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National Transport Authority

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Cycle propensity modelling: An extreme cycling uptake study

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Introduction

- Topic: Extreme cycling – what would Ireland look like if the population where as amenable to cycling as they are to walking and e-bikes were extremely popular
- Using strategic transport models to understand the likely “ceiling” for cycling
- Beyond realistic – more cycling modelled than present in the Netherlands, Denmark etc.
- Study to inform discussions – **not a forecast**
- Single mode study – we are not looking at cycling to public transport or the last mile problem, pure cycle trips
- Eastern and South Western Regions study areas for 2028 case study– allows comparison of potential for cycling uptake by level of urbanisation
- Modelling based research – high level results presented today

Introduction

- In transport modelling we try to quantify as many elements of the transport experience as possible in the *generalised cost of travel*
- Examples: Travel time, trip distance, fares, walking/cycling speeds, traffic congestion, public transport crowding, cycling infrastructure
- But important elements will remain uncaptured, due to data issues, personal preferences/experiences, and the strategic/geographic level of the model(s)
- Modelling accounts for these with a *Propensity or Alternative (mode) Specific Constant (ASC)*
- Examples: Perceived safety (distinct from infrastructure that may increase safety), Cultural perceptions, Tax incentives, Dutch style bikes, bike ownership

- A simple understanding of how we model any mode's utility/attractiveness is:

Quantified elements (generalised cost) + unquantified elements (propensity/ASC)

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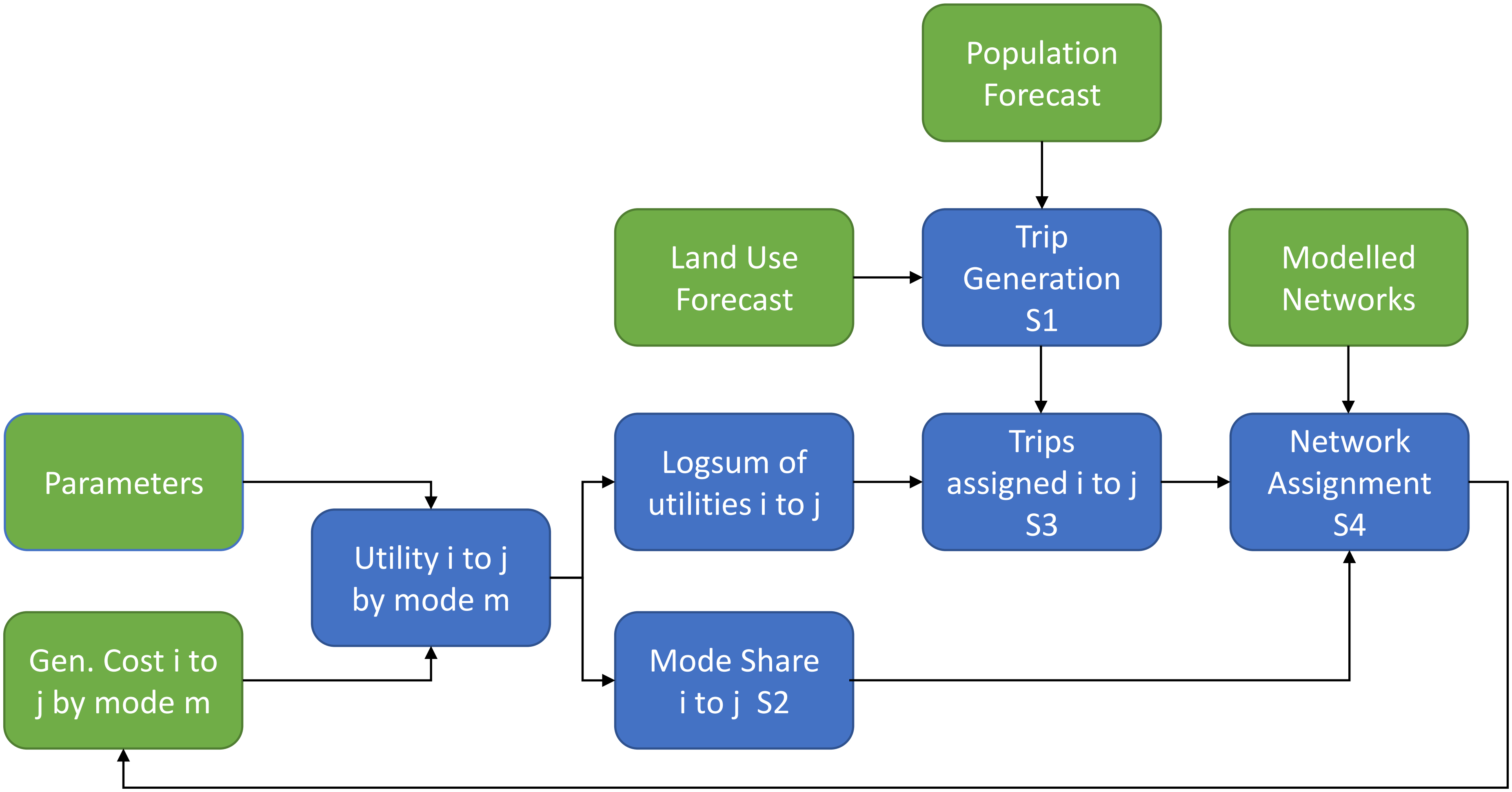
- The NTA Regional Modelling System (RMS) is a strategic transport model based on the classic four stage transport model
- The RMS covers:
  - 5 regions
  - 5 modes (road, PT, walk, cycle, park and ride)
  - 33 trip purposes
  - 11 million daily trips
  - Large modelled PT/walk/cycle/road networks
- Mode share estimation and trip distribution is undertaken via logit model (actually over 150 segment specific ones)
- Logit model parameters have been estimated from both the National Household Travel Survey and the CSO's POWSCAR dataset – Ireland specific parameters
- Models are run for multiple loops to account for factors such as parking distributions, public transport crowding, and congestion

NTA Model


Population Forecast
Land Use Forecast
Trip Generation S1
Modelled Networks
Parameters
Logsum of utilities i to j
Trips assigned i to j S3
Network Assignment S4
Utility i to j by mode m
Gen. Cost i to j by mode m
Mode Share i to j S2

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Mode choice utilities for trips are defined as:

$$U_{ijm} = \alpha GC_{ijm} + \beta \ln(GC_{ijm}) + IZM_m IZ + ASC_m$$

Where:

m is the mode from full set M of car, PT, PnR, walk, and cycle;

U_{ijm} is the modal utility for travelling between zones i and j by mode m;

α, β, IZM_m and ASC_m are the utility function parameters, as follows;

α and β are scaling parameters which determine whether the relationship between utility and generalised cost is (α) or logarithmic (β);

IZM_m is an additional cost applied only to intrazonal trips and is used to correct any underrepresentation of intrazonal generalised costs;

ASC_m is the alternative specific constant and represents unquantified costs for that mode[22];

$GCijm$ is the generalised cost for travelling between zones i and j by mode m; and

IZ is a Boolean flag which is 1 if $i = j$ and 0 elsewhere.

