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@ClairCity

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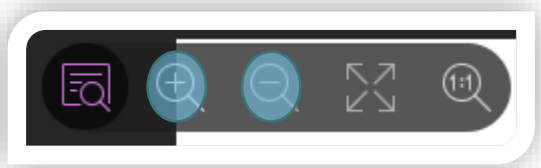
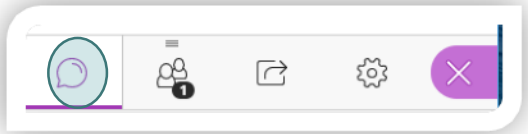


Have a technical question or a question for the speakers, please write them in the chat box



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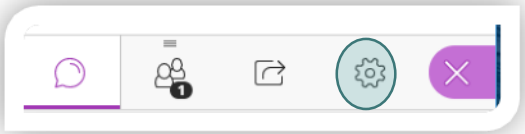

Presentations and the recording will be made available afterwards. Enjoy!

This project received funding for the European Union's Horizon 2020 research and innovation programme under grant No. 689289.

ClairCity: see citizens in the modelling

Kris Vanherle, Transport & Mobility Leuven, Belgium

An Kewo, Technical University of Denmark (DTU), Denmark

Vera Rodrigues, University of Aveiro, Portugal

Dr Enda Hayes, University of the West of England (UWE-Bristol), England

Citizens at the Centre

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Outline

Enda Hayes - Introducing ClairCity (5’)

Kris Vanherle - Introducing the ClairCity modelling approach (5’)

Kris Vanherle - Zooming in on transport (10’)

Q&A (10’)

An Kewo - Zooming in on residential energy use (10’)

Vera Rodrigues - Zooming in on the air quality modelling (15’)

Q&A (15’)

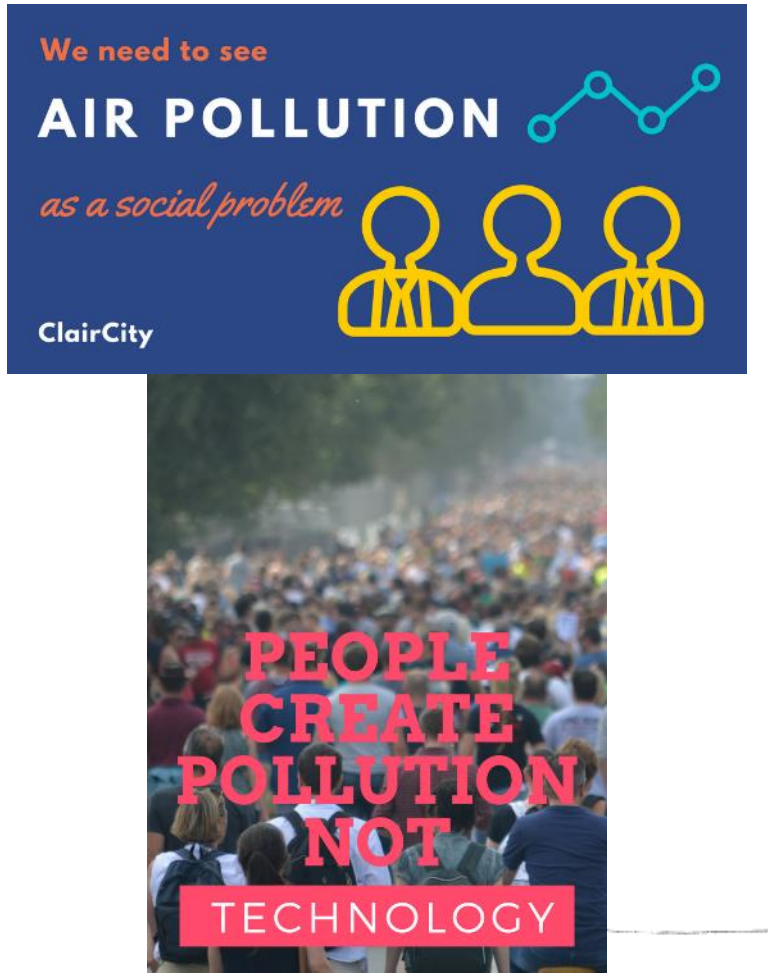
Citizen-led air pollution reduction in cities

Everyday, air pollution and carbon emissions are produced by our daily practices, activities and behaviours.

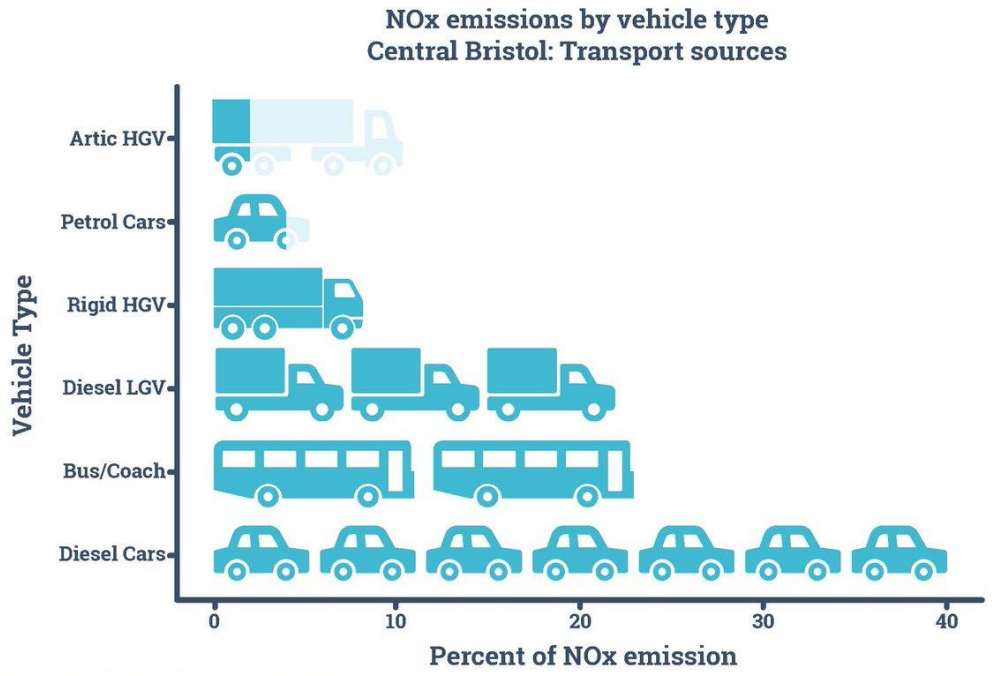
Understanding how we live and the societal factors that influence our daily behaviour is key to improving air quality, reducing carbon emissions and improving public health.

The ClairCity concept…

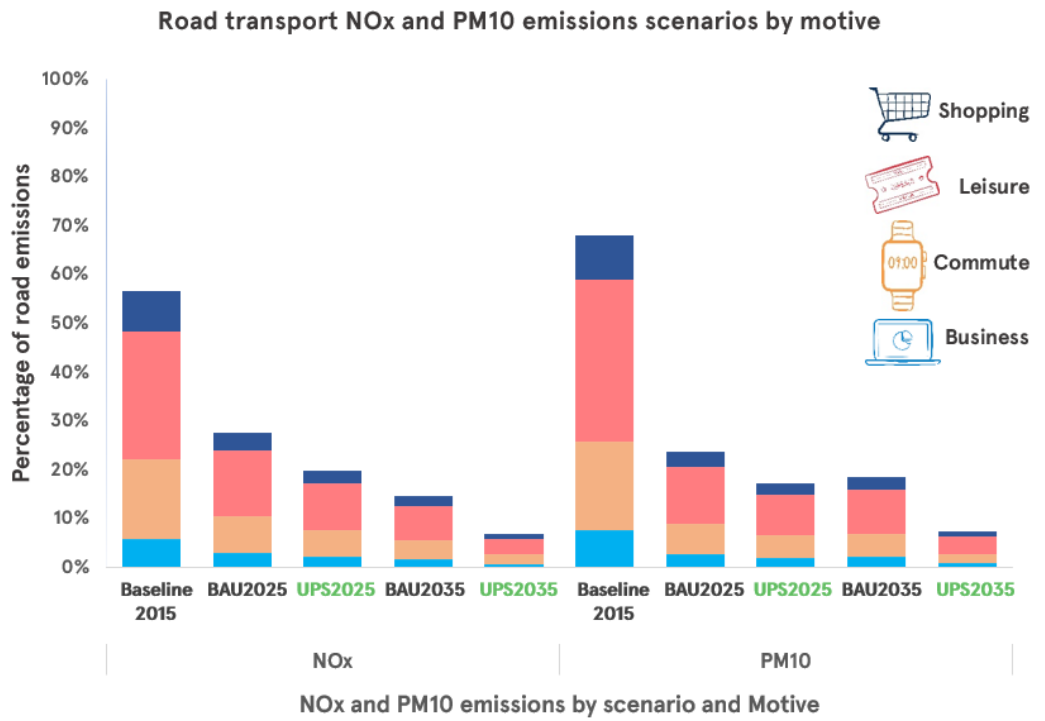
Where and what? ⇨ Who and why? ⇨ ClairCity



Unfortunately I use my car!



