Quantifying the future, transport–related impacts of land use policies for Cambridge, UK

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Research Projects

- **SOLUTIONS (S**ustainability **O**f **L**and **U**se and **T**ransport **I**n **O**uter **N**eighbourhood**S**)
  - Design, development and testing of city-scale land use and transport options at the neighbourhood Level
  - Case-study driven (London & South-east, Tyne & Wear, Cambridge)
  - See: http://www.suburbansolutions.ac.uk
- **ReVISIONS (RE**gional **V**isions of **I**ntegrated **S**ustainable **I**nfrastructure **O**ptimised for **N**eighbourhoods**)**
  - Expansion of SOLUTIONS into the regional level
  - Include water, waste and energy sectors
  - Include air-quality (and other) transport indicators
  - See: http://www.regionalvisions.ac.uk/ReVISIONS/Home.aspx
- Both projects funded by UK Engineering and Physical Sciences Research Council (EPSRC)

SOLUTIONS Scenarios (1)

- ***Baseline 2001 scenario***

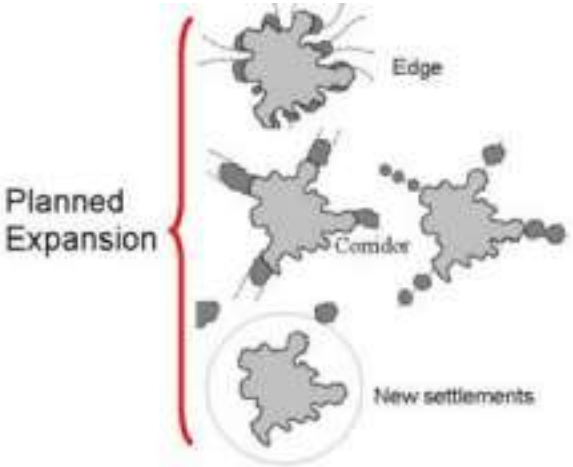
- ***Business As Usual (Trend) scenario to 2021***
  - *Existing policies extrapolated*
  - *Mixture of public and private transport improvements*
  - *Favour public transport provision over highway improvements*

- ***Urban Compaction to 2021***
  - *High density living within existing urban footprint*
  - *Target central areas and public transport*

Solutions Scenarios (2)

- ***Market Dispersal to 2021***
  - *Market-driven development at medium to low density*
  - *Private transport oriented*

- ***Planned Expansion to 2021***
  - *Planned extensions of existing developments*
  - *Some new settlements*
  - *Target areas with strong employment growth*
  - *Mixture of public and private transport provision*



- ***Road User Charging (RUC) to 2021***

Cambridge Region

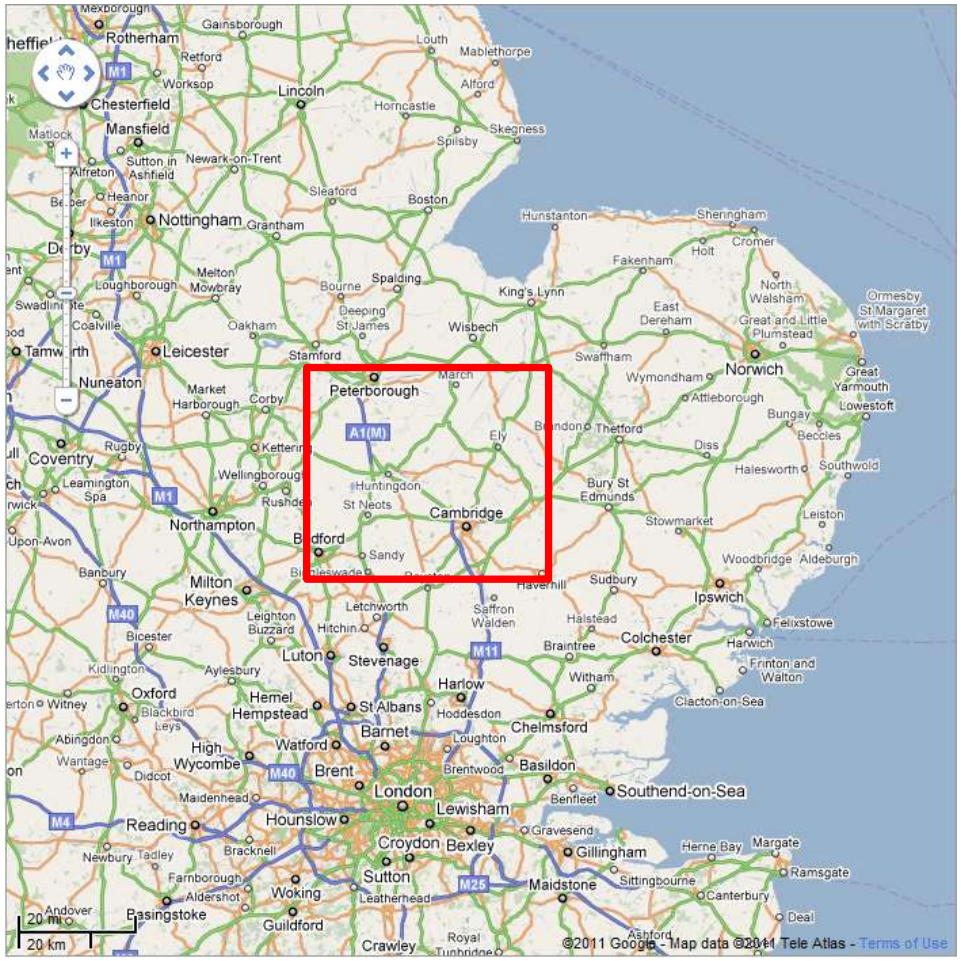
Cambridgeshire, UK

- *Situated: 50km NNE of London*
- *Area: 3,389 km^2*
- *Population: 770,000 (2001 Census)*
- *Population density: 227 / km^2*
- *County town: Cambridge*

Cambridge

- *Area: 116 km^2*
- *Population: 108,863 (2001 Census)*
- *Famed for 2nd oldest University in the English-speaking World*
- *Population includes: 22,000 students*
- *Recent growth in high-tech industries*

(Sources: UK Office for National Statistics, Cambridgeshire.gov.uk, and Wikipedia)



(Sources: Google Maps, Tele Atlas)

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Current Situation

UK Targets for CO_2 reduction

- *34% reduction by 2020 on 1990 levels*
- *80% reduction by 2050 on 1990 levels*

Cambridge AQMAs

- *Cambridge City Centre and Cambridge-Huntingdon Corridor*
- *7 areas declared for NO_2 and 1 for PM_{10}*
- *Cambridge (and UK-wide) issues with calculated NO_2 concentrations not matching expected reductions*
- *UK as a whole likely to be fined by the EU for not meeting AQ targets – Central government likely to pass fines on to local authorities*

(Sources: Cambridgeshire.gov.uk – Local Transport Plan 3, Images: traveladvisor.co.uk and Cambridgeshire County Council)