The calculation of generalised cost is different for each mode. Further information on the derivation of generalised costs can be found in Sections 6.14, 7.9, 8.8 and 9.6.

Mode choice probabilities for trips are defined as:

$$P_{m|ij} = \frac{e^{-\lambda_M U_{ijm}}}{\sum_{m \in M} e^{-\lambda_m U_{ijm}}}$$

Where:

$P_{m\,|\,ij}$ is the probability of traveling by mode m between zones i and j; and

$\lambda_M > 0$ is the mode choice spread parameter.

Need for Cycle Propensity

Why do we need to look at changes to cycle propensity?

- Strategic models (historically) don't model cycle parking, safety perceptions, cycle share schemes, bike to work incentives, and other important factors
- Models are only really valid within their estimation bounds – we have all types of road traffic conditions in Ireland (and hence in our estimation data), but we don't have observations from areas with continuous high quality cycling infrastructure (Ireland doesn't yet have Dutch levels of infrastructure)
- Response beyond a certain point is unknown (from a modelling perspective)
- Cycling uptake in the future may be non-linear, current conditions don't provide enough information

“Extreme” Cycling Runs

We wanted to know what are the **limits** of cycling

- Where will the uptake occur?
- What is the maximum mode share (by trips and kilometres)?
- What modes might these trips transfer from?

Idea:

- We have estimated propensities for all modes in the models
- **What if people we as amenable to cycling as they are to walking?**
- Still accounts for the physical effort and exposure to the weather
- Simply assign cycling the propensity/ASC estimated for walking
- Add on 5 gen. mins. to account for locking bike, getting it out of the shed, putting on a helmet etc. – just a judgement call
- Increased cycling speed by 4 kph to model e-bike uptake (+2 kph)/improved infrastructure (+2 kph) – cycling retains large speed advantage over walking
- No other changes to the networks (car or public transport)

Parameters

L	M	N	O	P
ASC_Car	ASC_PuT	ASC_PnR	ASC_Wlk	ASC_Cyc
-4.7345	25.9545	16.6354	3.2851	37.8648
-6.159	17.9565	14.4004	3.6724	43.8801
99	-21.107	99	-84.5084	59.6317
99	-40.5145	99	-60.8846	110.9743
-11.8491	14.38315	99	4.5576	19.81945
-1.6548	-1.4269	99	-4.0605	20.2977
8.0931	19.1799	99	-47.5707	16.6857
99	-14.521	99	-35.6396	35.4471
99	-35.3537	99	-50.9451	68.407
86.9108	-11.8665	99	-253.536	9.2348
-1.4993	99	99	18.7102	99
0.0384	99	99	17.1725	99
0.0523	99	99	17.1586	99
99	-14.943	99	-16.174	33.0353
99	-21.9499	99	-29.1661	48.0888

L	M	N	O	P
ASC_Car	ASC_PuT	ASC_PnR	ASC_Wlk	ASC_Cyc
-4.7345	25.9545	16.6354	3.2851	8.2851
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99	-40.5145	99	-60.8846	-55.8846
-11.8491	14.38315	99	4.5576	9.5576
-1.6548	-1.4269	99	-4.0605	0.9395
8.0931	19.1799	99	-47.5707	-42.5707
99	-14.521	99	-35.6396	-30.6396
99	-35.3537	99	-50.9451	-45.9451
86.9108	-11.8665	99	-253.536	-248.536
-1.4993	99	99	18.7102	23.7102
0.0384	99	99	17.1725	22.1725
0.0523	99	99	17.1586	22.1586
99	-14.943	99	-16.174	-11.174
99	-21.9499	99	-29.1661	-24.1661
99	45.7132	99	-17.0294	-12.0294

