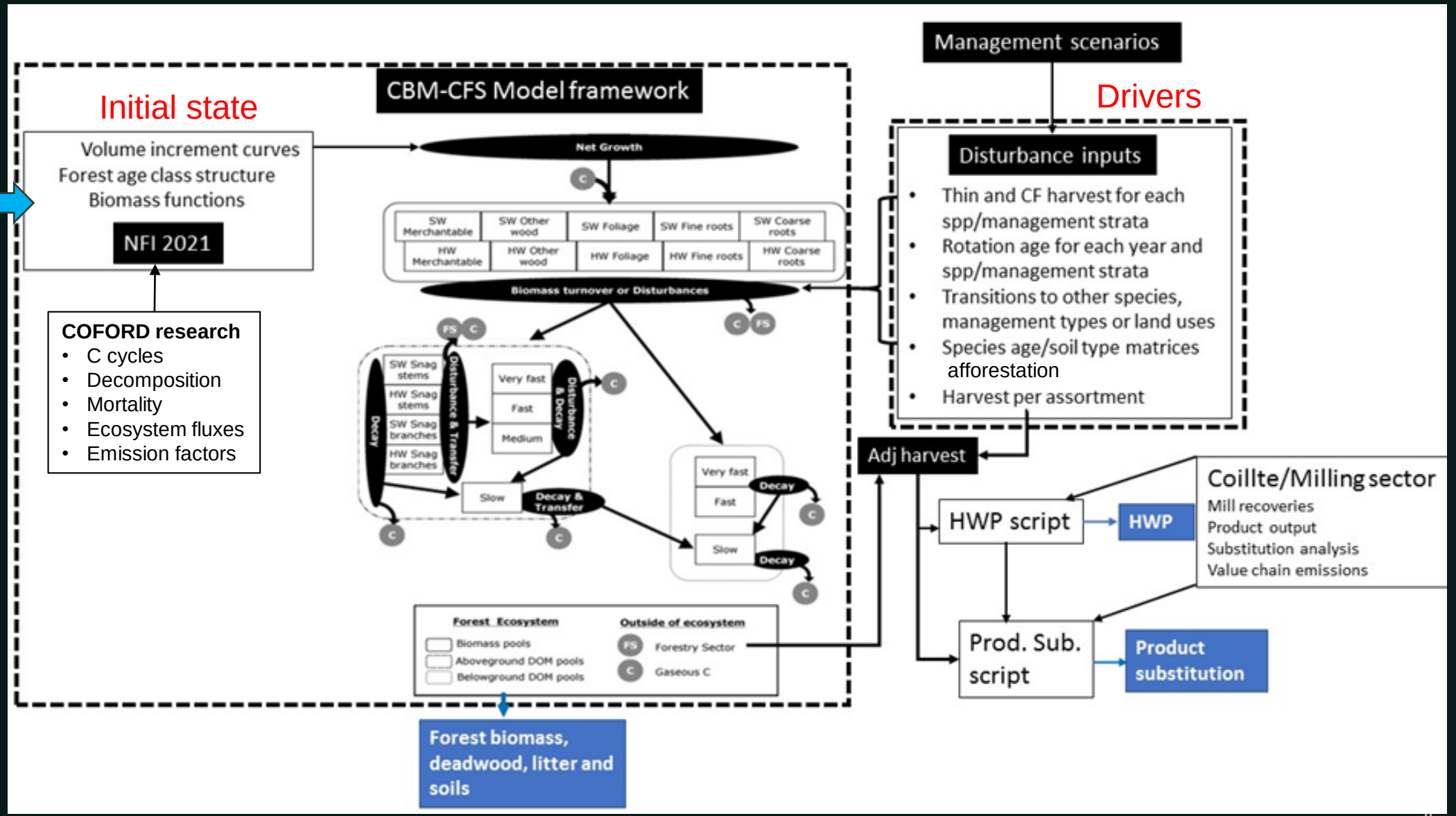
- Forestry is a long term business
  - **Impacts are long term and dynamically alter as management changes**
  - **Baseline is not static (measures assessed relative to a baseline (BAU))**
- Model net ecosystem exchange- gains (growth) losses (disturbances, mortality, extreme events)
- A complete carbon cycle in forest and HWP pools
- Must reflect silviculture, species productivity, age class structure
- Manipulation of drivers for scenario analysis
- **Must align with GHG inventories and resemble something close to reality (validation)**
- Range of models CBM, CARBWARE, G4M, EFISCEN
  - Different scales (stand to landscape, regional to global)
  - System boundaries (all pools , some pools, dynamic static)