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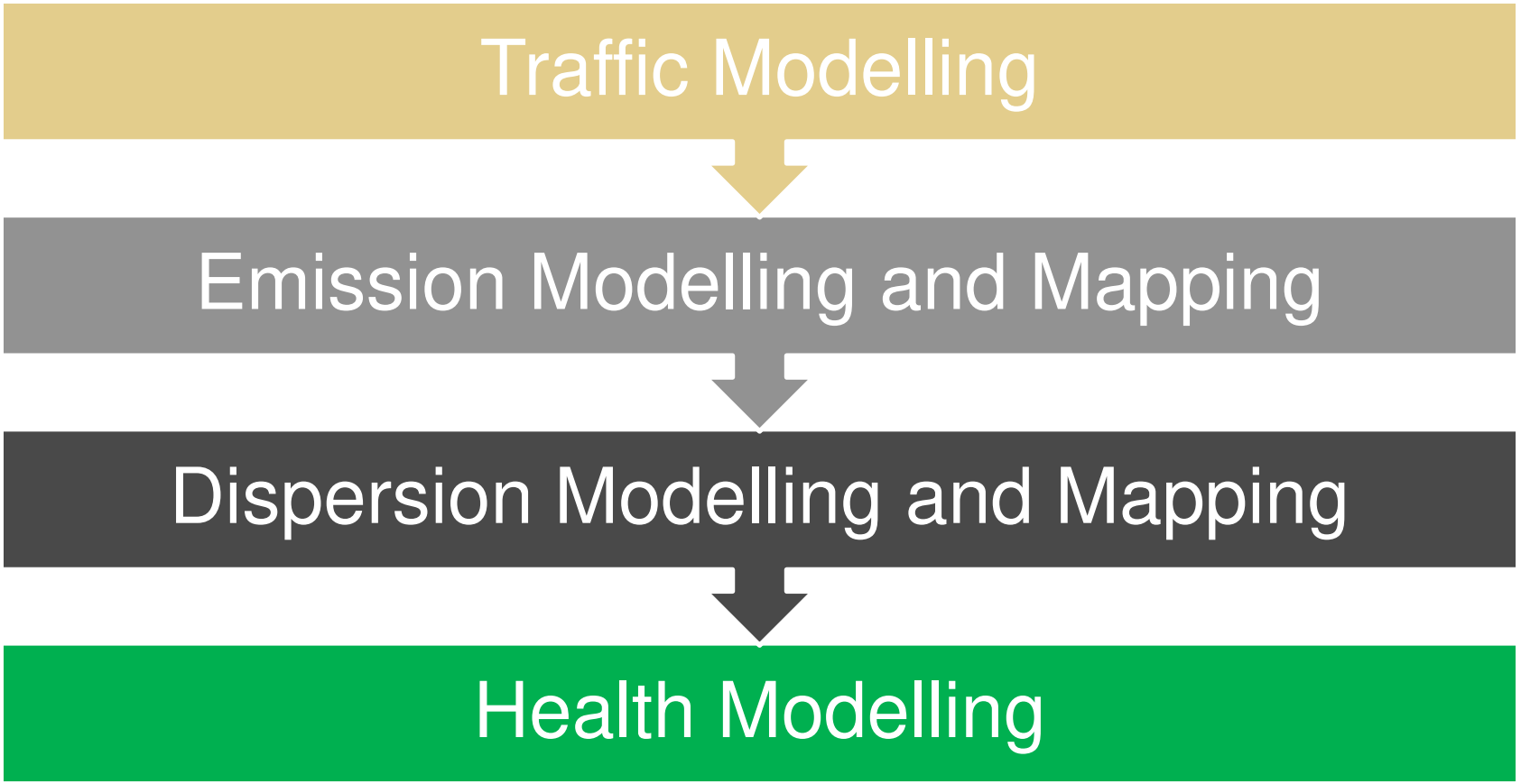
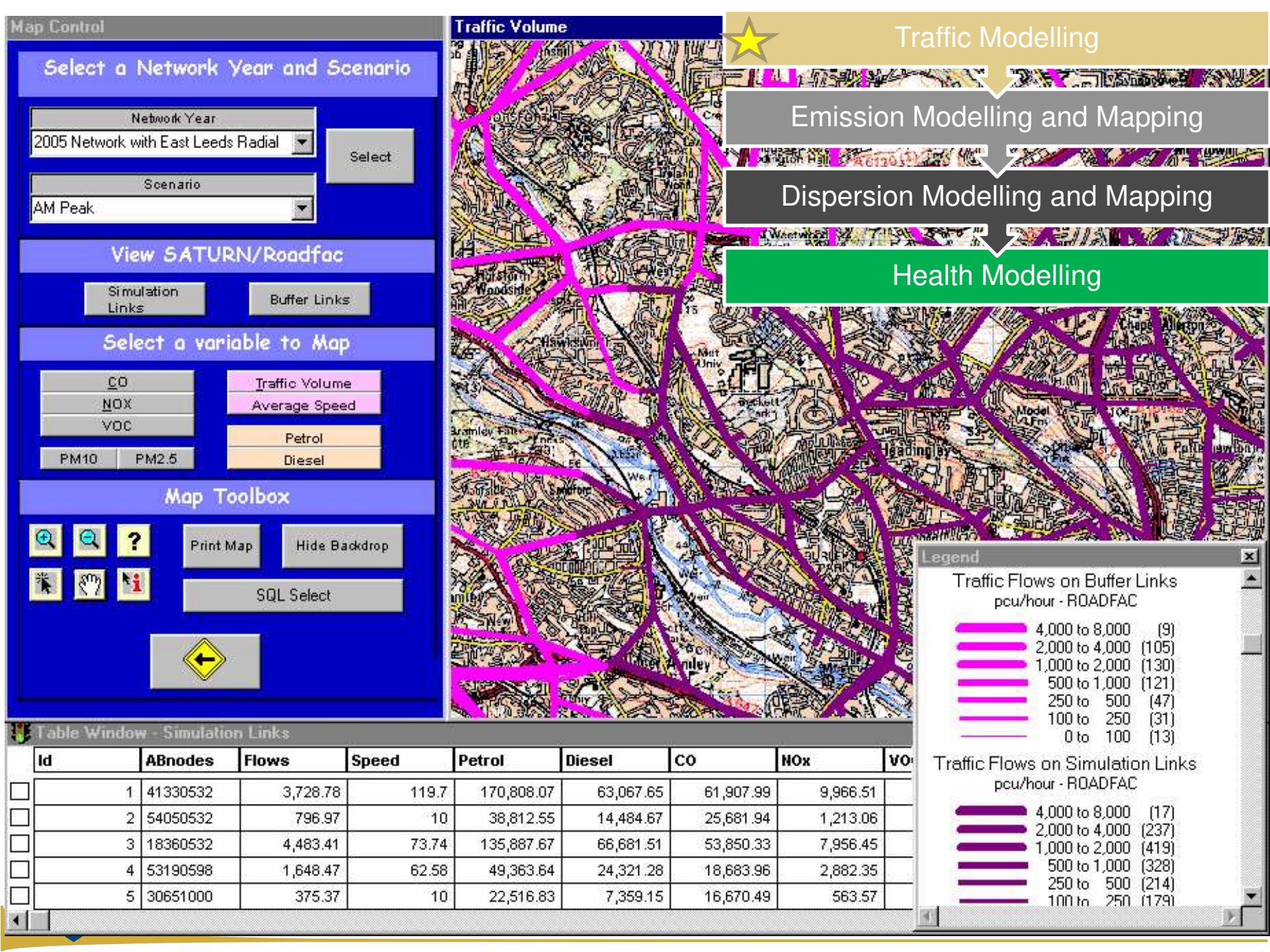
MODELLING TOOL

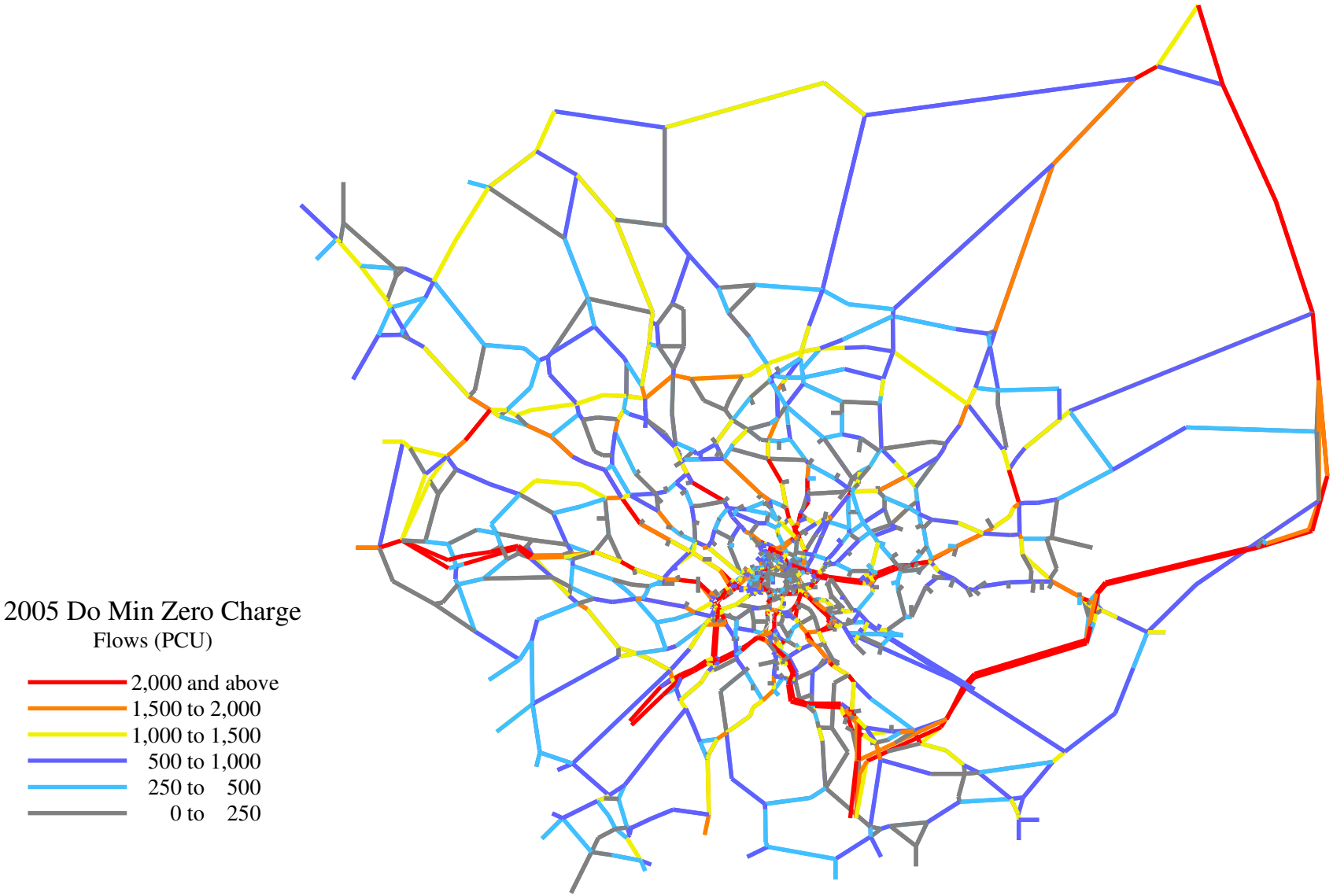
PITHEM (Platform for Integrated Traffic, Health and Emission Modelling)