Data from Bristol City Council Cabinet Agenda, 15 Aug 2017, page 105.
Available from https://democracy.bristol.gov.uk/documents/g2557/Public%20reports%20pack%2015th-Aug-2017%2016.00%20Cabinet.pdf?T=10



Source: ClairCity Project

"Heavy loads, steep hills, small children, tired – I just want to get home!"

"I simply don't see accessibility and cost of public transport ever being better"

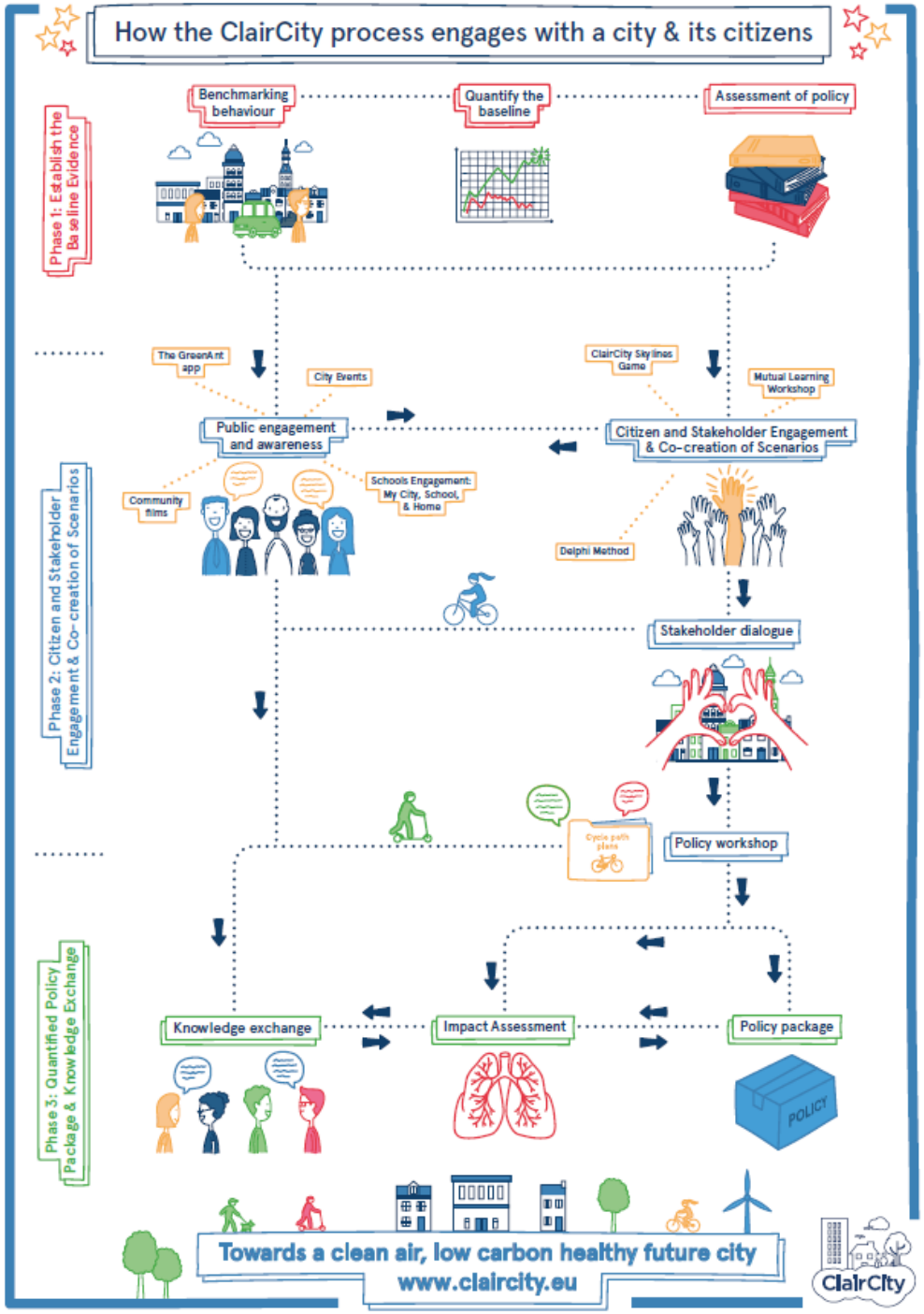
"I need flexibility to go where I want, when I want"

"I need to pick my kids up and work part time so don't have the time to cycle or take the bus"

Project Aim & Objectives

The ClairCity aim was to create a major shift in public understanding towards the causes of poor air quality, inviting citizens to give their opinions on air pollution and carbon reduction to shape the cities of the future.

1. To put citizens' behaviour and activities at the heart of air quality and carbon management and policy making;
2. To develop a suite of innovative toolkits for enhanced quantification, engagement and impact evaluation;
3. To explore the integration of citizens behaviour in relevant city policies and ensure that future city policies are reflective of citizens visions for their future city; and
4. To raise awareness of environmental challenges and their solutions through proactive dissemination of the project outcomes.



The ClairCity process...

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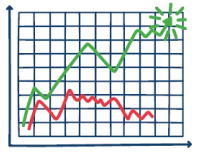
How the ClairCity process engages with a city & its citizens