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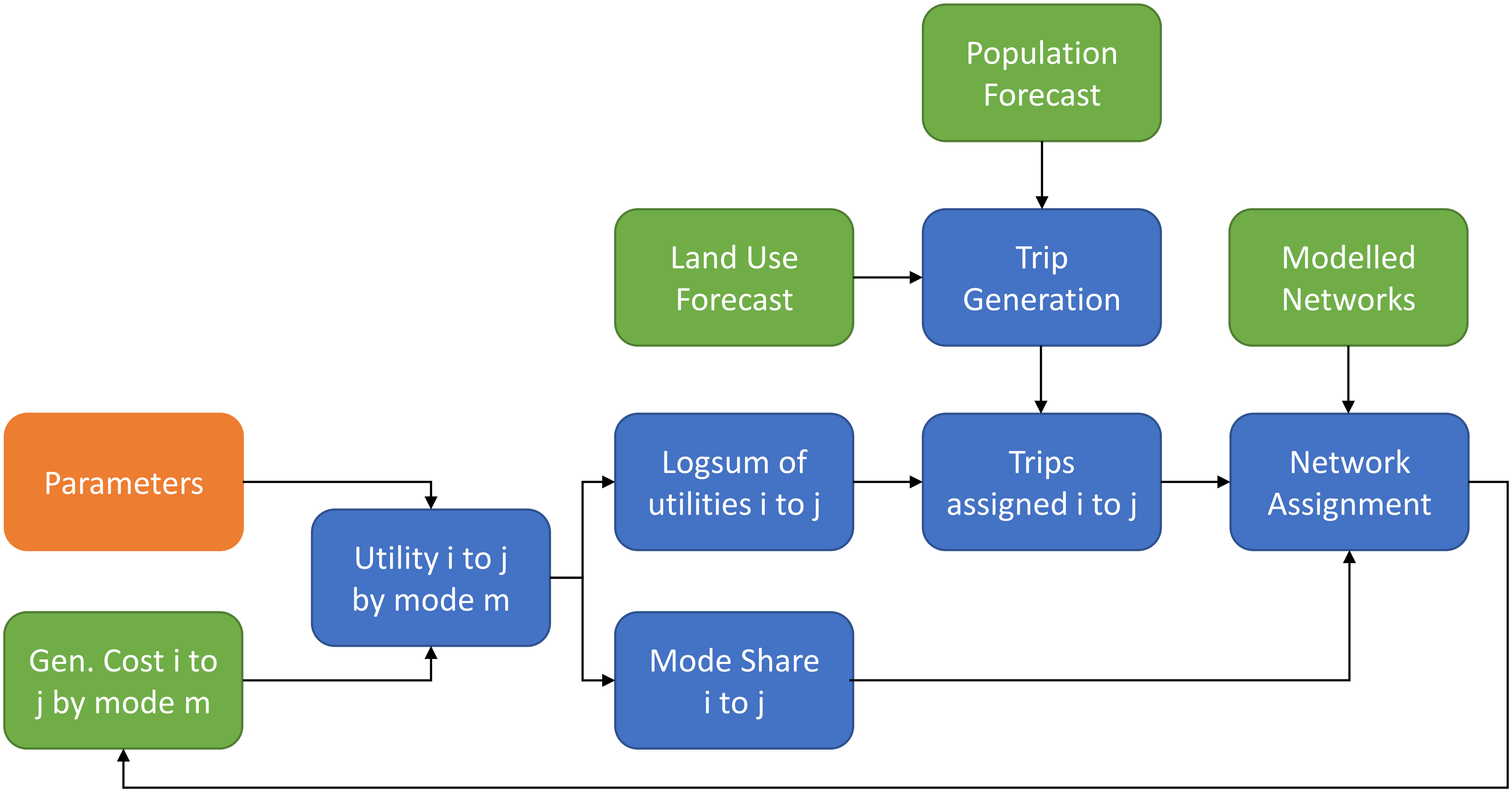

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Gen. Cost i to j by mode m
Mode Share i to j

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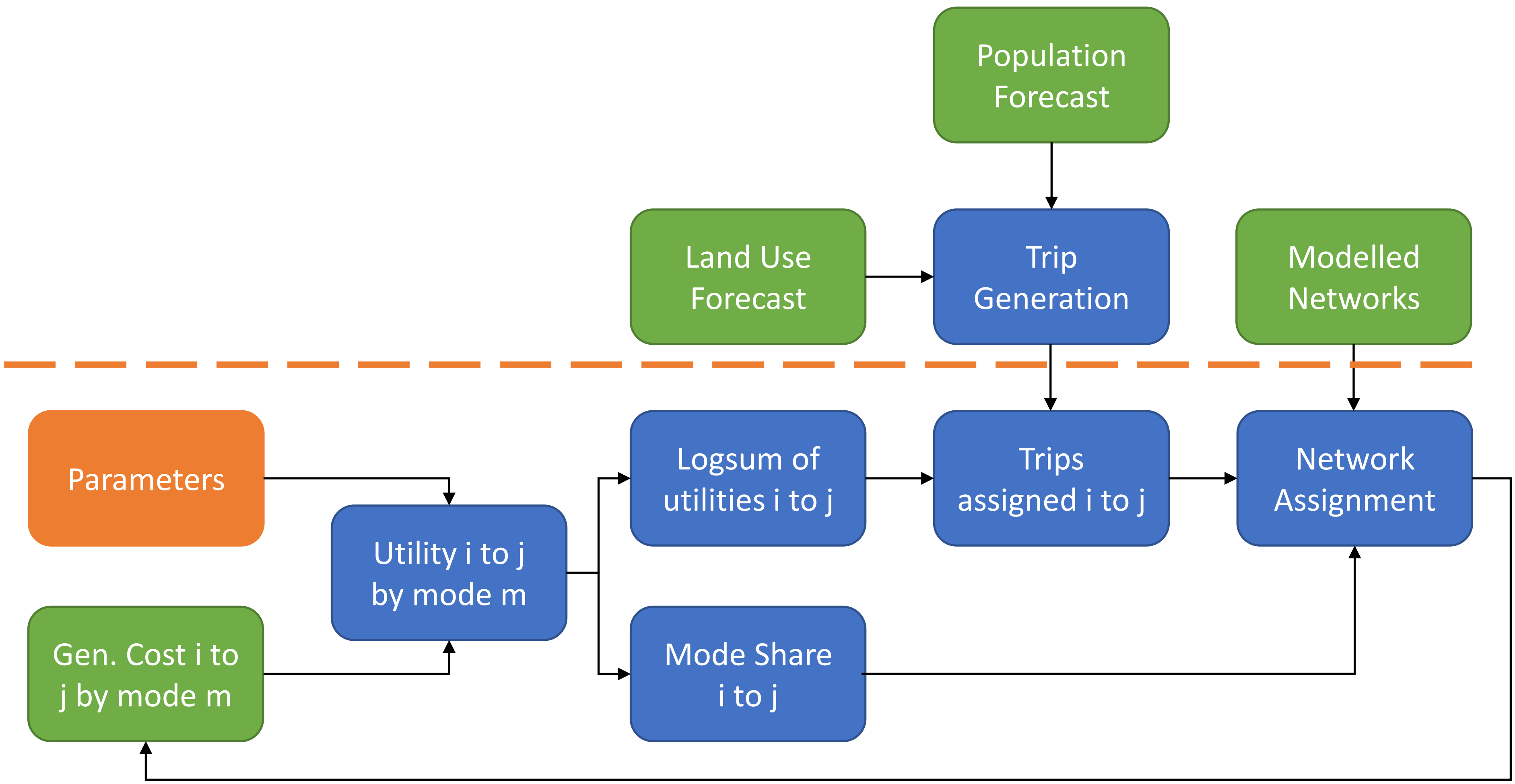