CBM-CFS

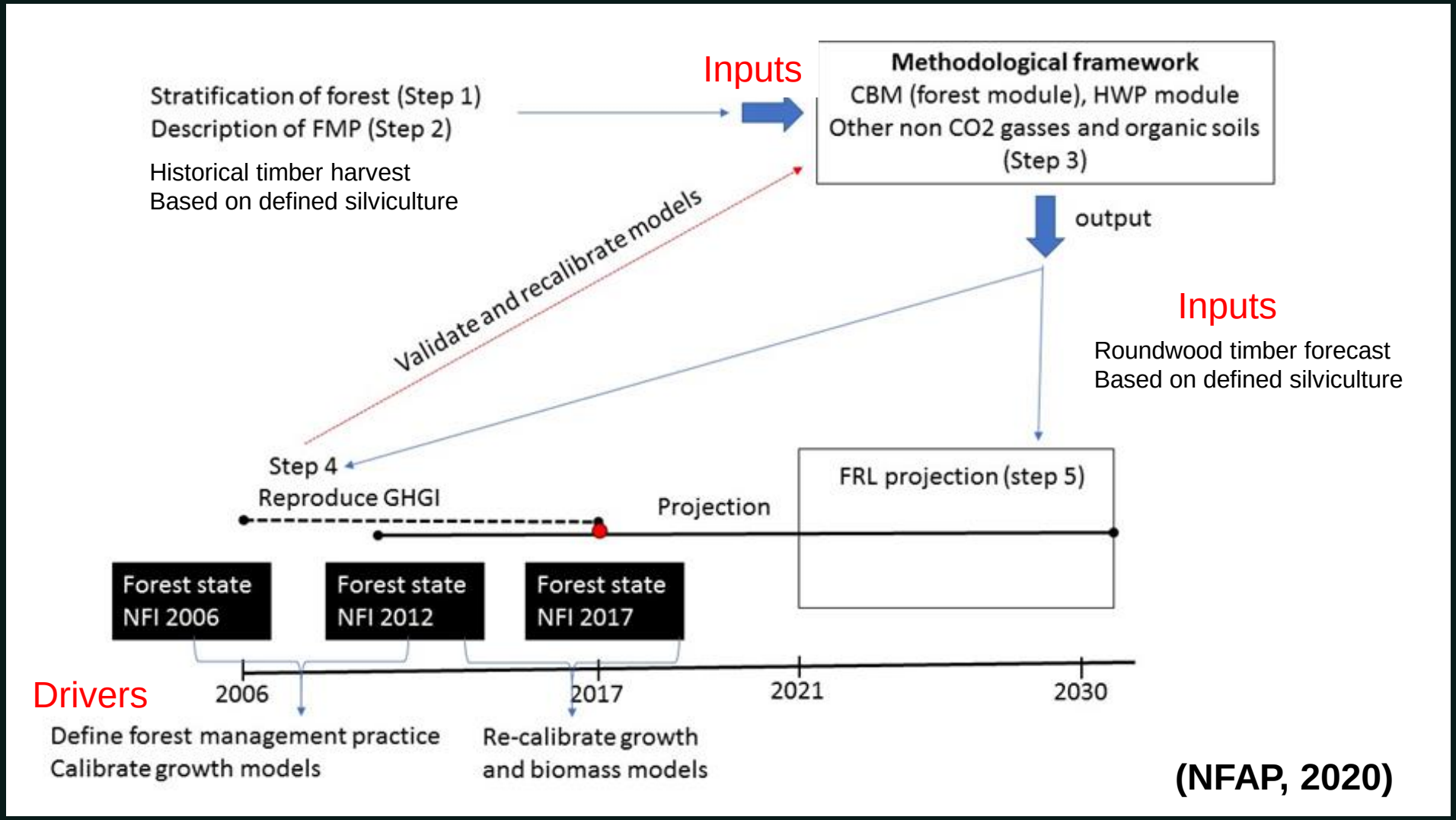
- Software framework that uses local models
- Developed in Canada for carbon accounting under UNFCCC and IPCC guidelines (regional and landscape scale)
- Calibrated for Irish conditions using the National forest inventory (NFI) and over 20 years of COFORD research
- Used in the GHG inventory, for Ireland, Czechia, Poland, Canada, EU JRC
- Used for the KP 2013-2020 FM projections and EU LULUCF regulation (NFAP, 2019), Coillte strategy 2023, Teagasc MACC, 2023
- Validated using NFI, research data