Phase 1: Establish the Baseline Evidence

Benchmarking behaviour

Quantify the baseline



Assessment of policy

Phase 2: Citizen and Stakeholder Engagement & Co-creation of Scenarios

The GreenAnt app

City Events

Public engagement and awareness

Community films

Schools Engagement: My City, School, & Home

ClairCity Skylines Game

Mutual Learning Workshop

Citizen and Stakeholder Engagement & Co-creation of Scenarios

Delphi Method

Stakeholder dialogue

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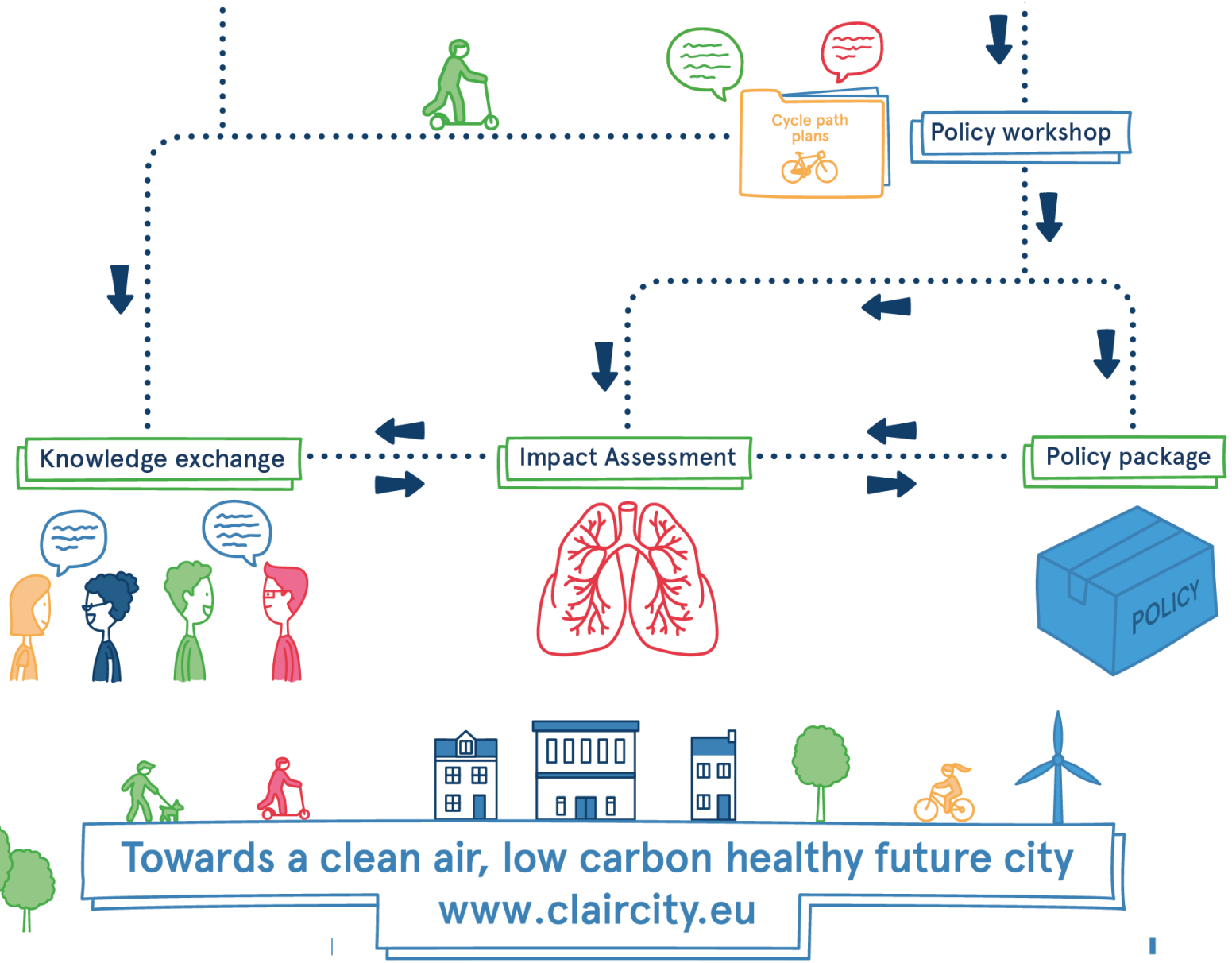
ClairCity

How the ClairCity process engages with a city & its citizens

Phase 3: Quantified Policy Package & Knowledge Exchange



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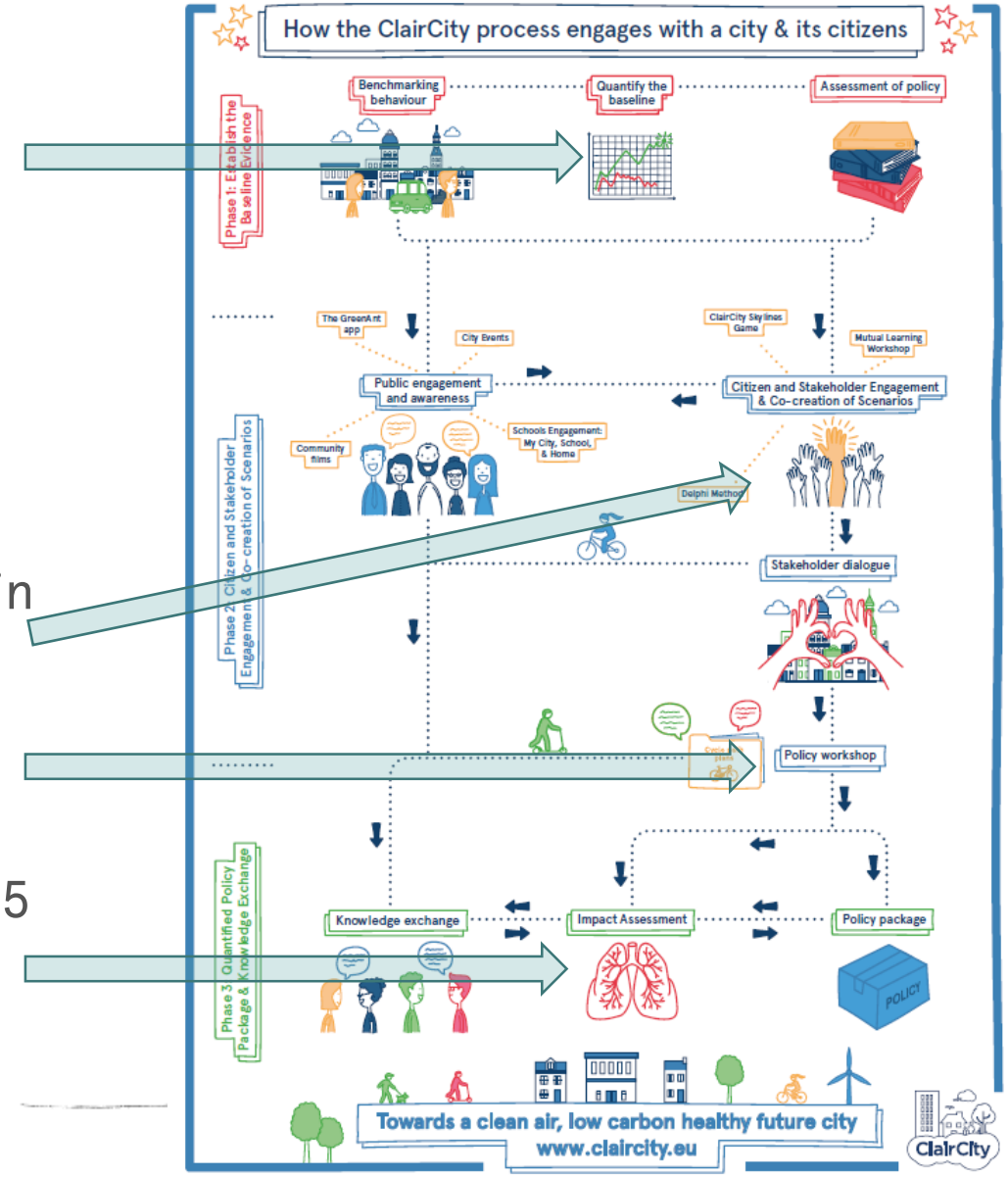
Modelling in ClairCity

Kris Vanherle, Transport & Mobility Leuven (TML), Belgium

Citizens at the Centre

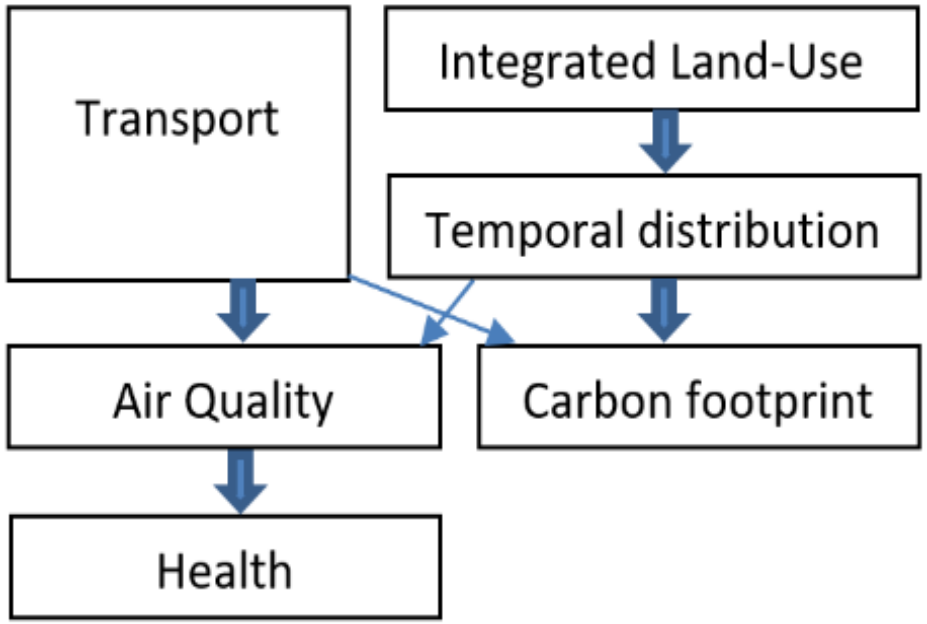
Modelling in ClairCity – Assessment process