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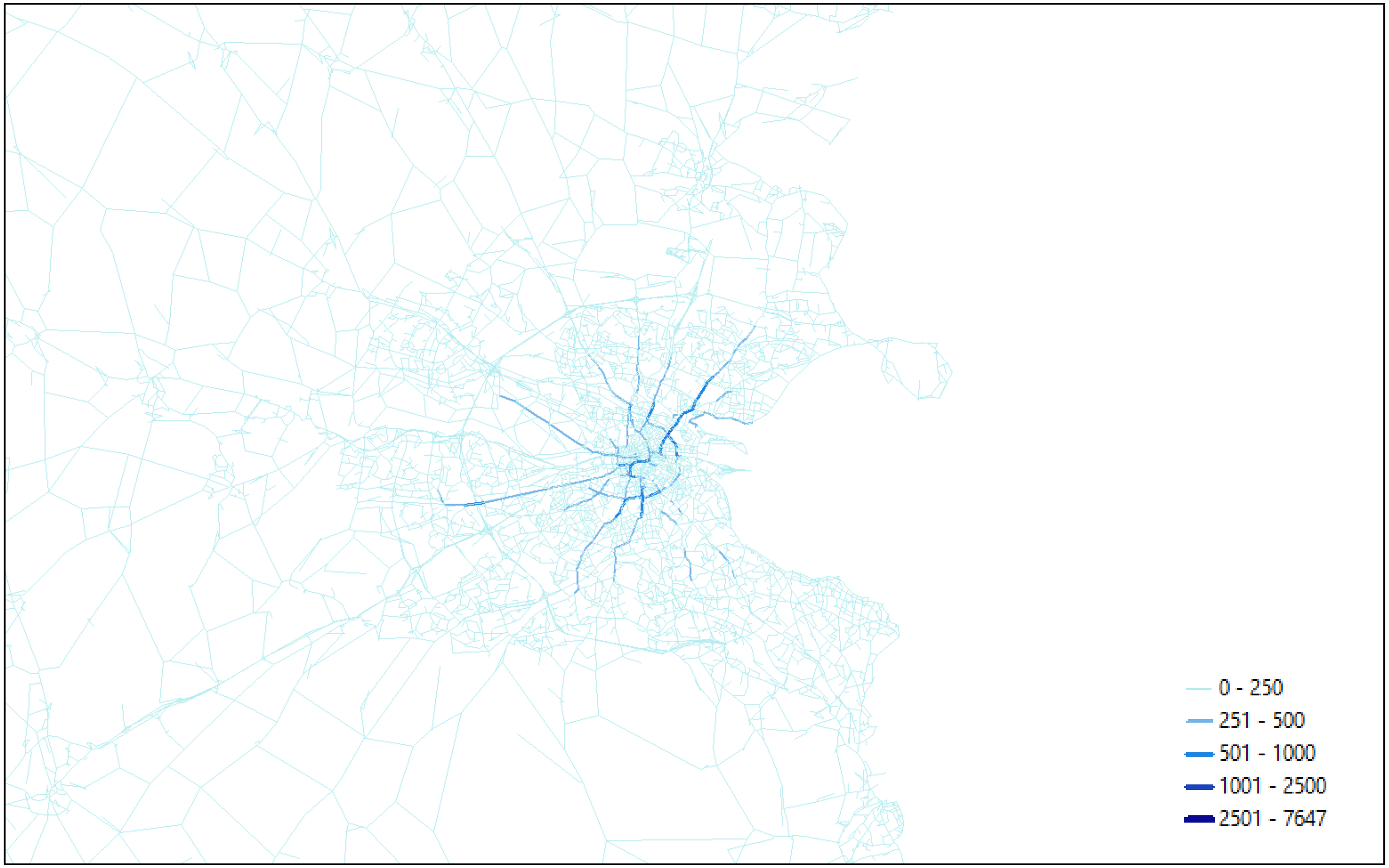
“Extreme” Cycling Runs

What is the advantage of this approach:

- Increase propensity to cycle – creates higher mode share
- But still account for
  - Land use
  - Trip lengths
  - Segment and trip purpose specific values of time and cycling speeds
  - The presence of competing modes
  - The role of car availability and car parking
- Mode share and trip distributions change between each origin and destination, capturing the heterogeneity of the response to increased cycling uptake
- Note:
  - No changes to the car network is made, this is simple a “carrot” approach
  - Cycle to public transport/transit is not currently included in the model (scoping currently underway)

AM Cycle Flows



Note: scaled to extreme cycle levels

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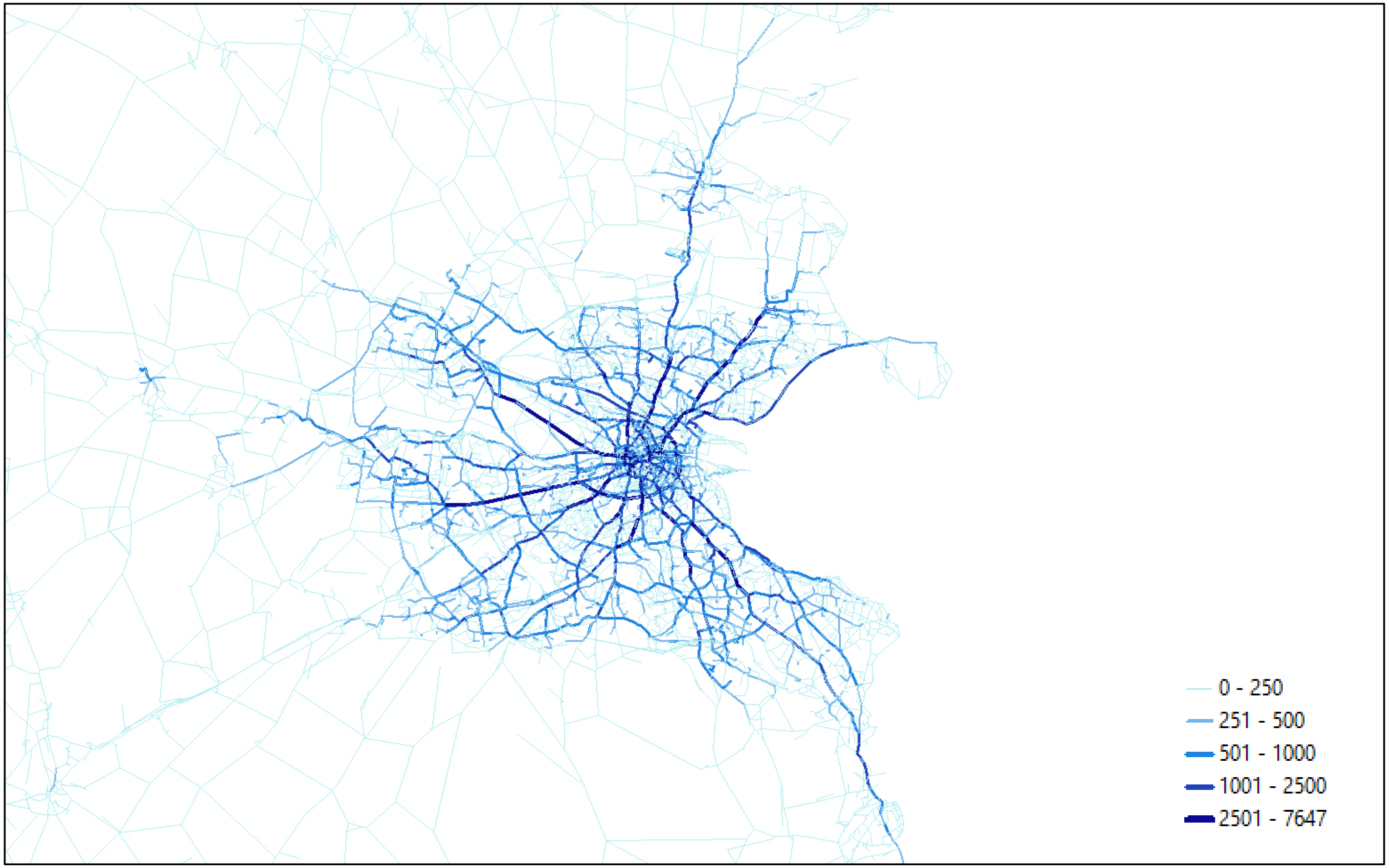