CBM-CFS-overview

CARBWARE (Black 2016)
Single tree models
CCF
Uneven aged, mixes spp models



Calibration of models for GHG projections



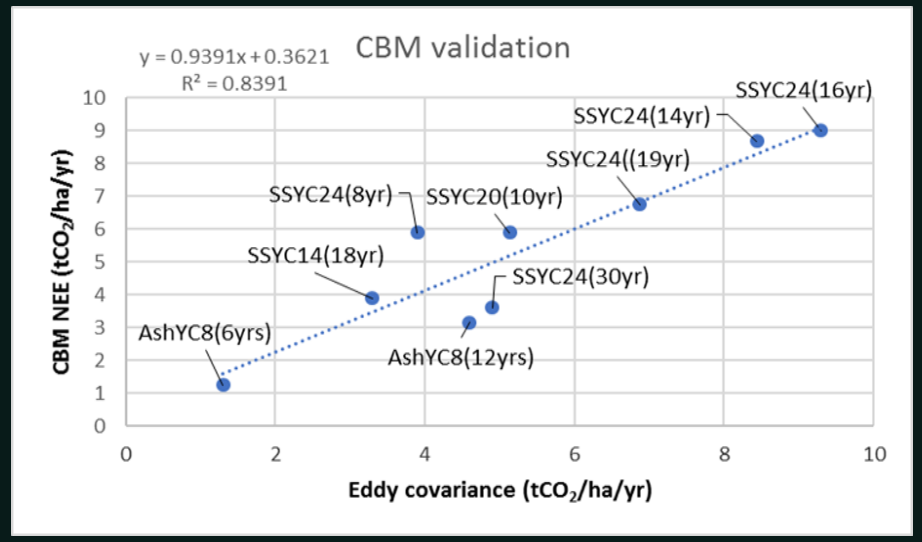
Validation of CBM

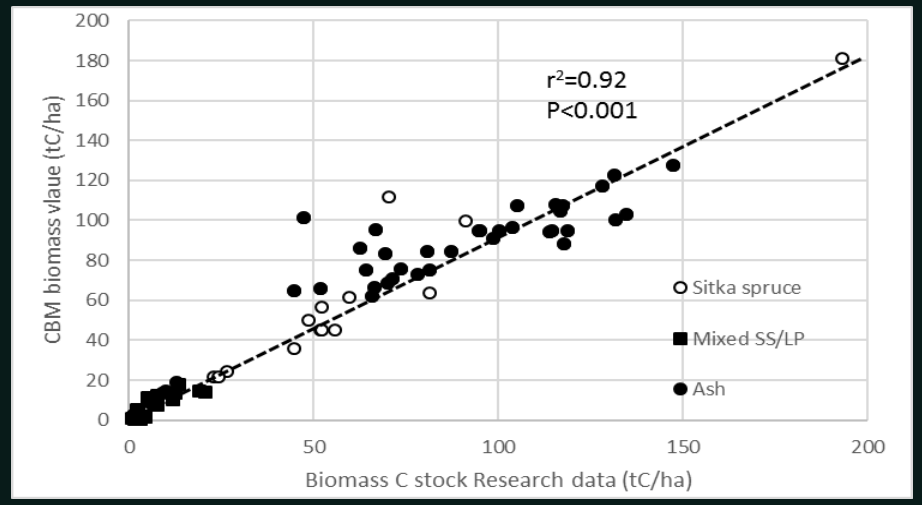
NFI 2006-2021

	Biomass C stocks (MtC)			
			Confidence interval (95%)	
Year	CBM	NFI	Lower	upper
2006	38.9	37.3	35.8	38.8
2012	47.2	48.5	46.5	50.5
2017	54.3	55.9	53.8	57.9
2021	59.4	63.2	59.3	65.6