- Baseline development (2015) + verification
- Establish Business as Usual (BaU) assumptions leading to emission and air quality estimates for 2025, 2035 and 2050
- Scenario assessment in 2 steps
  - Collecting input from citizens and stakeholders in Stakeholder Dialogue Workshops ("SDW") scenario's – explorative in nature.
  - Feedback process leading to a single scenario definition in the Policy Workshop ("PW")
  - Emission and air quality estimates for 2025, 2035 and 2050 for the Unified Policy Scenario ("UPS")



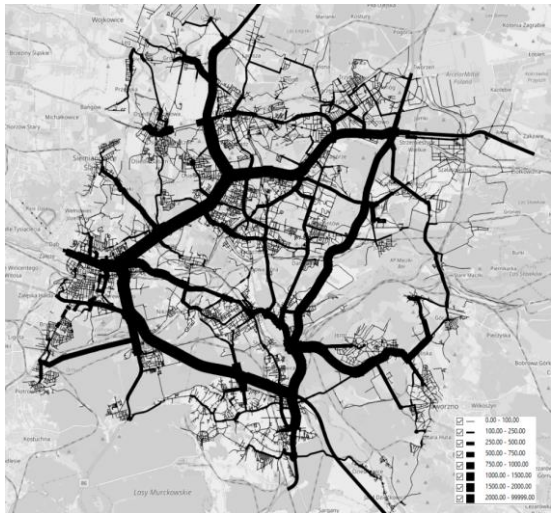
Modelling in ClairCity

- Classic sequential chain of
  - activity (e.g. vkm)
  - emissions (total Nox emitted)
  - air quality (Nox/PM concentration, daily & yearly mean)
  - health impact (DALY,...)
- Adding an extra step: citizens behaviour
- Include carbon footprint
- Modular approach

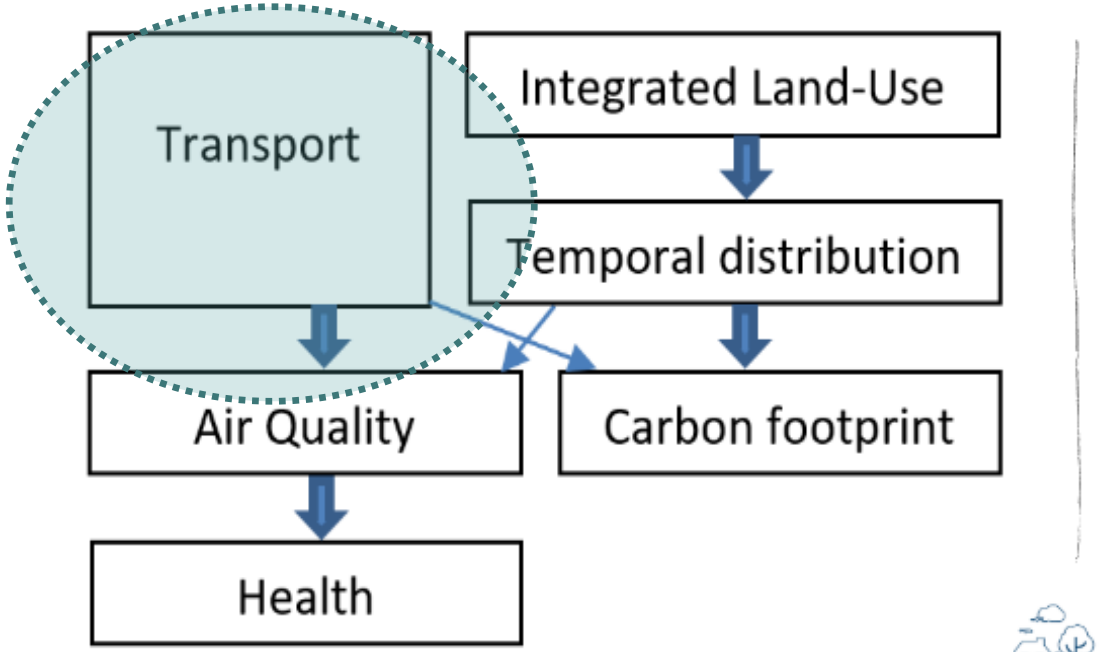


Modelling in ClairCity – transport

- Focus on road transport
- All modes: car/bus/truck
- Bottom-up, verified top-down

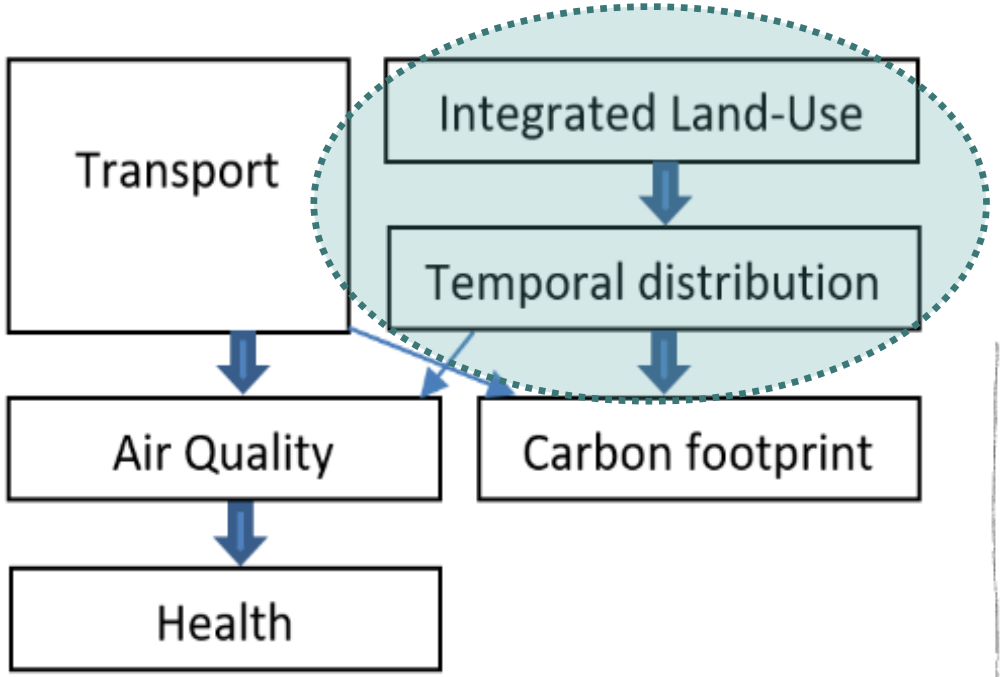


- Source apportionment by citizen behaviour !!! **NEW** !!!
- Spatial allocation !!! **NEW** !!!



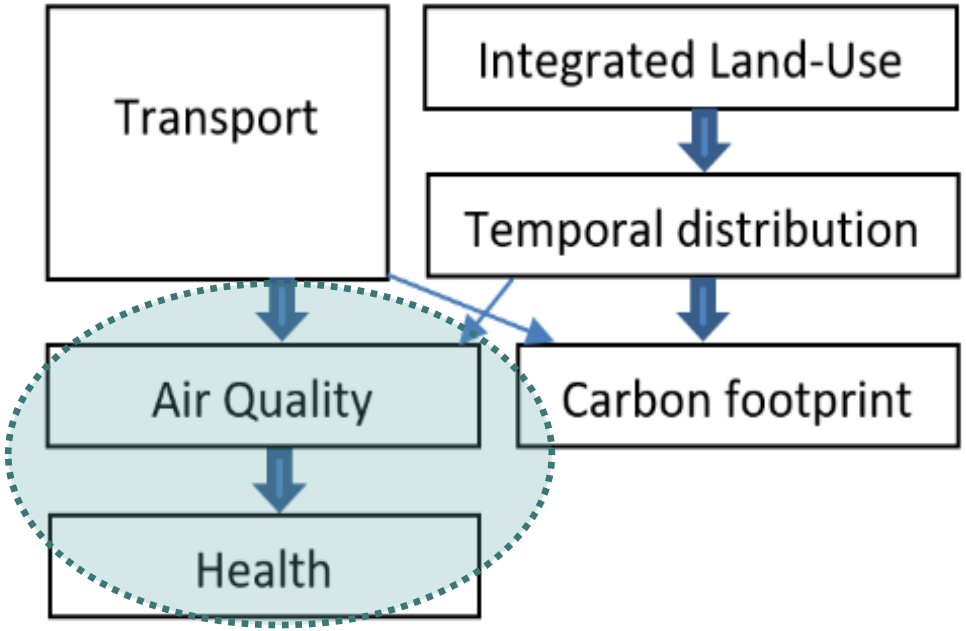
Modelling in ClairCity – energy use

- Assessment of domestic energy consumption
- Combination of top-down approach and bottom-up load profile model.
- Proportional matched profile between city's profile and household's profile: Occupancy, behaviour and time use of appliances !!! **NEW** !!!