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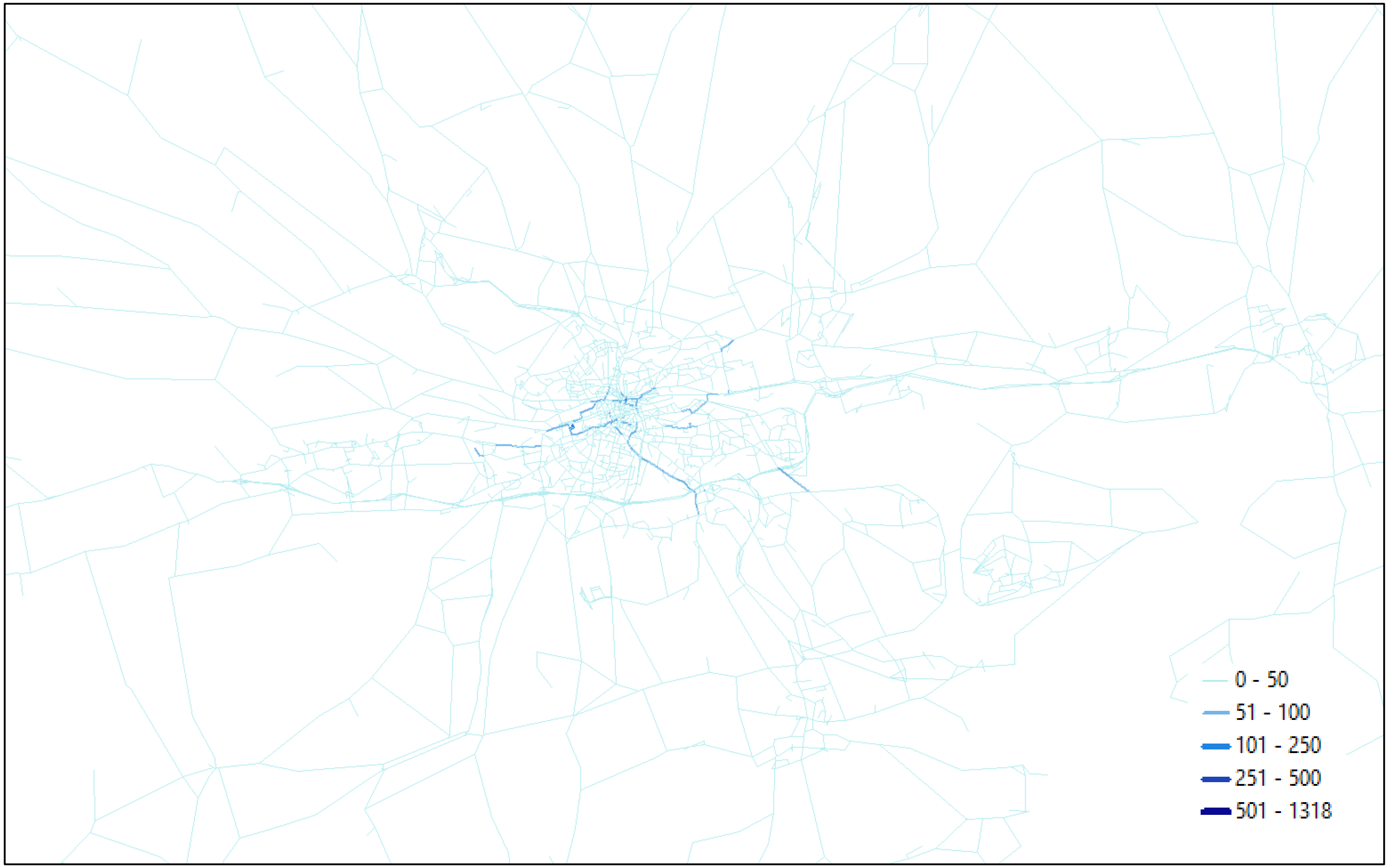