Currently recalibrating using the 2021 NFI

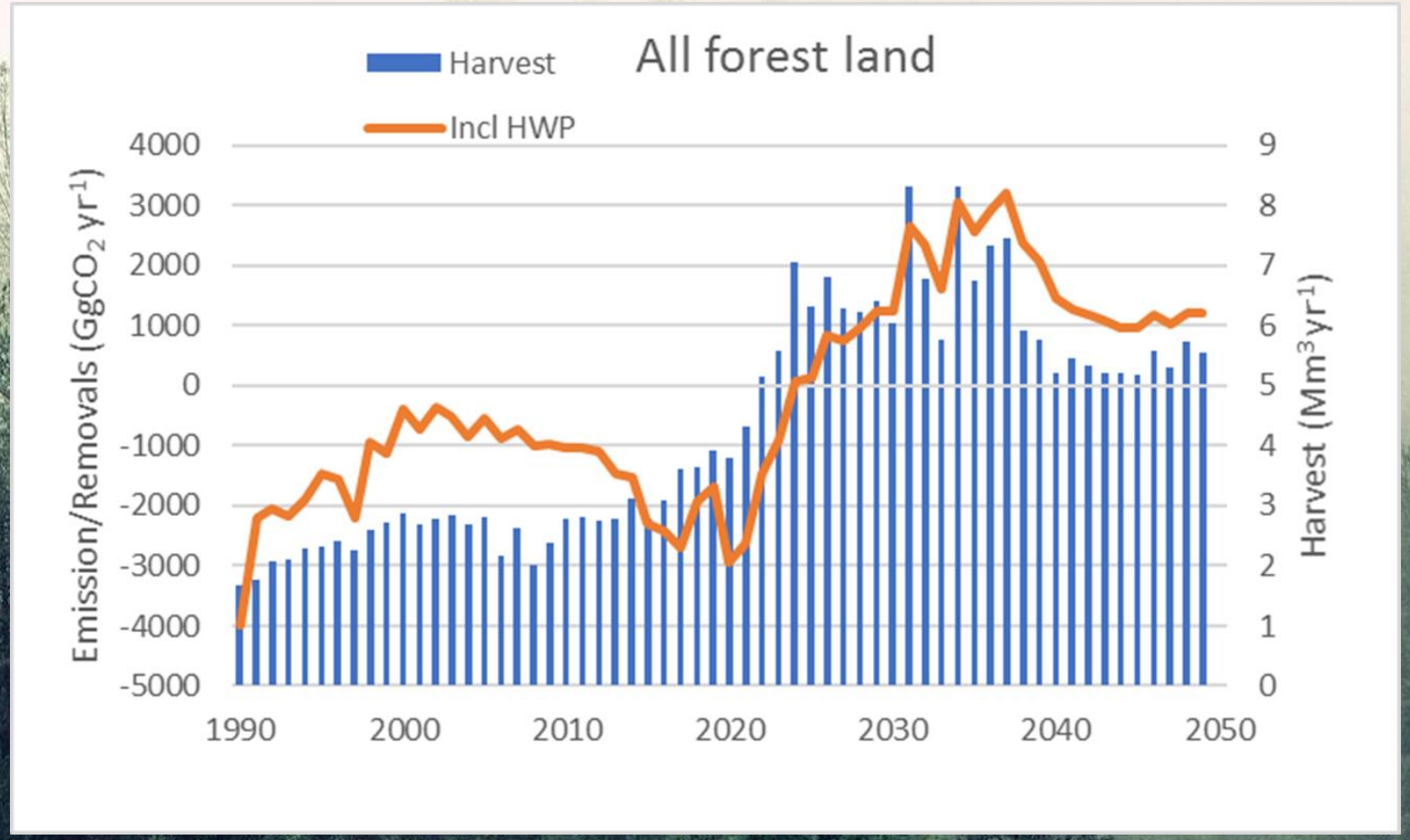
Research stands





2021 GHGi

- AR (299kha):- 2.8MtCO_2e
- FM (481 kha): 1.6MtCO_2e
- HWP: -0.9MtCO_2e



Including Climate change action plan afforestation targets (8000 ha per year)

Trends

Large legacy impact: Future trends pre-determined 20-30years ago

Drivers

AFFORESTATION

- Reduction in afforestation from 25,000 in 1990s to 2,000 ha .
- Afforestation of organic soils.

DEFORESATATION

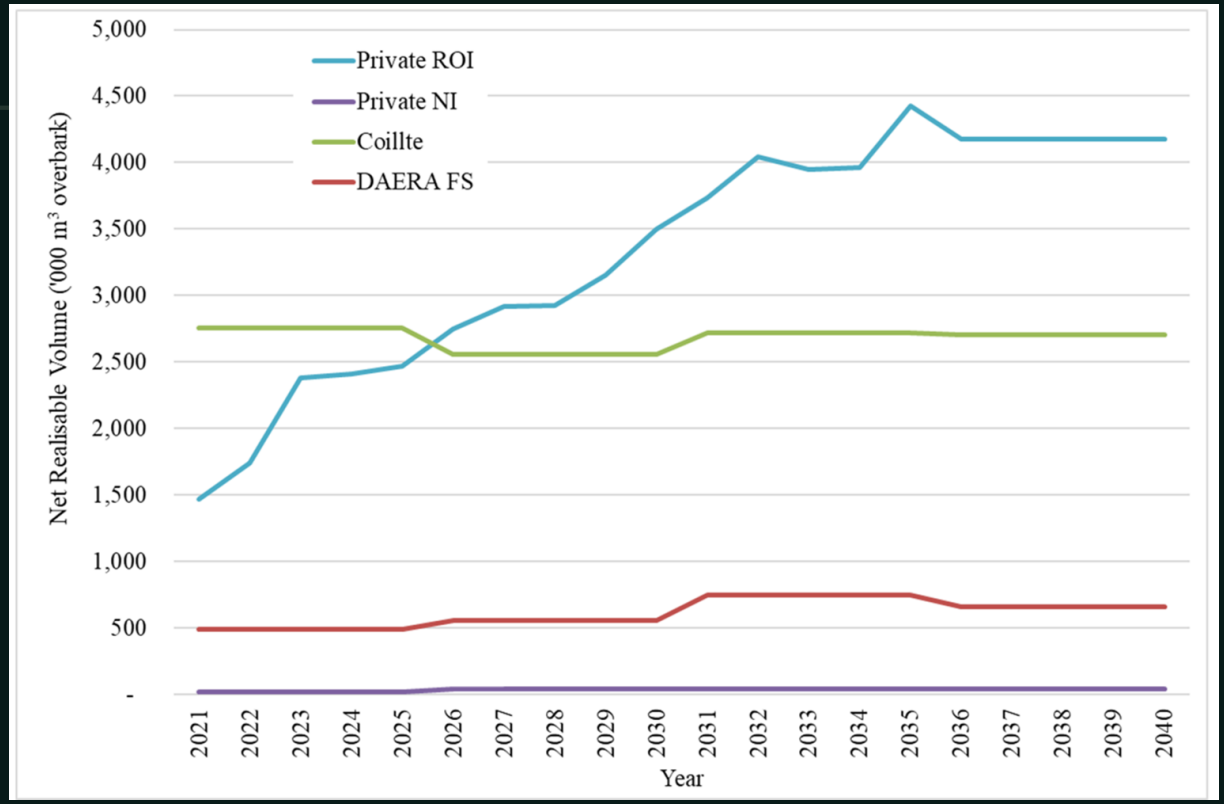
- 725 ha per year

FOREST MANAGEMENT

- Continued emissions from organic soils
- Increase in historical harvest from 1 to 4 Mm^3 per year.
- Shorter rotation ages
- 5-fold increase in harvest to 2040
- Age class legacy effects.