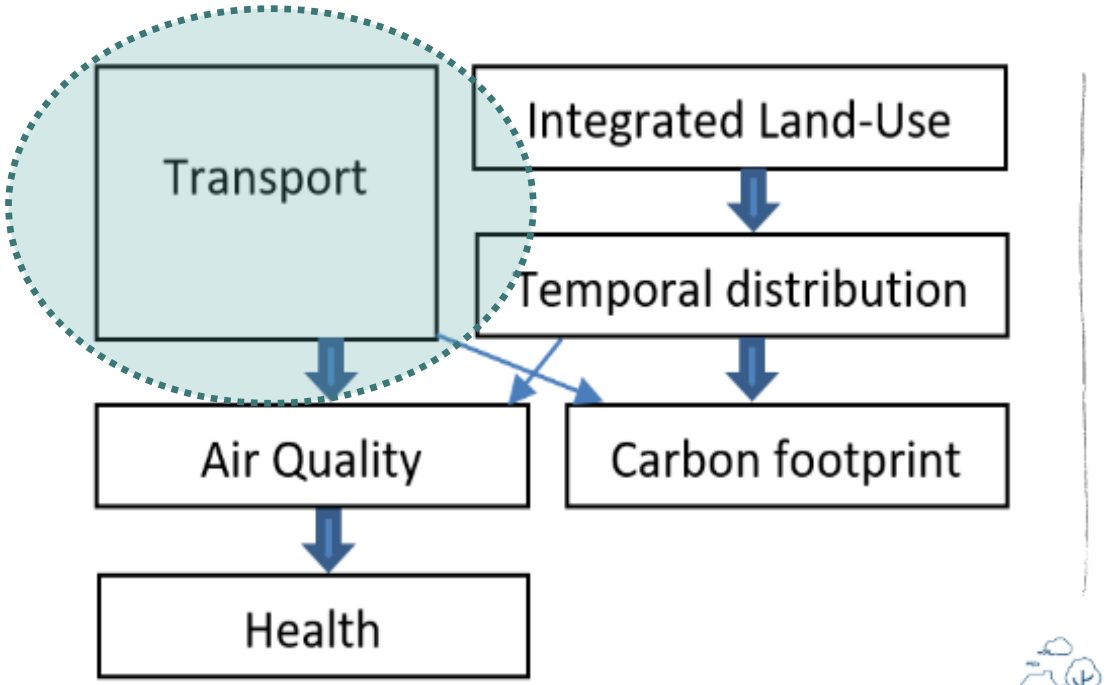


Modelling in ClairCity – Air Quality

- Air quality modelling
  - At mesoscale using the WRF-CAMx model
  - At urban scale using the 2nd generation Gaussian model URBAIR
    - Background concentrations
    - Adjustment procedure
  - Source apportionment
- Population exposure
- Health assessment
  - Estimating mortality health outcomes and the years of life lost due to exposure to air pollution in a given population



Zooming in on transport



Transport in ClairCity

Two innovative methodological features:

1. Use of open source tools to estimate transport emissions at link level, in data-poor environments
2. Use of travel survey data, to link traffic demand to citizen practices

Transport in ClairCity

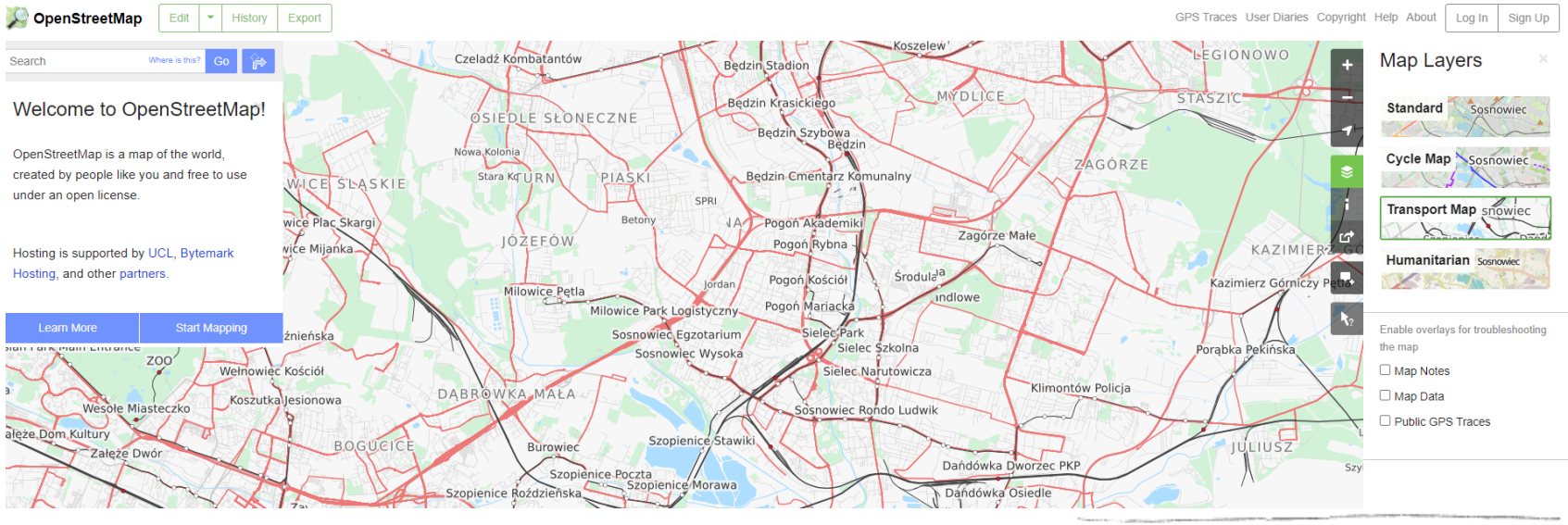
Two innovative methodological features:

1. **Use of open source tools to estimate transport emissions at link level, in data-poor environments**
2. Use of travel survey data, to link traffic demand to citizen practices

Transport in ClairCity

Road network: use open source: OpenStreetMap

- Data is collected and updated (!) by voluntary contributors
- Data is complete for most key parameters (all roads, road types,..)
- Spatial accuracy often better compared to typical transport models
- Lack transport data – OpenTransportMap not complete



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Transport in ClairCity

Transport demand: use a mix of available data

- Land-use data (OSM, UrbanAtlas,…) to generate transport demand
- Modal split data at city level typically well know
  - Travel survey data
  - TRANSPHORM database
- Network assignment from open source algorithms

  (*Dijkstra shortest path*)

Example Liguria (Morandi-bridge):