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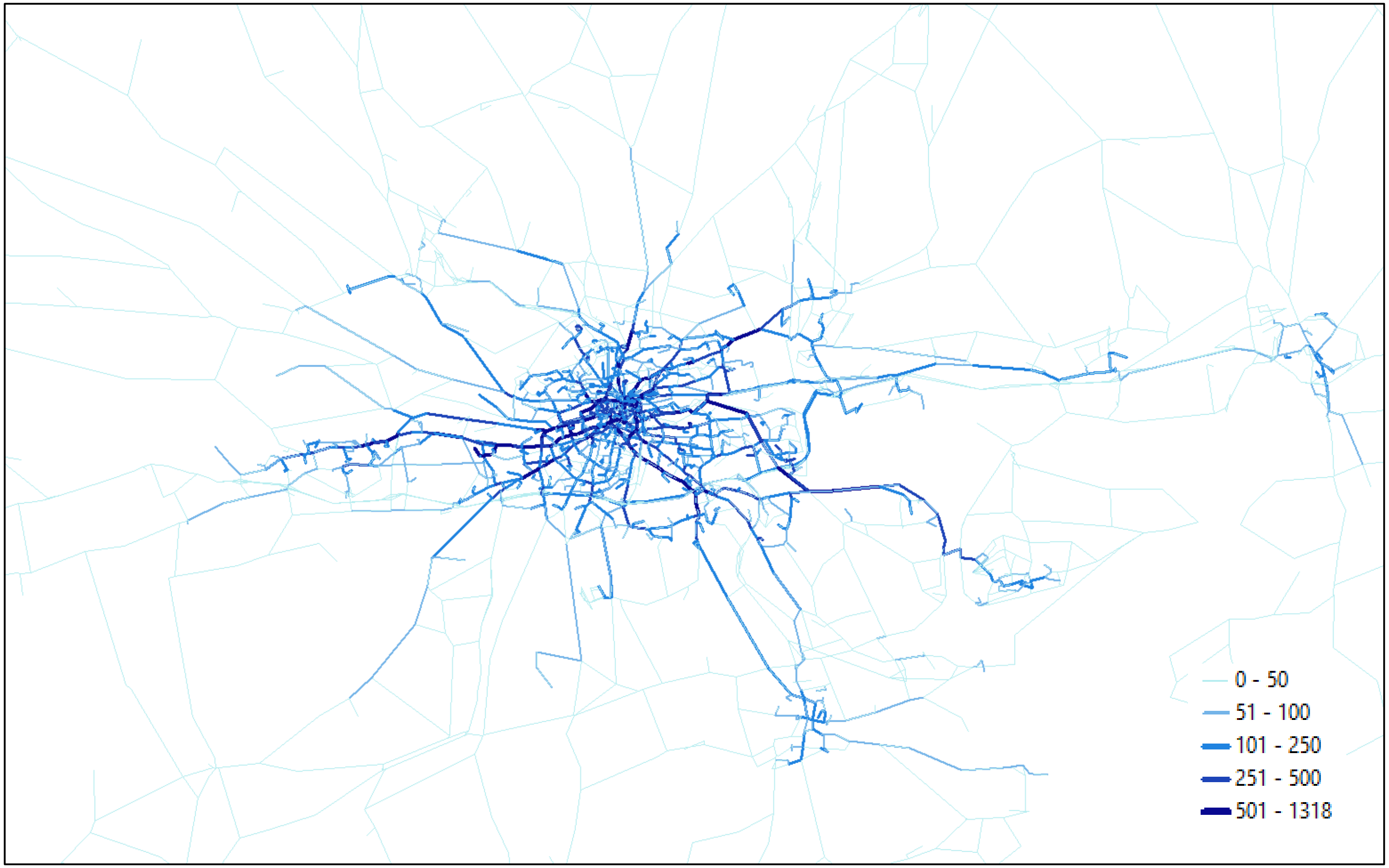