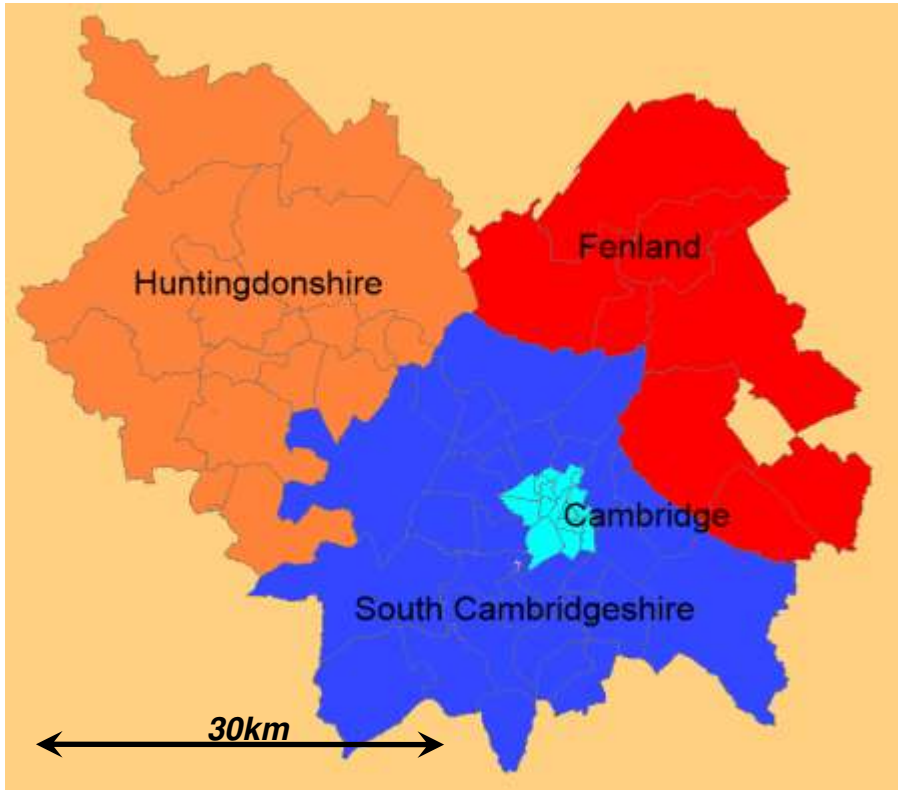


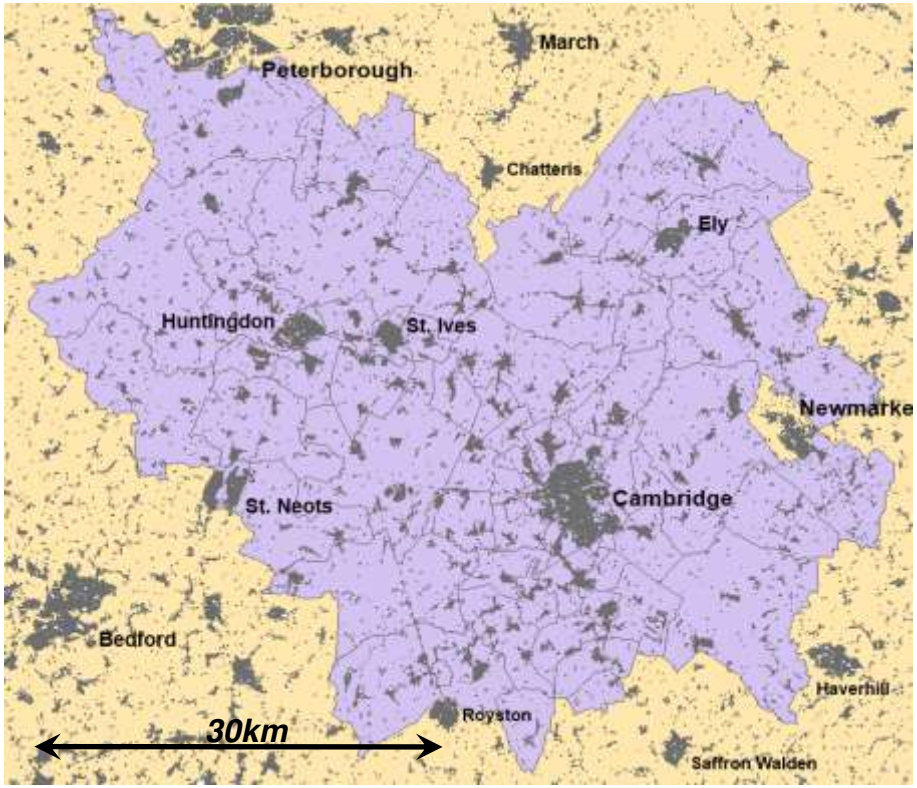
Id	ABnodes	Flows	Speed	Petrol	Diesel	CO	NOx	VO
1	41330532	3,728.78	119.7	170,808.07	63,067.65	61,907.99	9,966.51	
2	54050532	796.97	10	38,812.55	14,484.67	25,681.94	1,213.06	
3	18360532	4,483.41	73.74	135,887.67	66,681.51	53,850.33	7,956.45	
4	53190598	1,648.47	62.58	49,363.64	24,321.28	18,683.96	2,882.35	
5	30651000	375.37	10	22,516.83	7,359.15	16,670.49	563.57	

Vehicle flows (PCU/hr)



LUTI Model Zones





67 Internal Zones in 4 Administrative areas

14 Zones in Cambridge City

10 External Zones for rest of UK

Major built-up areas in grey

Peterborough UA (NW) : pop. 160,000 (2001)

Bedford (WSW) : pop. 147,000 (2001)

Other towns : pop. 7,000 – 26,000

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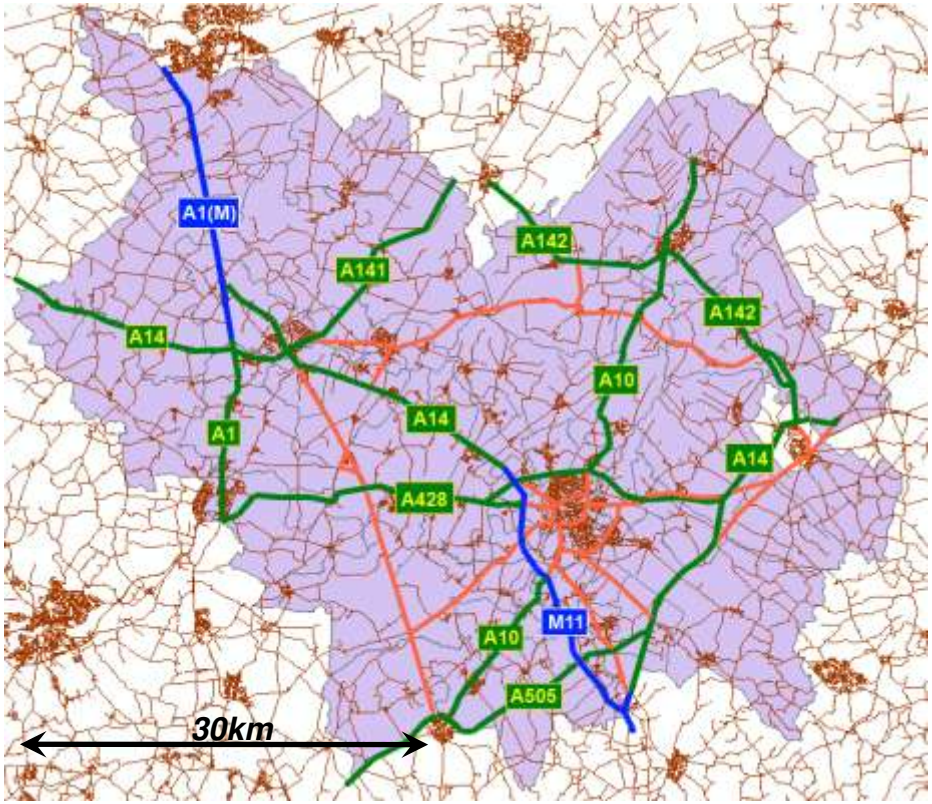
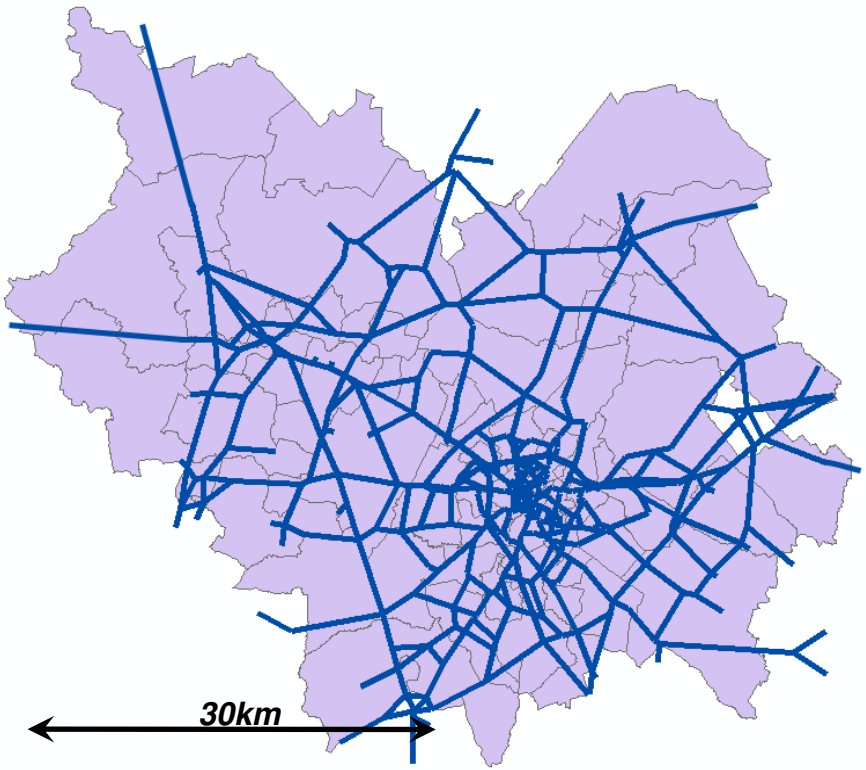
Road Transport Network





Actual Road Network:
Motorway (Blue), Primary 'A' Roads (Green), Secondary 'B' Roads (Brown), Other (Red)

Modelled Road Network:
SATURN Software
(https://www.saturnsoftware.co.uk/7.html)