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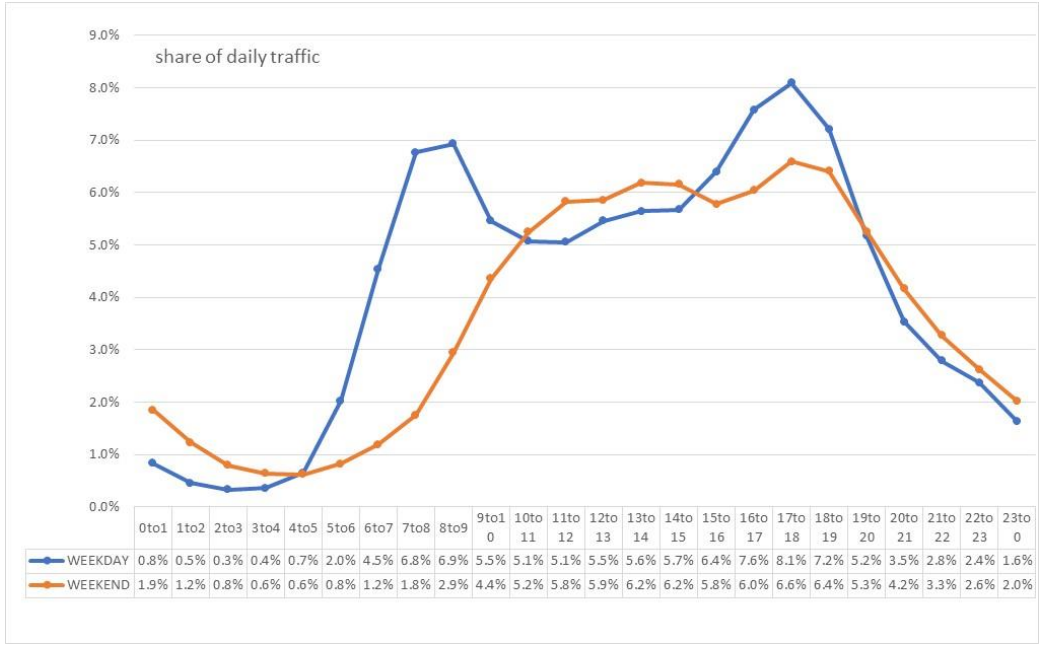
Transport in ClairCity

Post-processing

- Match with traffic counting data insofar available – 2 step approach:
  - High-level: adjust traffic generation to fit main roads
  - Local-level: adjust route choice by adapting disutility of road segments
- Hourly profiles – typically available
- Applying emission factors
  - Country-specific fleet composition
  - COPERT emission factors



	0to1	1to2	2to3	3to4	4to5	5to6	6to7	7to8	8to9	9to10	10to11	11to12	12to13	13to14	14to15	15to16	16to17	17to18	18to19	19to20	20to21	21to22	22to23	23to0
WEEKDAY	0.8%	0.5%	0.3%	0.4%	0.7%	2.0%	4.5%	6.8%	6.9%	5.5%	5.1%	5.1%	5.5%	5.6%	5.7%	6.4%	7.6%	8.1%	7.2%	5.2%	3.5%	2.8%	2.4%	1.6%
WEEKEND	1.9%	1.2%	0.8%	0.6%	0.6%	0.8%	1.2%	1.8%	2.9%	4.4%	5.2%	5.8%	5.9%	6.2%	6.2%	5.8%	6.0%	6.6%	6.4%	5.3%	4.2%	3.3%	2.6%	2.0%

Transport in ClairCity

- Highly flexible approach in terms of data availability and required quality of resulting emissions
- Emission as **line sources**, also for the smallest roads (though uncertainty is higher for smaller roads)
- Solves spatial mismatches which are common in traffic models (Bristol, Amsterdam)
- Due to generic approach and open source nature, easy to replicate for other cities/regions at low cost

Transport in ClairCity

Two innovative methodological features:

1. Use of open source tools to estimate transport emissions at link level, in data-poor environments
2. **Use of travel survey data, to link traffic demand to citizen practices**

Transport in ClairCity

- Typically, transport emission estimates starts from "activity": vkm
- What's driving demand?...
- Policy's targeting behaviour need better reflection of underlying behaviour in transport demand

➔ National travel survey data

- Extensive database of travel patterns of citizens
- Differs between country's (UK: NTS, NL: Ovin, BE: OVG,...), semi-standardized

Transport in ClairCity

Challenge: to link activity data from the transport activity in the emission model to travel survey data:

- Emission calculation:

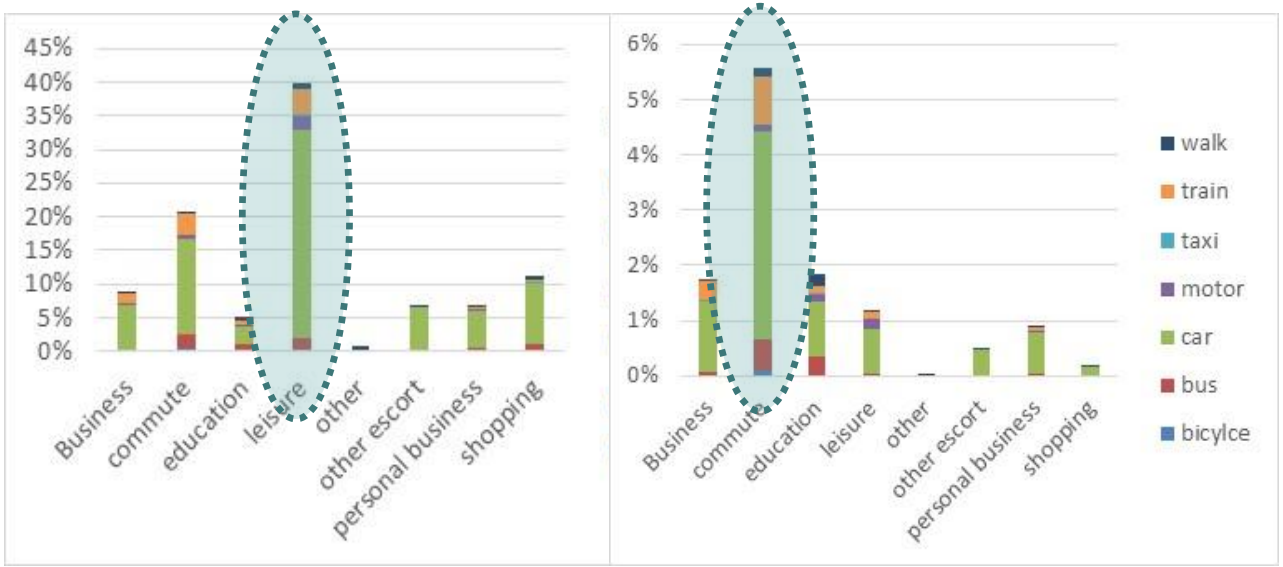
type	time	day
car	hourly	week/weekend
van		
bus		
motorcycle		

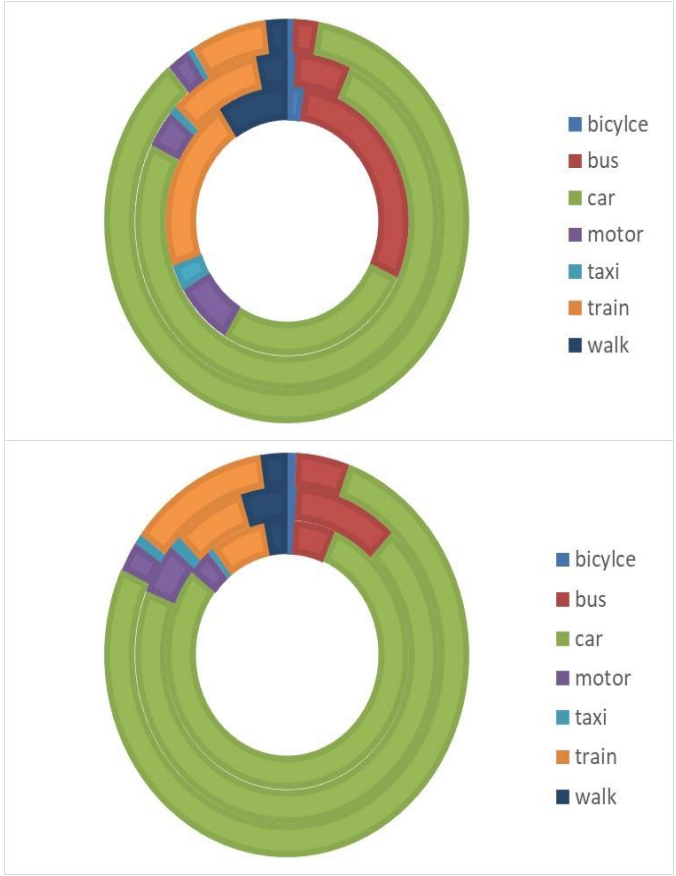
- NTS (Bristol case):

mode	motive	income	age	sex	time	day
walk	commute	<25k£	0-15	male	night	weekday
bicylce	Business	<25-50k£	16-25	female	morning peak (7-9)	weekend
car	education	>50k£	26-49		midday	
bus	shopping		50-69		evening peak (16-20)	
train	other escort		70+			
taxi	personal business					
motor	leisure					
	other					