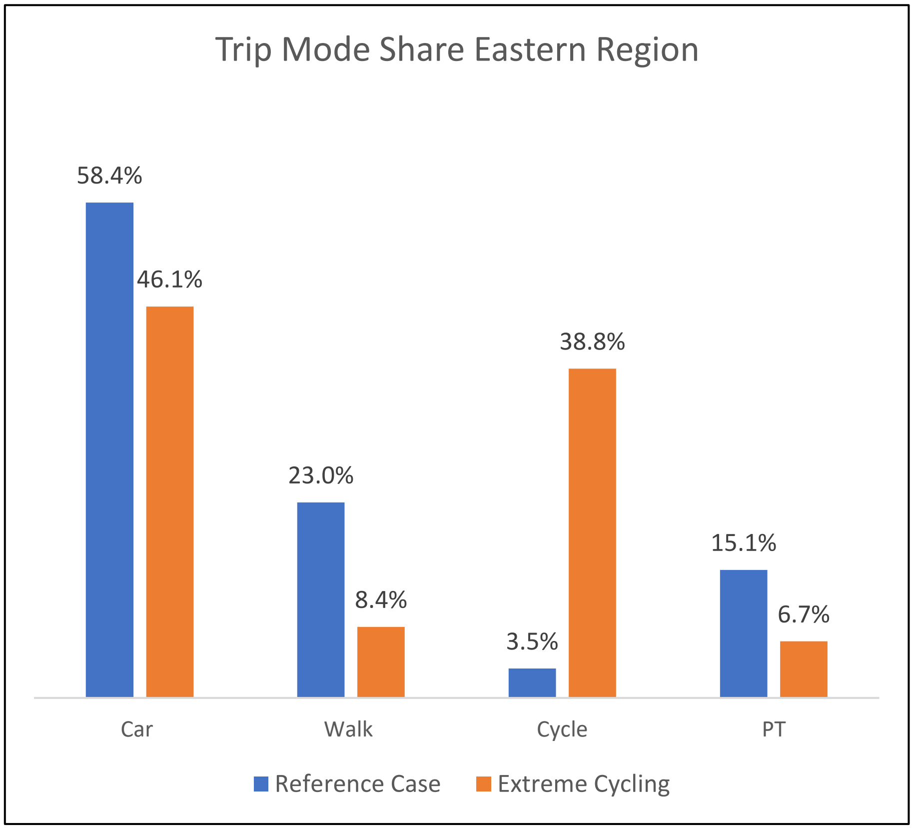
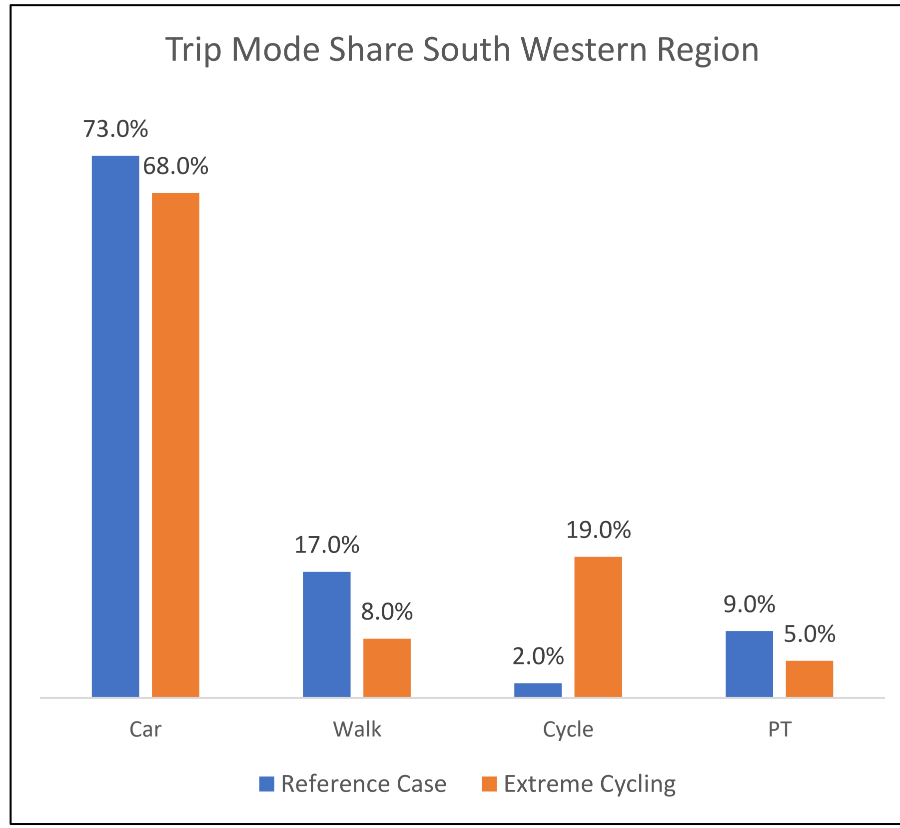
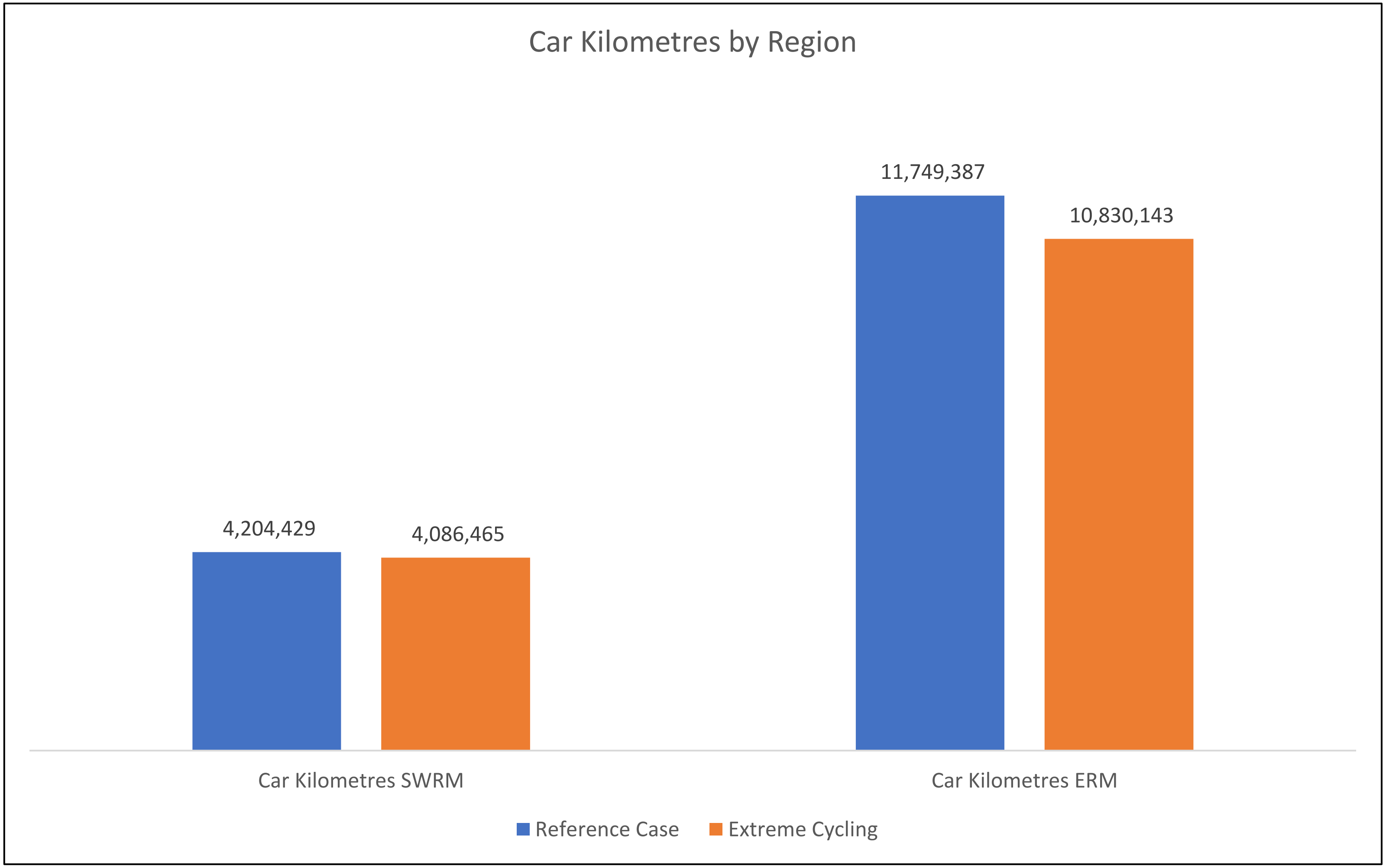