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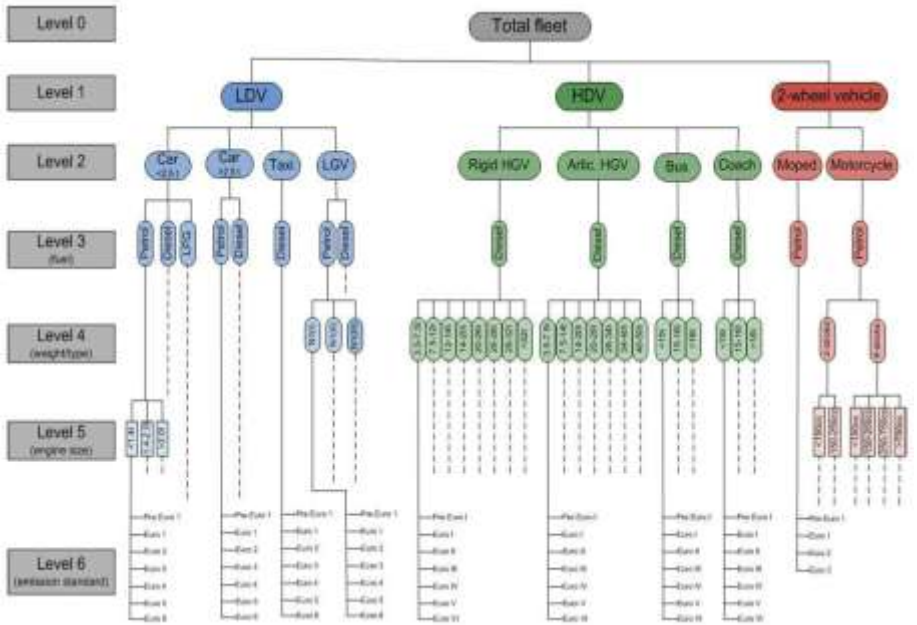
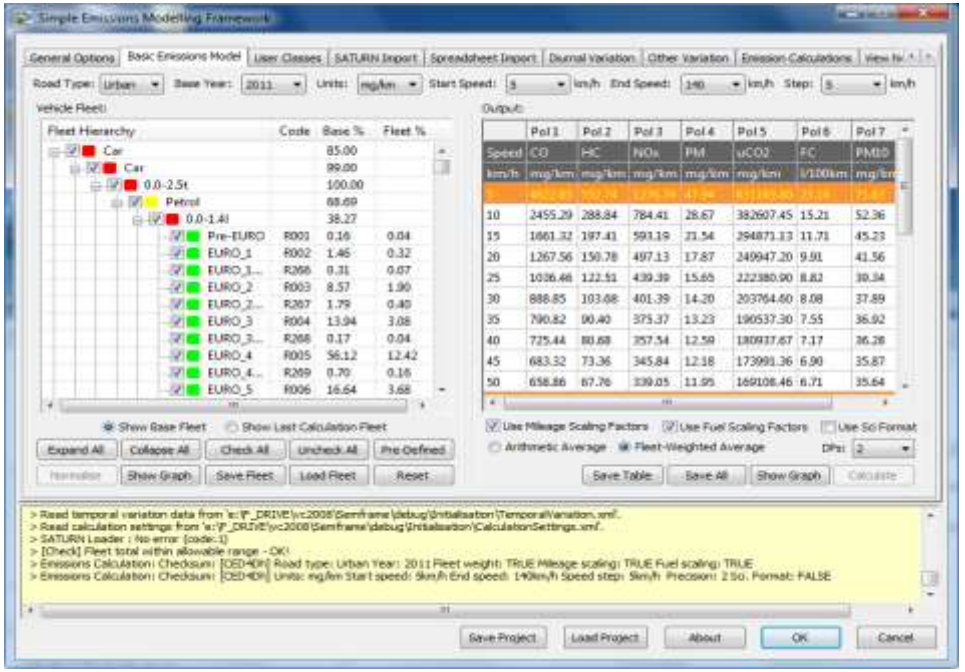
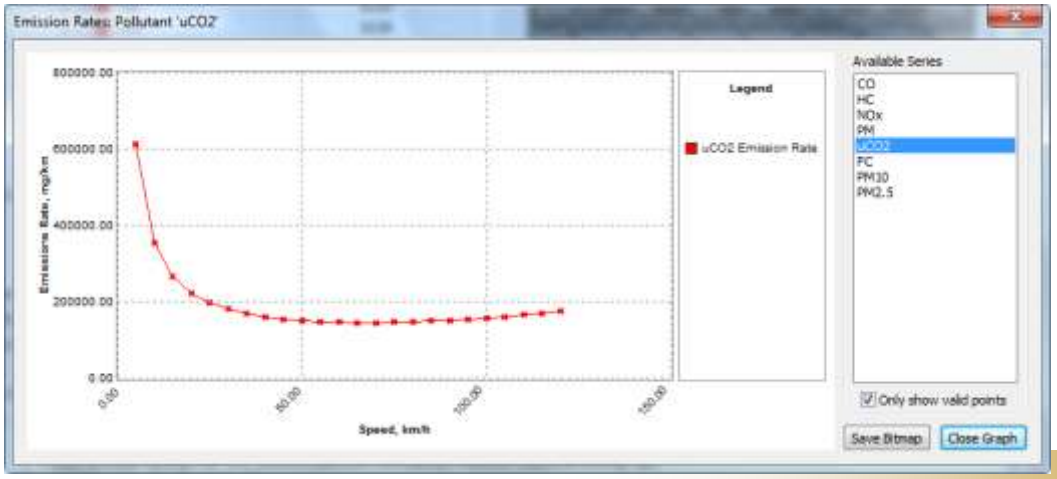
Emissions Modelling (1)

- ***Based on UK emissions inventory***
  - *Speed-emissions curves* *(Source: DfT/TRL, 2009 – Regulated Emissions, AQEG, 2005 – Particulate Matter)*
  - *Hierarchical model of vehicle classes* *(Source: TRL, 2009)*
  - *Fleet Projections from 1996 to 2026* *(Source: DfT/AEAT, 2009 – National Fleet Projections)*
- ***Scenarios modelled using:***
  - *Flows and speeds from SATURN model* *(Source: SOLUTIONS Project)*
  - *Peak-period data scaled to Weekday, Saturday and Sunday traffic* *(Source: UK National Transport Statistics, DfT, 2011)*
  - *In-House software PITHEM used*

Emissions Modelling (2)







- *Top Left: Fleet Hierarchy (source TRL, 2009)*
- *Top Right: Emissions Calculator*
- *Bottom: Sample CO_2 Emissions Curve*

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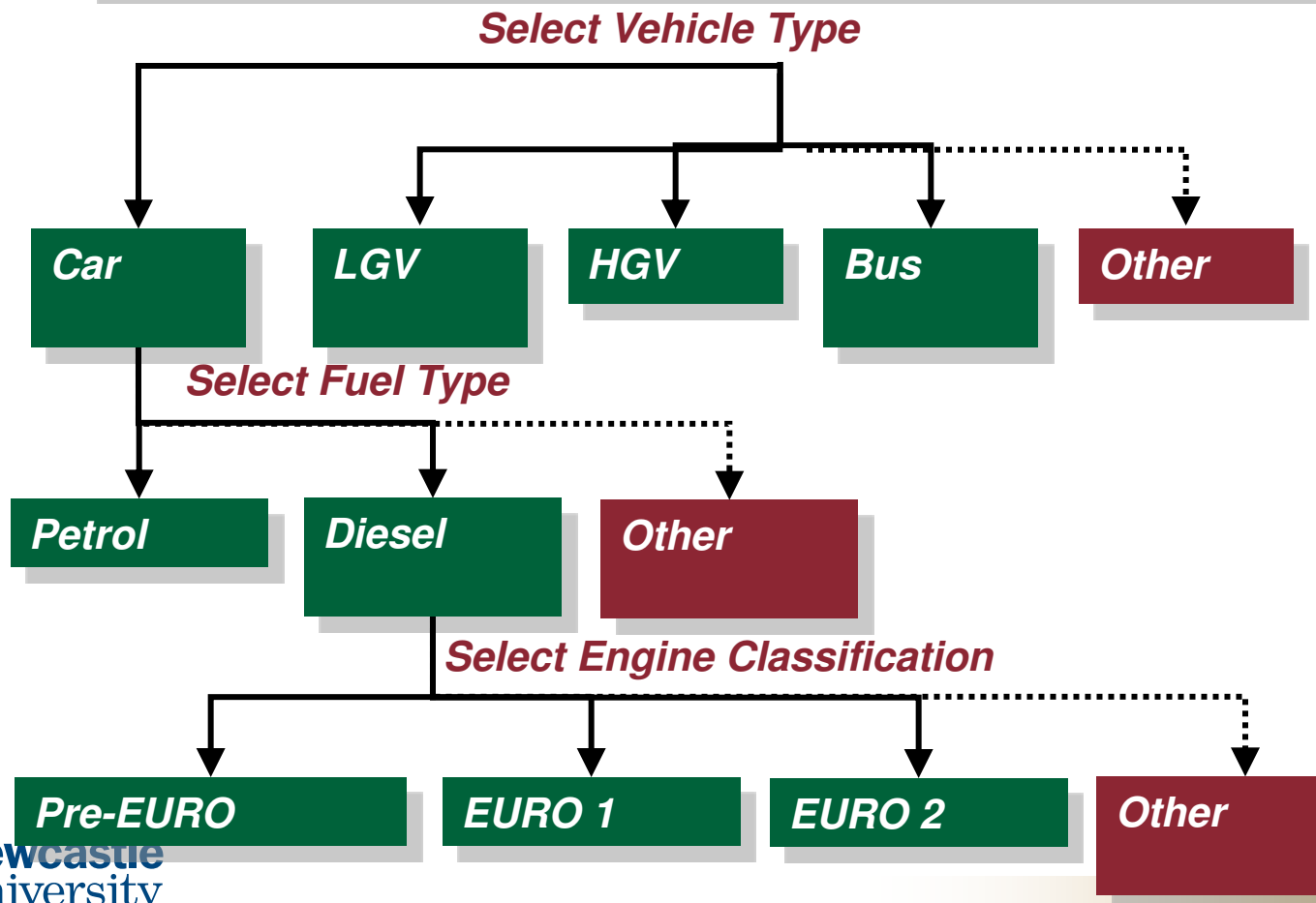
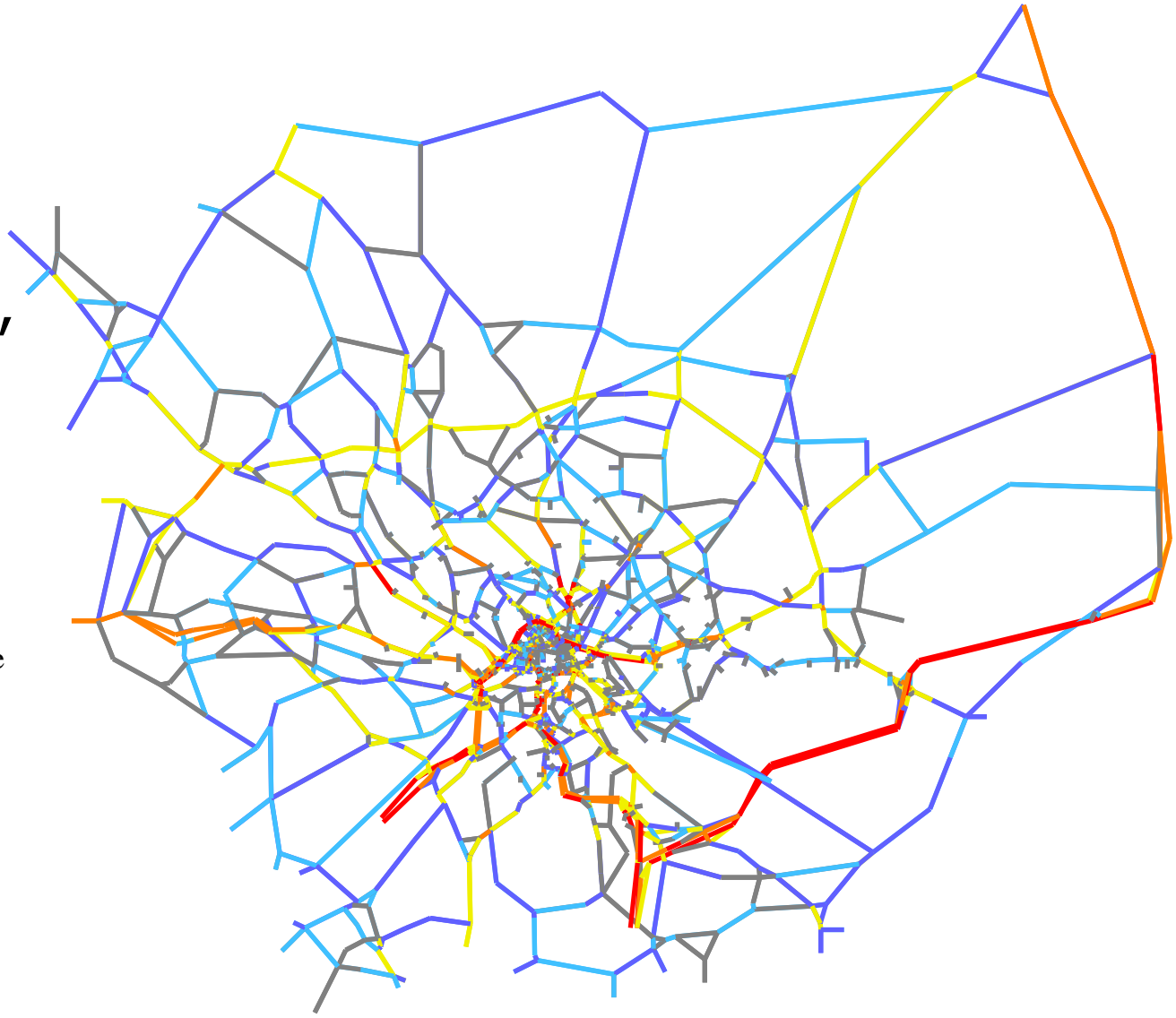
Vehicle Emissions Modelling