Harvest Roundwood forecast 2021-2040

- **Based on current silviculture and age class structure**
- **Previous forecasts accurate, verified by NFI**
- **Used in Kyoto protocol, NFAP (EU LULUCF reg) projections**



An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Age class legacy

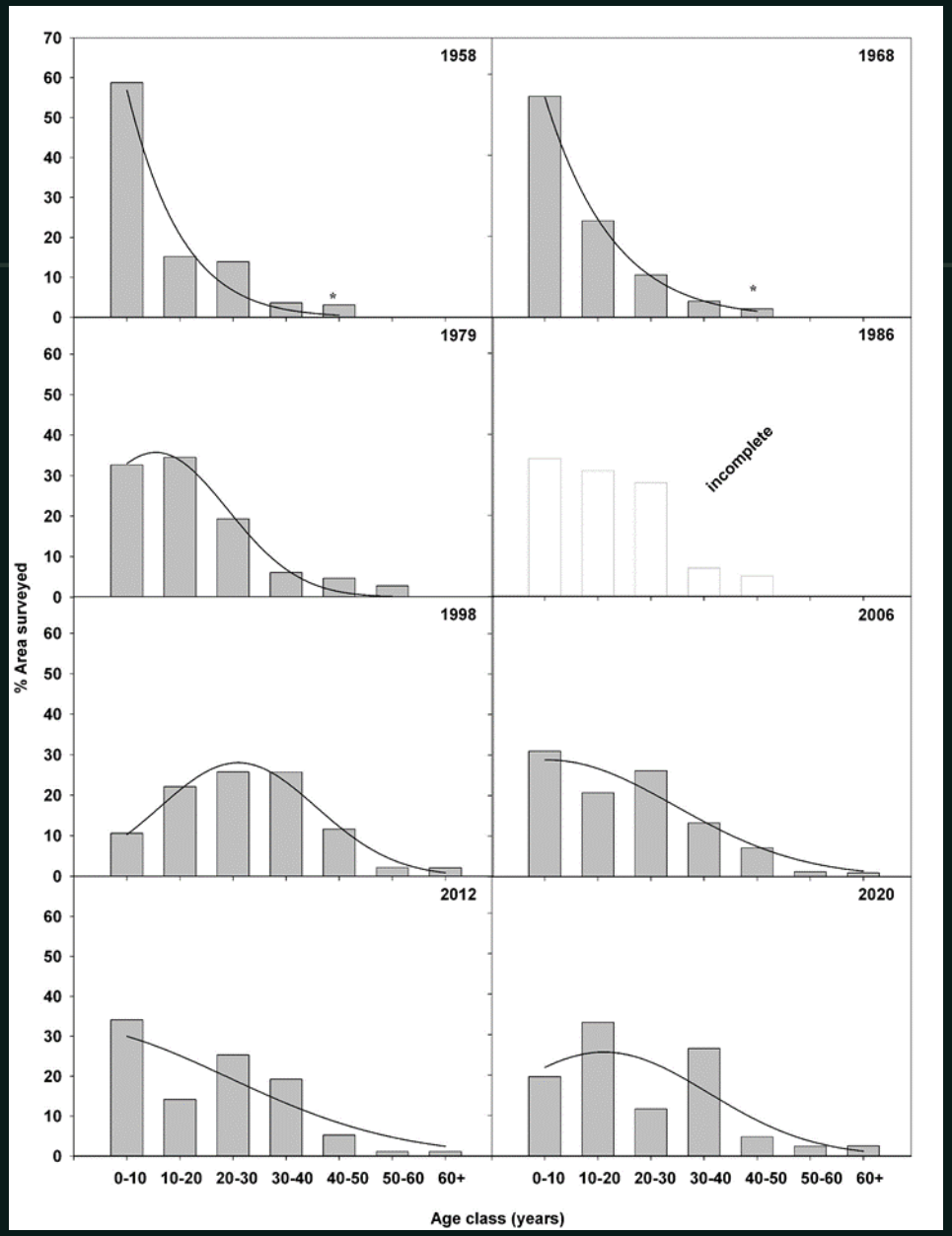
Forest growth and C capture declines after clearfell

High disturbance losses after replanting

All conifer forests afforested over period 1990 to 2020 due to be harvested in the next 20years (over 330,000 ha half the estate)

Typical for developing forestry sectors and results in natural fluctuations from sink to source