Mode Shares Trips

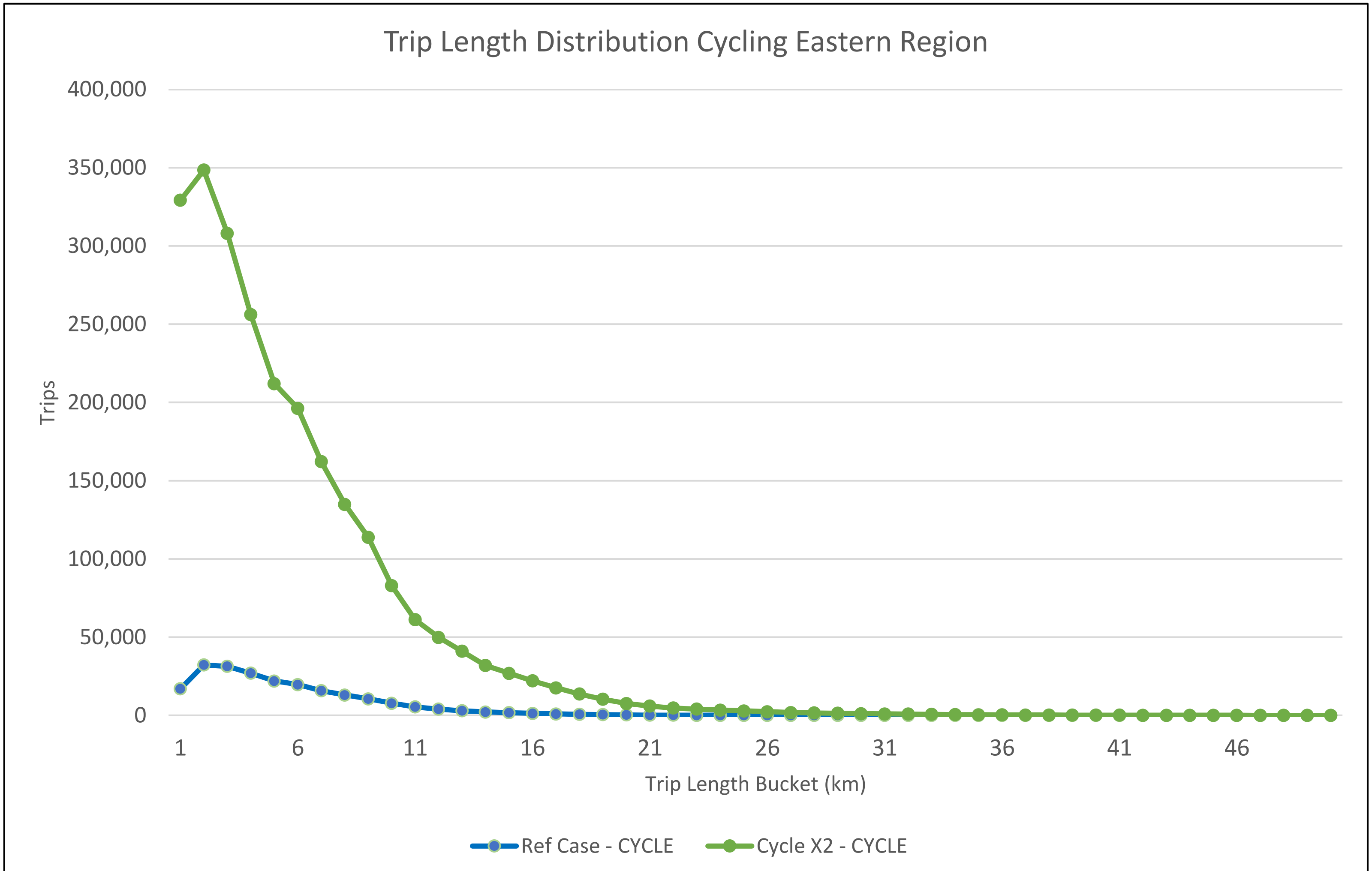




Car Kilometres



Trip Length Distributions



Sense Check

[Cycling facts: new insights | Brochure | Netherlands Institute for Transport Policy Analysis (kimnet.nl)]

Figure 1: *Division of number of trips per transport mode*[1]

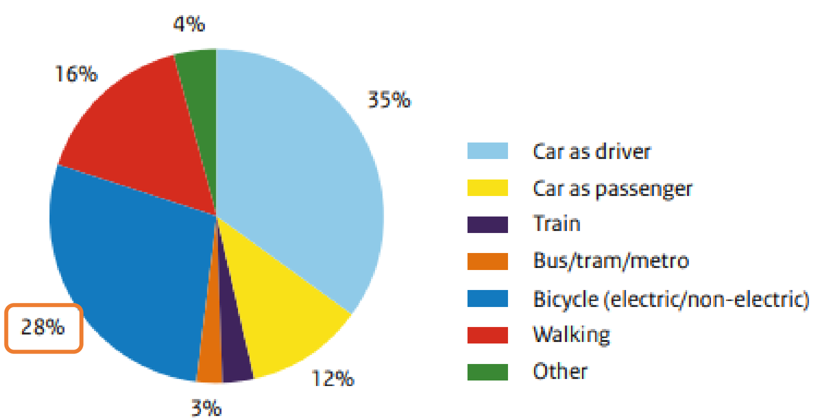
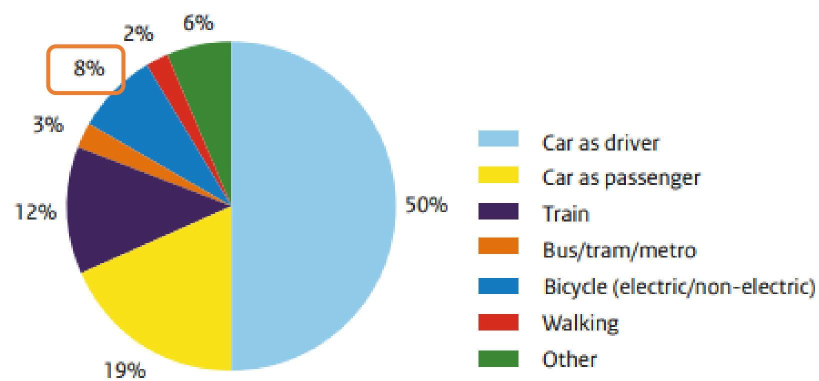


Figure 2: *Division of distance travelled per transport mode*[1]



Conclusions

- These tests are designed as sensitivity tests/discussion points, and are NOT forecasts based on interventions
- Are they realistic – no, probably not - but still useful – absolute outer bound
- Modelled levels of cycling greatly exceed even Dutch levels
- Cycling, even with e-bike adoption, is largely restricted to trips below 20km
- Mode share can be viewed from a either a trip or kilometres travelled perspective
- Large shifts seen from all modes by trip (especially walk and PT)
- Mode shift will depend upon the competitive advantage of respective modes
- Dispersed settlement and land-use patterns pose a major challenge for cycling's ability to tackle kilometres driven/emissions reduction
- Next steps – modelling increased accessibility and mobility impacts of increased cycling, as well as further analysis of emissions reduction potential

Thank you

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Any Questions?