Most Emission models typically use a similar 'tiered' classification system at the front end:



Link Based NOx emissions

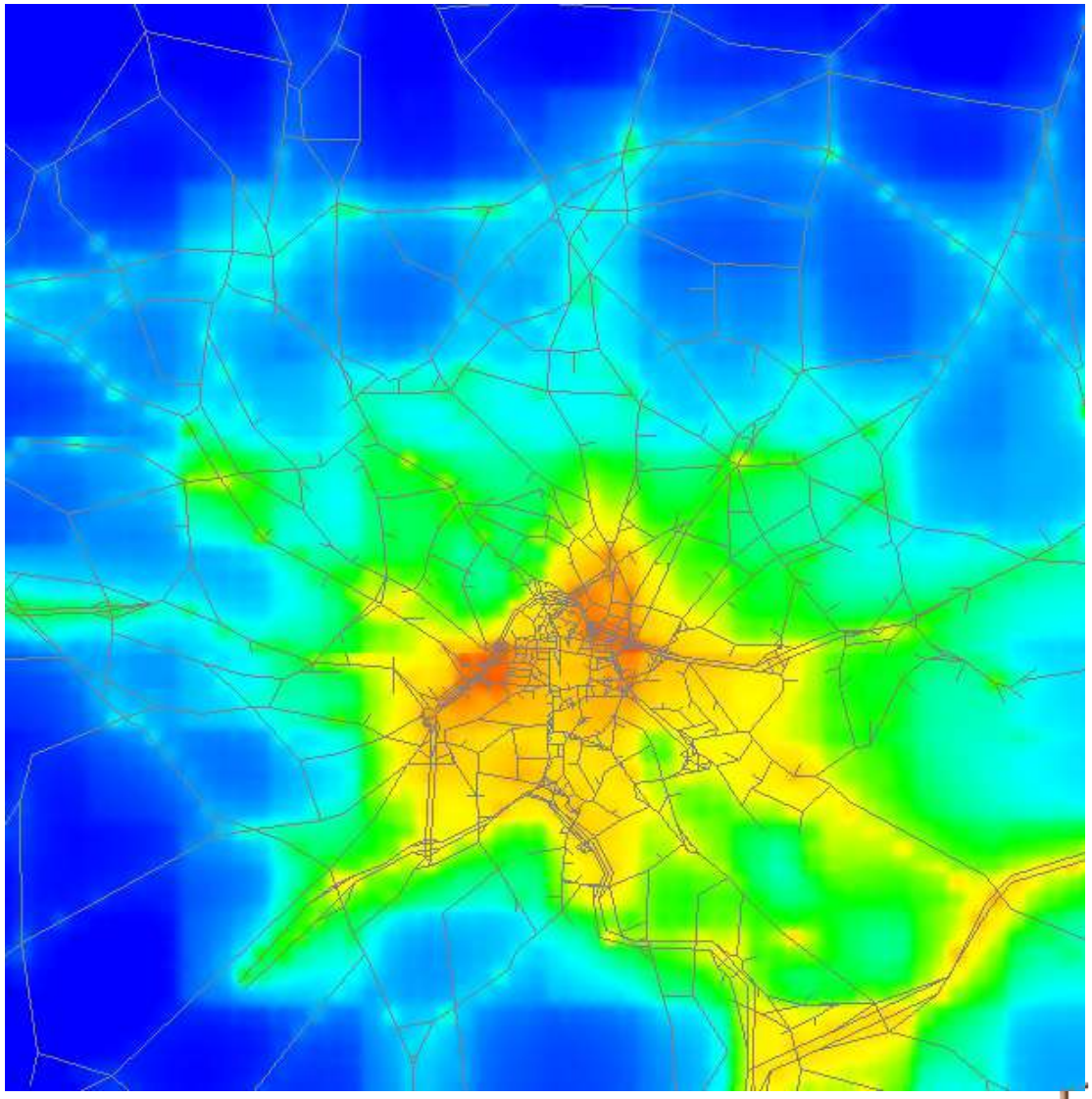
CO, NOx, PM_{10}, SO_2, Benzene, 1,3-Butadiene, CO_2