Transport in ClairCity

Some results





Available as Excel pivot tables for easy analysis:

- *Bristol: https://claircitydata.cbs.nl/dataset/bristol-apportionment-of-road-transport-emissions-by-behavior*
- *Amsterdam: https://claircitydata.cbs.nl/dataset/apportionment-of-road-transport-emissions-by-behavior-amsterdam*

Transport in ClairCity

Potential value:

- Better impact assessment of measures targeting behaviour (e.g. telework affects commuting only)
- Great value for awareness creation among citizens

(Current) limitations:

- As a post processing approach, potential in terms of impact on spatial distribution of emissions is lost

➔ *Potential to fully integrate in demand generation*

Q&A

Presentations and the recording will be made available after the Webinar

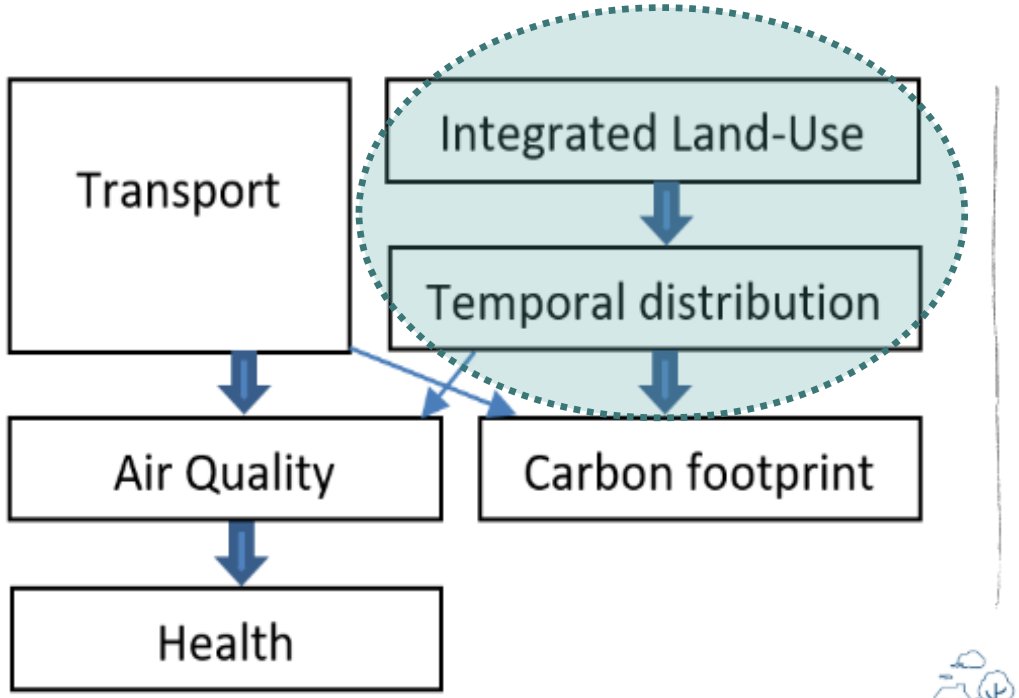
ClairCity is committed to the principles of Open Access. All relevant data and methodologies will be available in the coming week on our ClairCity community page on Zenodo.

This project received funding for the European Union's Horizon 2020 research and innovation programme under grant No. 689289.