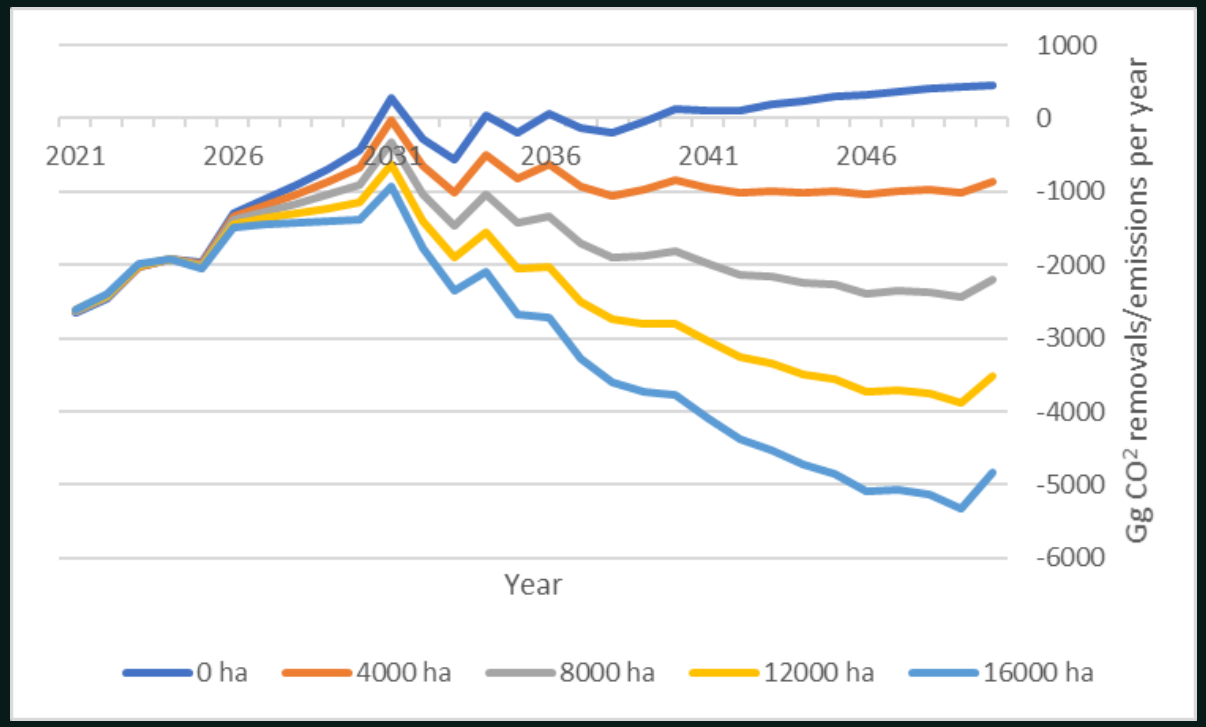
The bases for the forward looking base line (net-net accounting e.g. KP 2013-2020 EU LULUCF reg 2021-2025)



Black et al 2012

Model-Sensitivity

AFFORESTATION

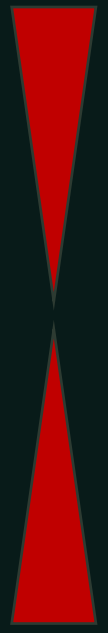


- Existing afforestation 1.4MtCO_2 emission from 2031-2050 or 0.5MtCO_2 by 2050
- Additional afforestation has a small short term but large long term impact
- Impact is dependent on:
  - Rate of afforestation
  - Species
  - Soils
  - Management options
  - Legacy afforestation rates and soils

Sensitivity- Modelled Forest management strategies

Climate change adaptation risk

High



High

Silvicultural pathways

Conifer short rotations
Max harvest of increment

Extend rotation age

CCF

Forests for nature

Long term retention

Climate change Mitigation potential

High disturbance emissions and high HWP storage (Short term residence time)

Low

High

High forest and soil C storage (long term residence time)

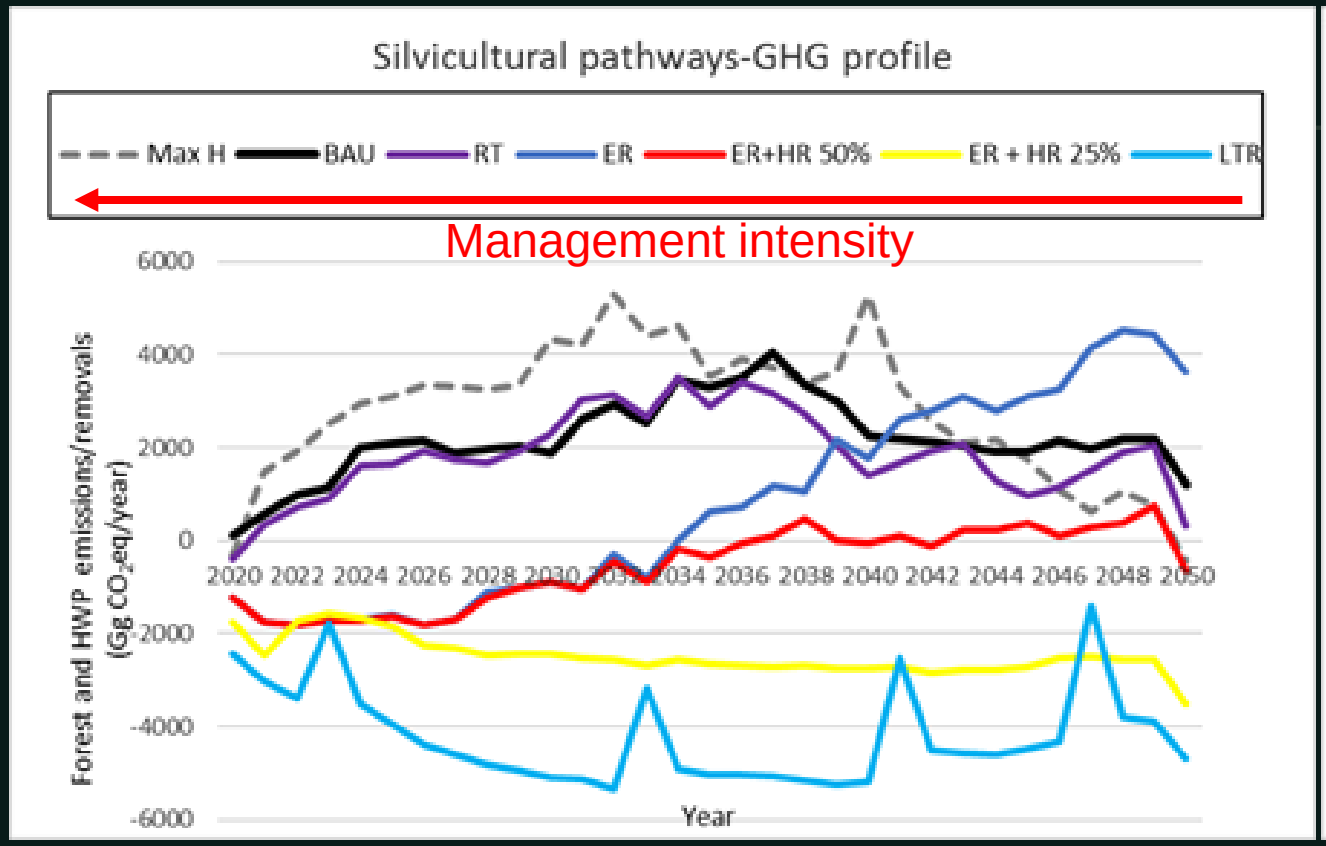
Management Intensity and timber production