Air Quality

NO_2

Annual Mean



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CAMBRIDGE RESULTS

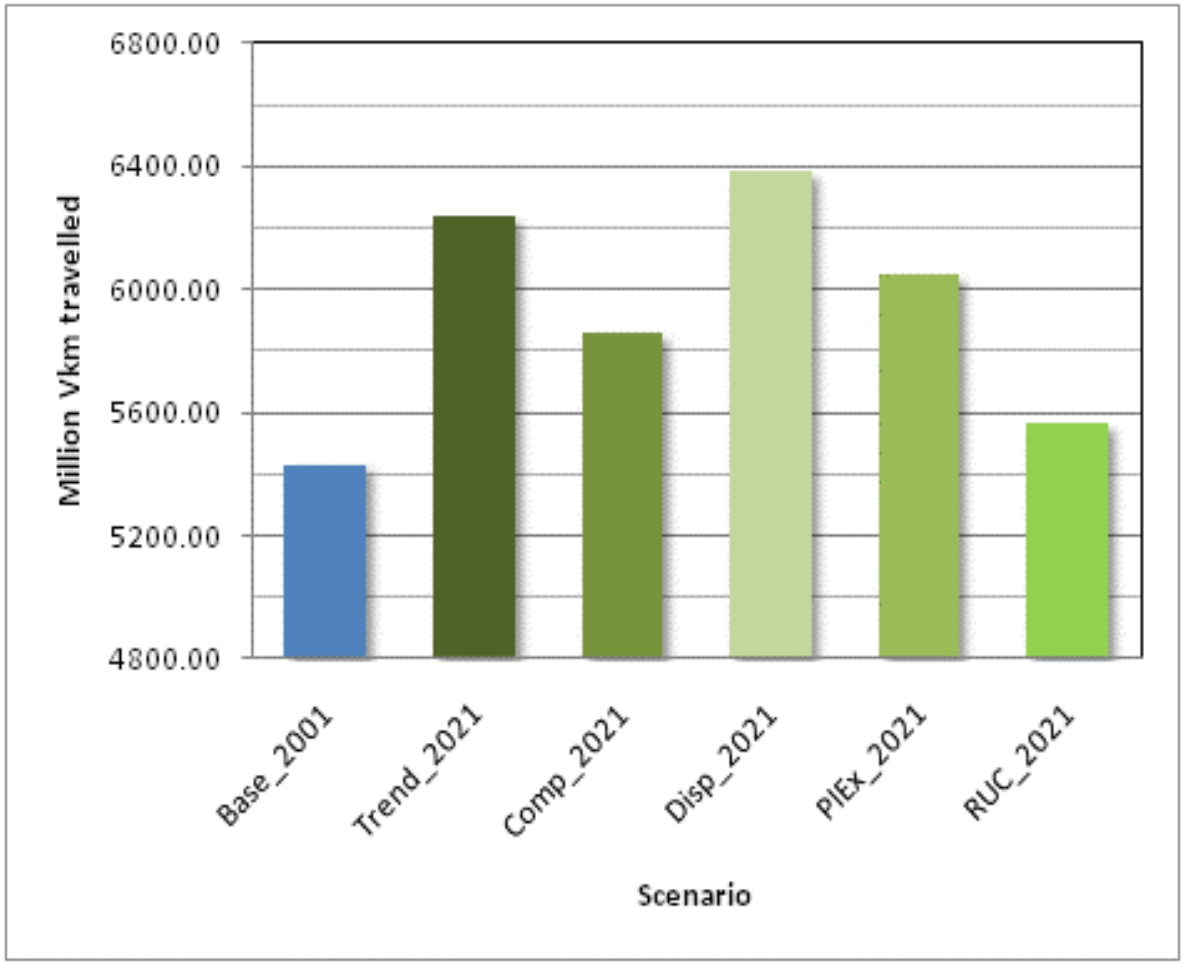
Traffic Volume

Million Vehicle.kms. Travelled

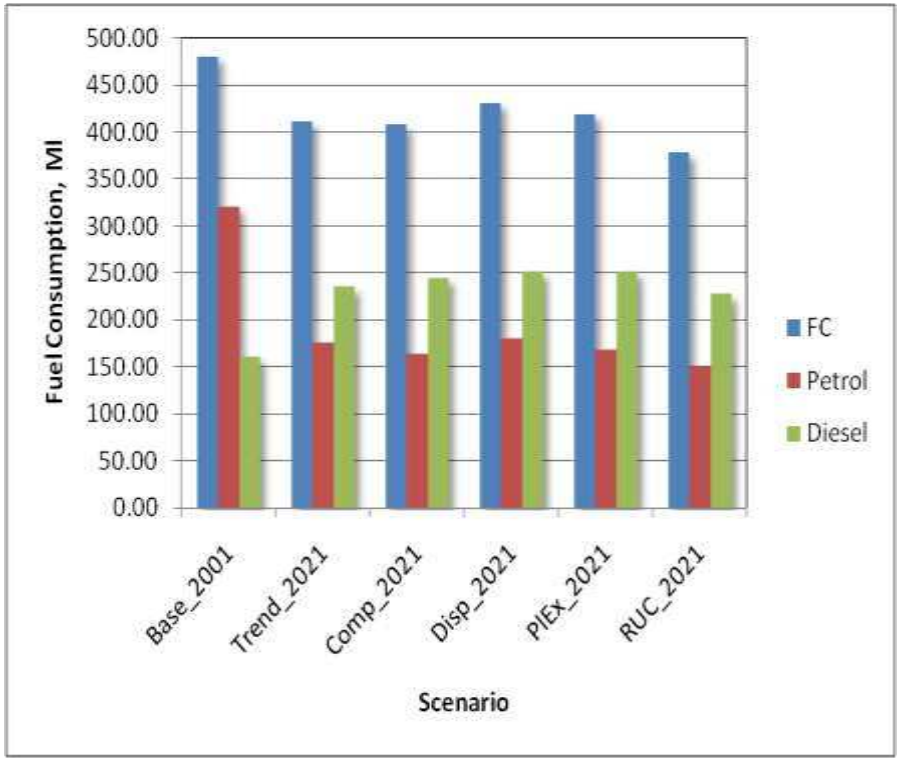
BAU Trend 2021 is 15% higher than 2001 base

Difference between Compaction and Dispersal options is approximately 500 million veh.km

As modelled, Road User Charging is more effective in restraining traffic growth than all planning options

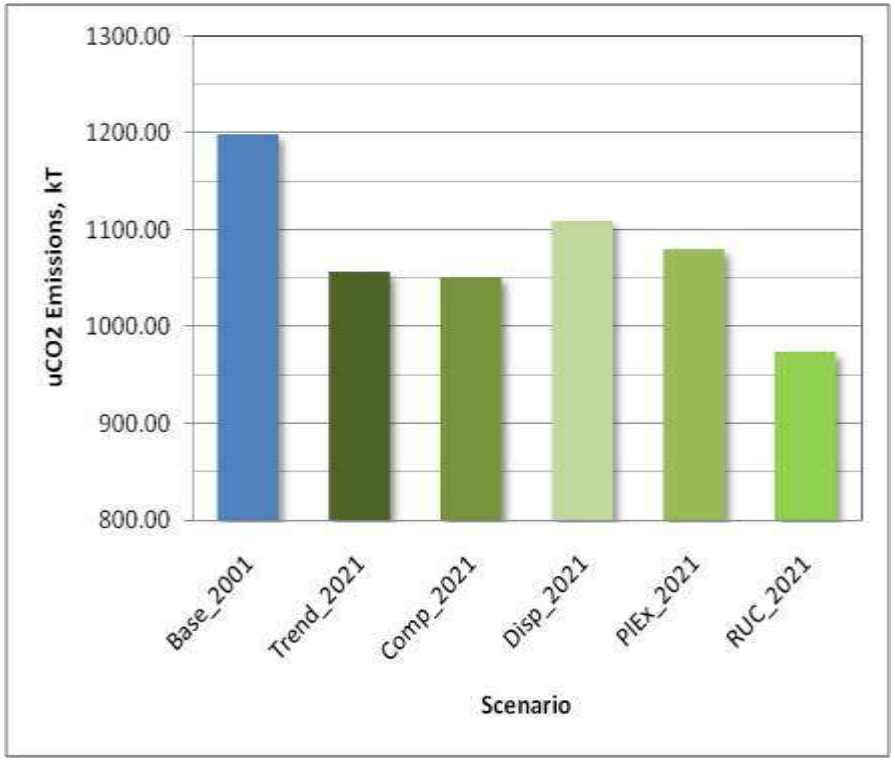


Fuel Consumption and GHG



Fuel Consumed, million litres

Increase in diesel consumption driven partially by private car fleet and increased bus patronage



uCO_2 Emissions, Kilotonnes

BAU Trend 2021 is 12% lower than 2001 base
RUC 2021 is 19% lower than 2001 base

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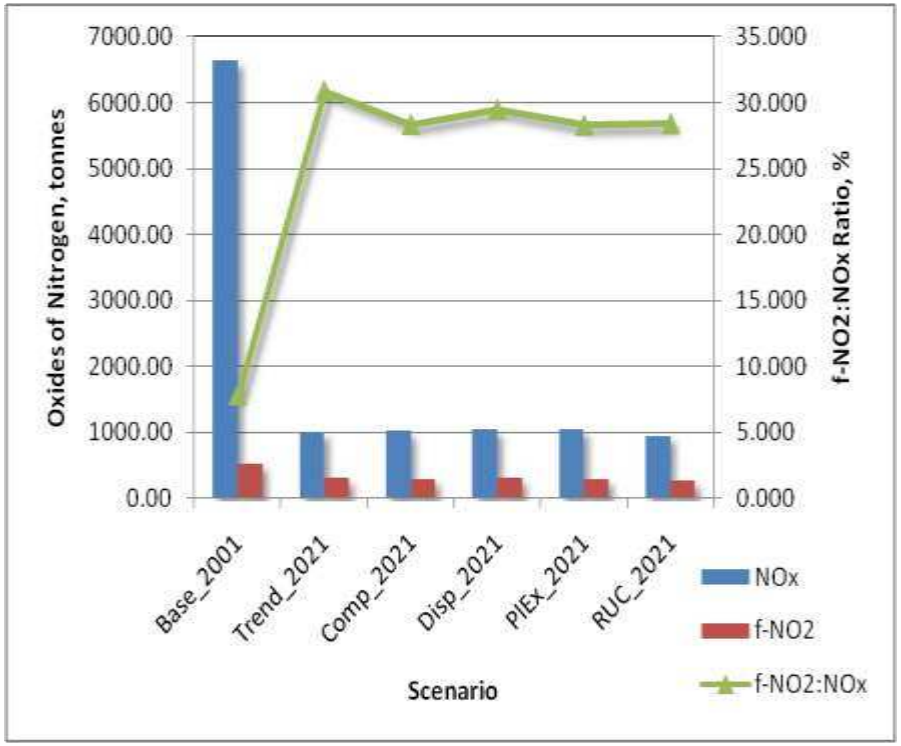
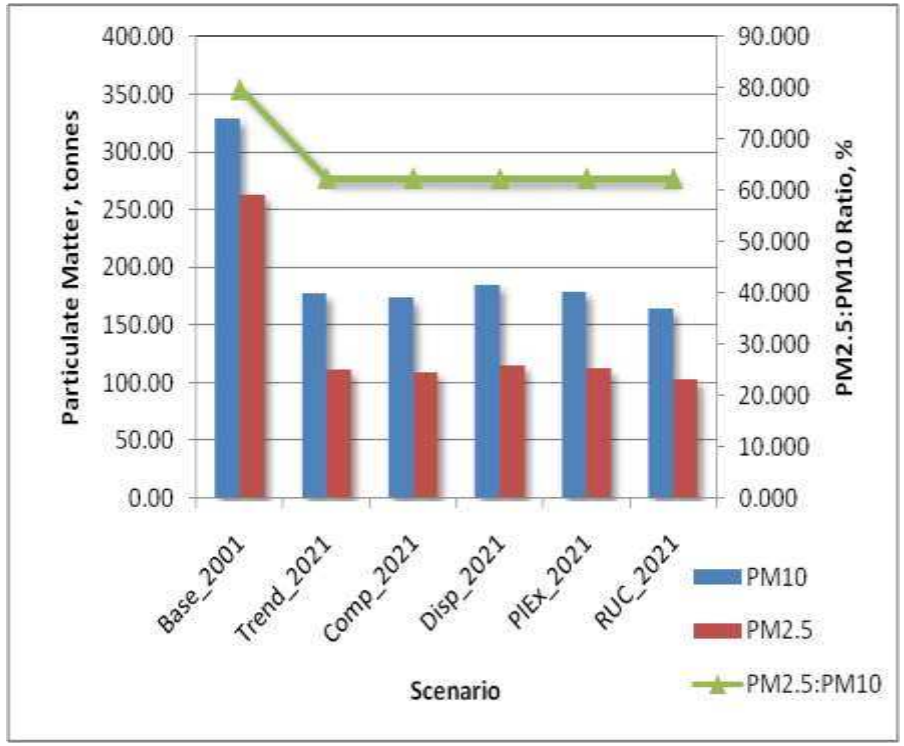
Regulated Pollutants



Oxides of Nitrogen, tonnes

EURO Class driven reduction of total NOx by around 85%, but total Primary NO_2 emissions only reduce by around 30%



Particulate matter, tonnes

EURO Class driven reduction of around 50% for PM_{10} and 40% for $PM_{2.5}$

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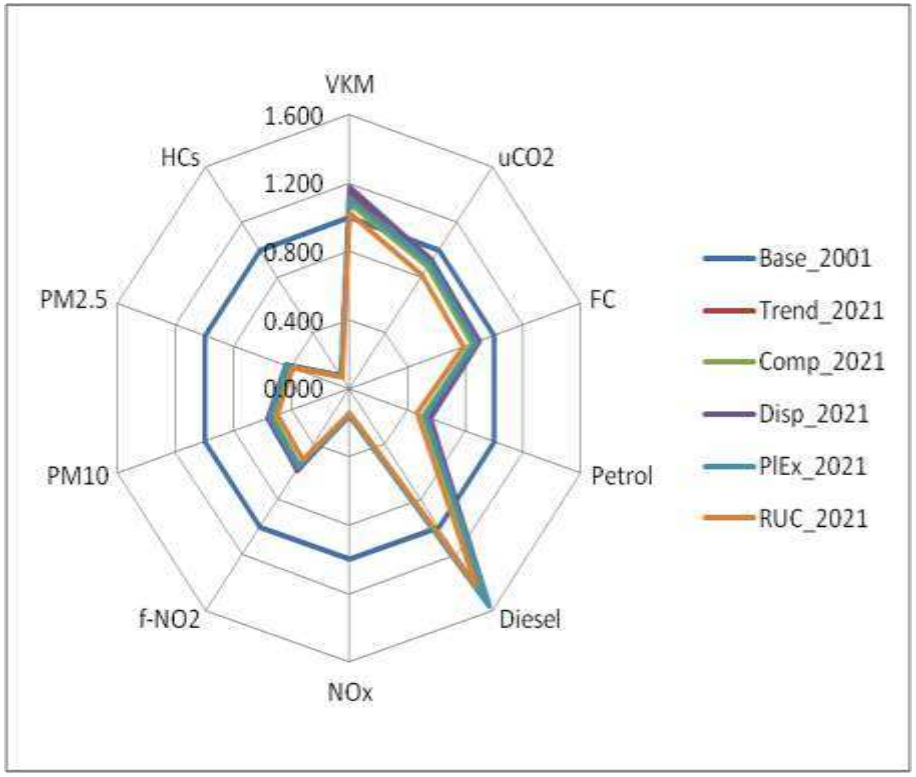
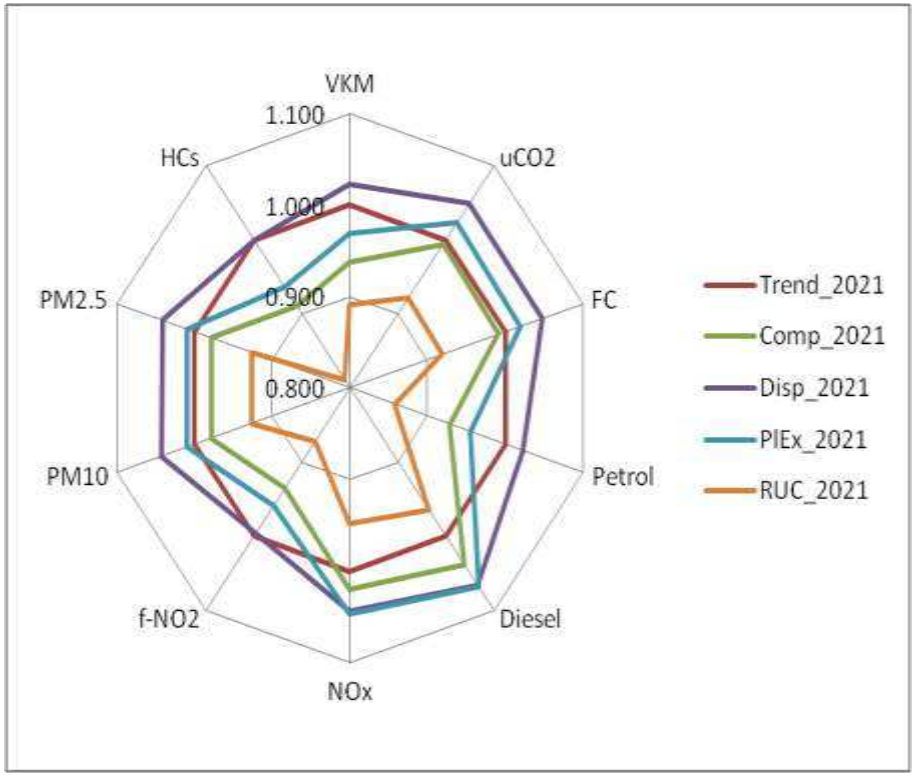
Relative Performance



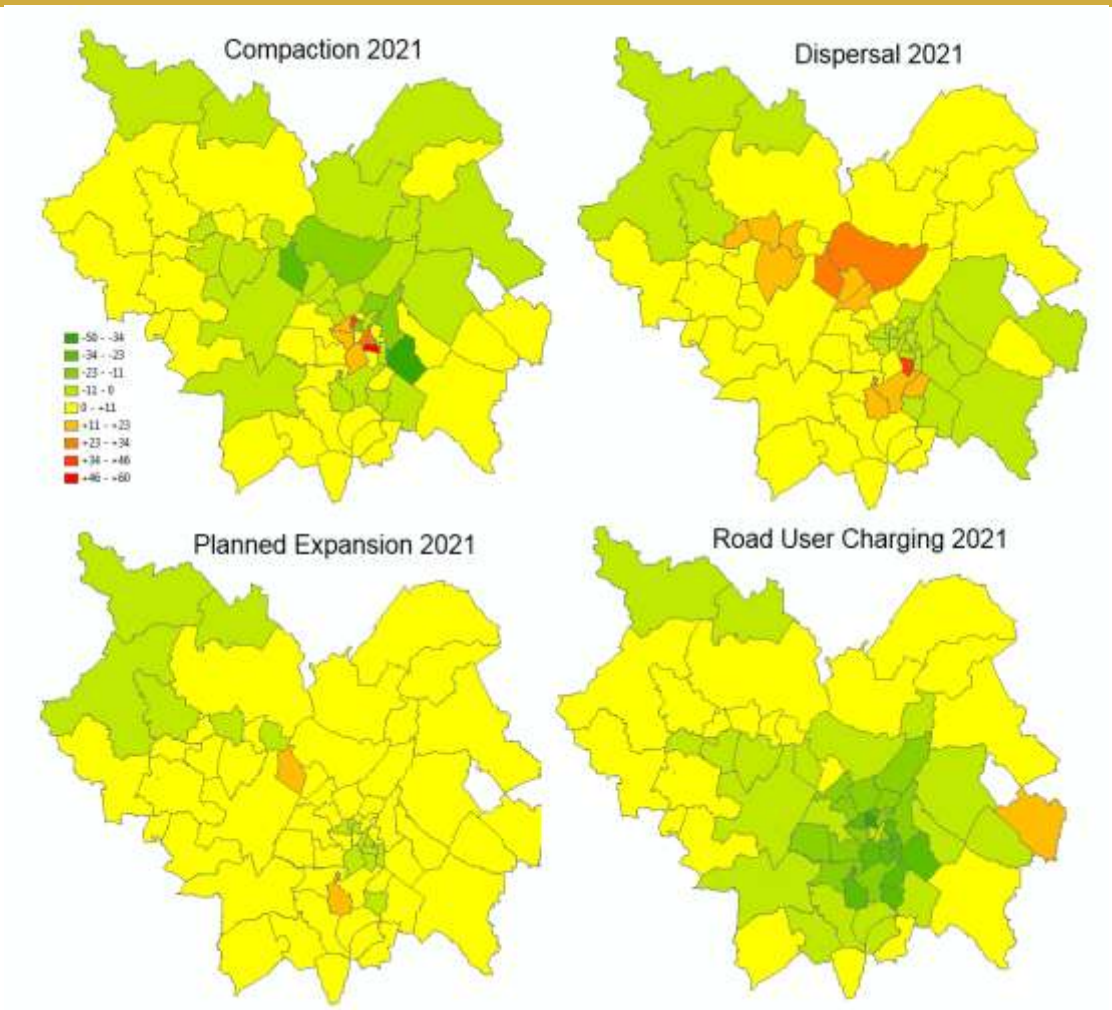
Performance of options relative to 2001 Base Scenario



Performance of options relative to 2021 Trend (BAU) Scenario

Spatial Distributions (1)