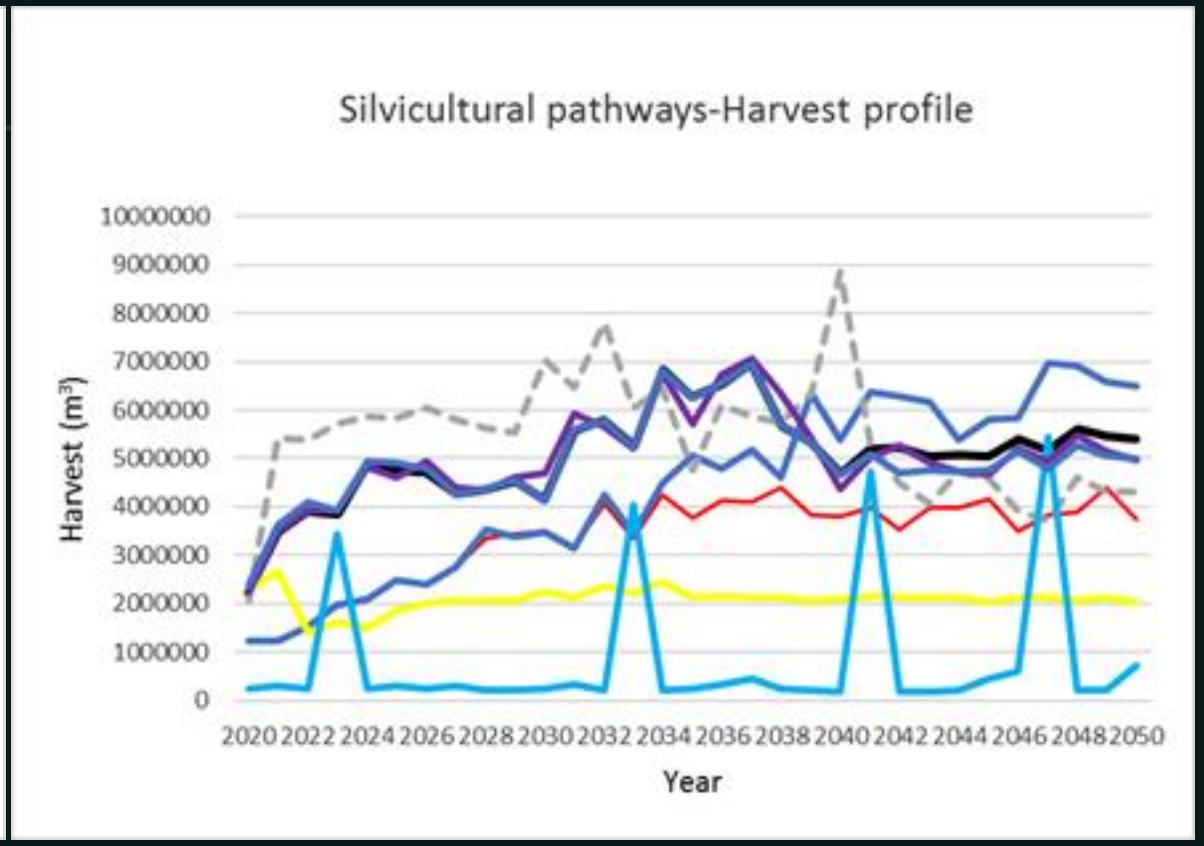
High

Low

Sensitivity

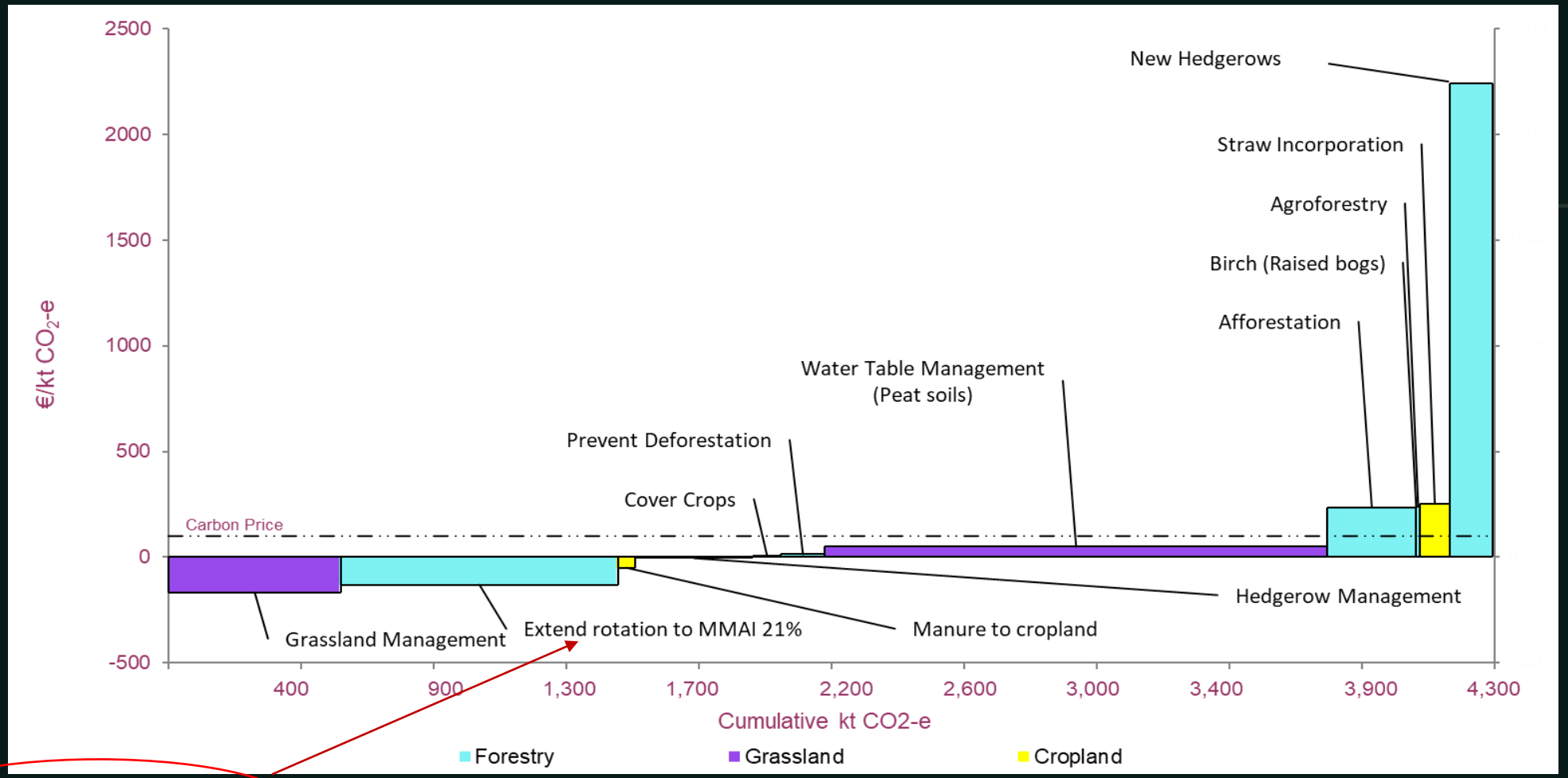
FOREST MANAGEMENT and NATURAL DISTUBANCES





- Max H- maximum harvest
- BAU- current silviculture
- RT- reduce thinnings (more no thin strategies)
- ER- extend rotation age
- HR- constrain harvest to 50 and 25% of increment
- LRT- long term retention (no harvest- high natural disturbance risk)

MACC-measures



Positive abatement

- Extend rotation age or conversion to CCF
- Conversion to native woodland (raised bogs)
- Avoid deforestation
- Afforestation/Agroforestry

Negative abatement

- Water framework (reduced productive area|)
- Rewetting of peatland forests
- Habitat constraints (Hen harrier)

Summary

- CBM fully compatible with GHGi
- Simulates all drivers in a dynamic manner
  - **No global or local economic drivers**
- Fully validated, provides confidence
- Afforestation, forest management and avoidance of deforestation can be considered
  - **Afforestation options**
  - **Long and short term measures**
  - **Alternative management pathways**
- Peatland forests?
  - **Rewetting (net emission)?**
  - **Alternative management strategy (Coillte 2023)**