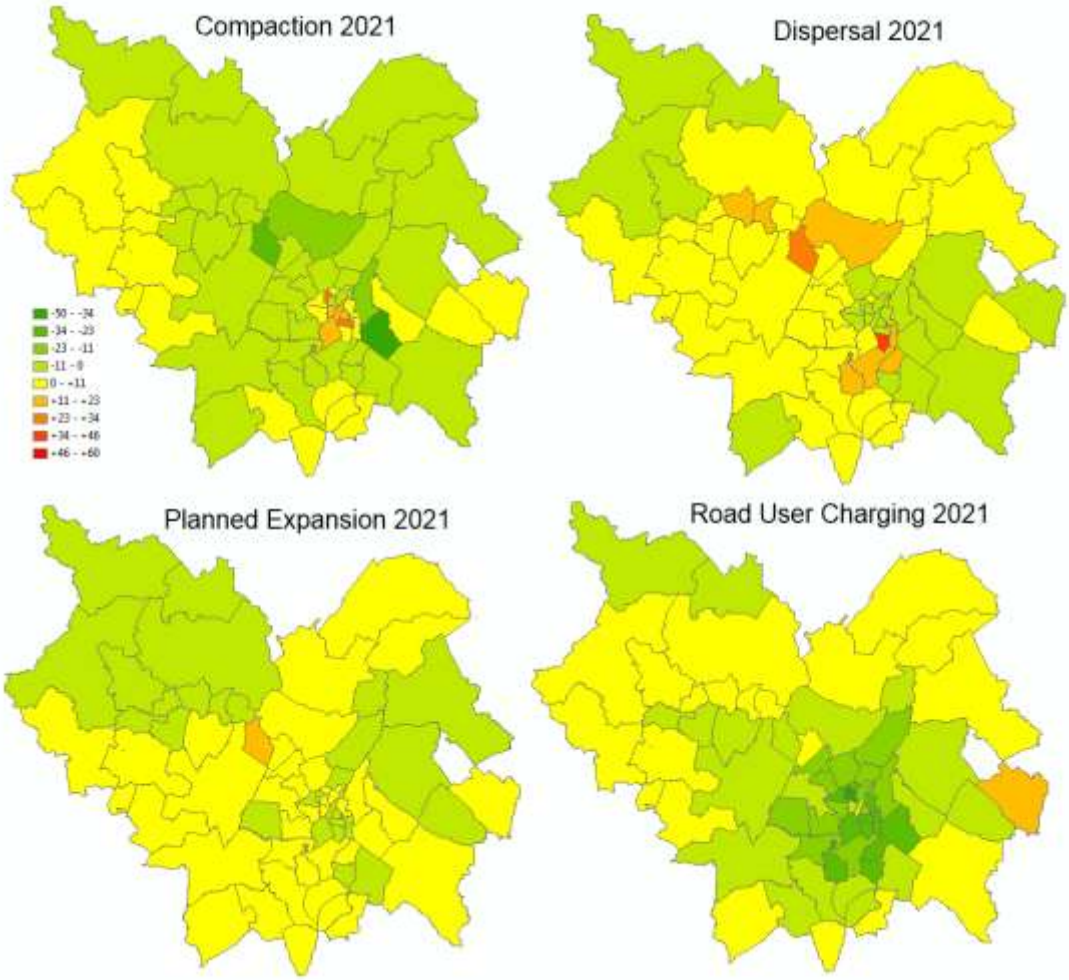
uCO_2 Emissions



Changes relative to Trend (BAU 2021)
Scale range -40% (green) - +60% (red)
Emissions normalised by zone area

Spatial Distributions (2)

PM_{10} Emissions



Changes relative to Trend (BAU 2021)
Scale range -40% (green) - +60% (red)
Emissions normalised by zone area

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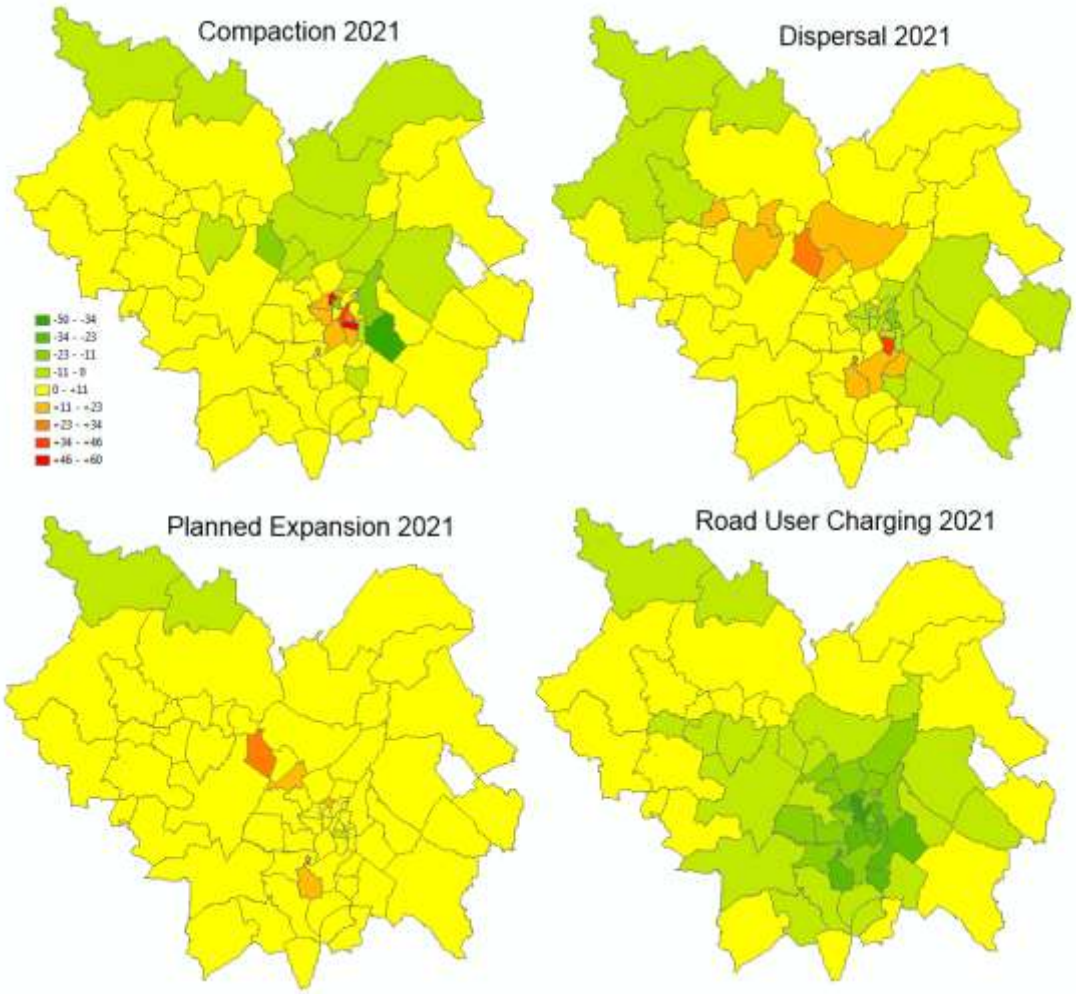
Spatial Distributions (3)

NO_x Emissions



Changes relative to Trend (BAU 2021)
Scale range -40% (green) - +60% (red)
Emissions normalised by zone area

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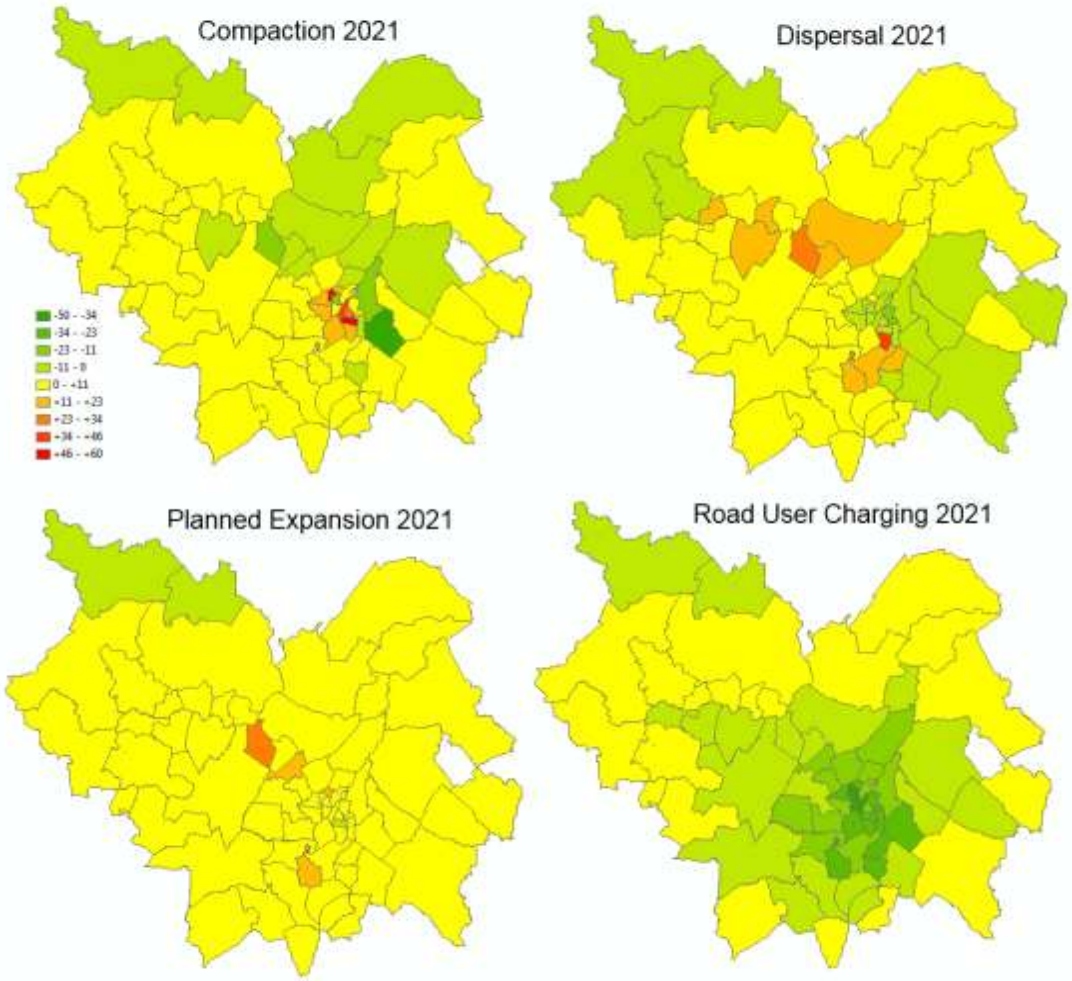
Spatial Distributions (4)

f-NO_2 Emissions



Changes relative to Trend (BAU 2021)
Scale range -40% (green) - +60% (red)
Emissions normalised by zone area

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Conclusions

- ***Conclusions from SOLUTIONS***
  - *As modelled, no planning option is as effective as the use of Road User Charging*
  - *CO_2 targets are challenging without further modal shift or behavioural change*

- ***Spatial-Analysis***
  - *Clear differences in the distribution pattern of emissions with planning scenario – even though the absolute emissions values are comparable*
  - *The compaction scenario could lead to issues within Cambridge City Centre, whilst reducing emissions for the county as a whole*
  - *Dispersal option increases emissions to the north of the city towards Huntingdon*

Future Work

- ***Expansion of PITHEM Software***
  - *Modules for road traffic noise, accidents, run-off and severance*
  - *Links to ADMS-Urban and AIRVIRO air-quality management software*

- ***Further environmental analysis in ReVISIONS***
  - *Further analysis and refinement of Cambridge Model*
  - *Proposed air-quality, population exposure and health/disease burden analyses*
  - *Expansion of scope to cover Greater South East region at the strategic level*

Thank you and any questions?

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