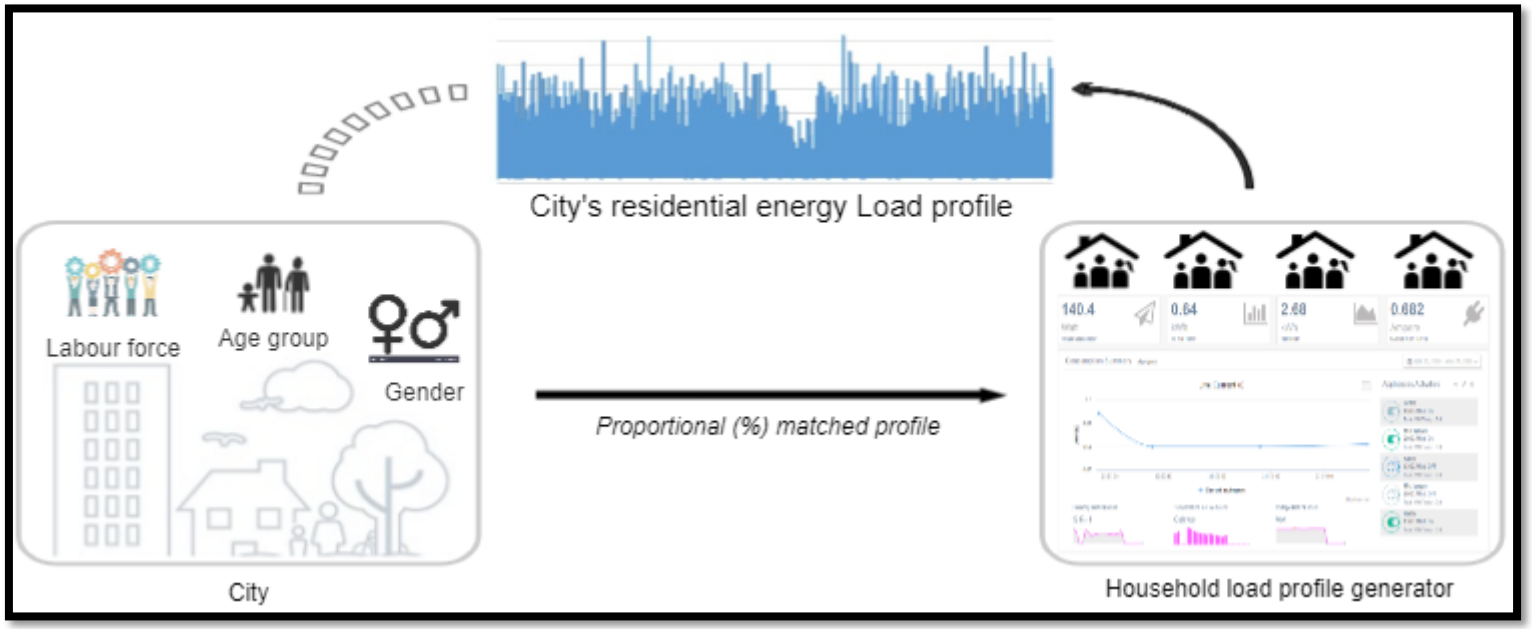
Zooming in on residential energy use

An Kewo, Technical University of Denmark (DTU), Denmark

Citizens at the Centre



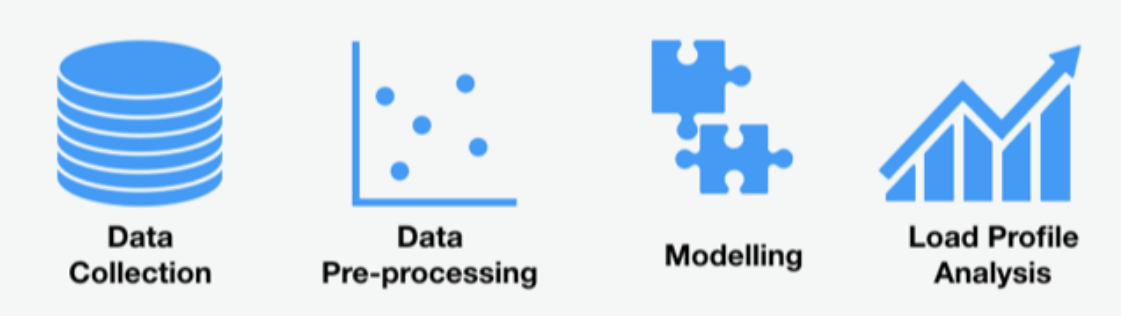
Residential energy use in ClairCity



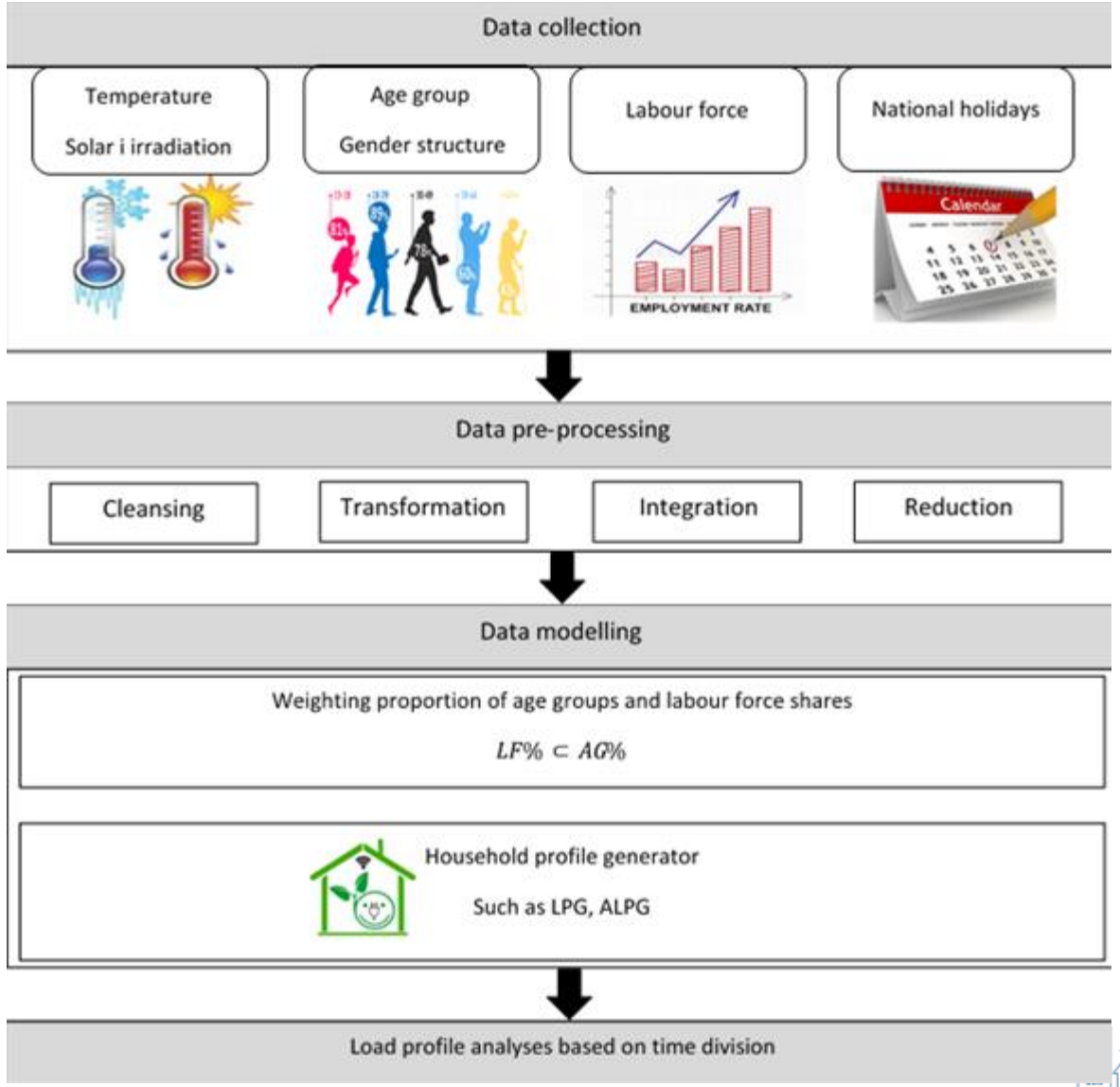
"Modelling Residential Energy Load Profile at the City/Region Level using Weighted proportion (Wepro) model"

Team: Per Sieverts Nielsen
Angreine Kewo
Xiufeng Liu

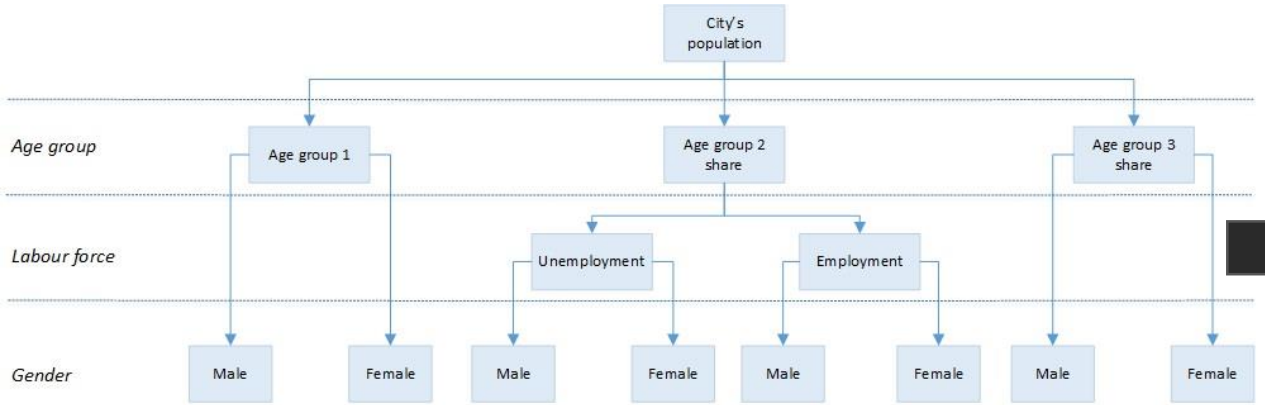
Residential's energy load profile



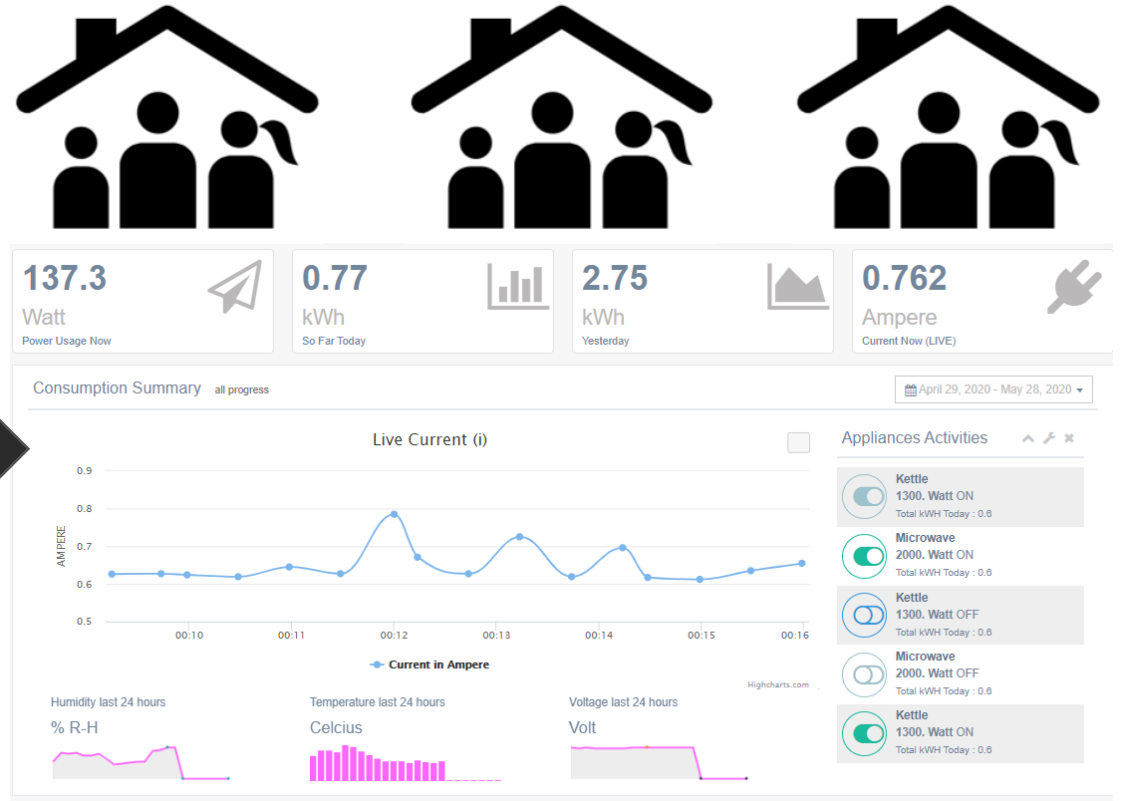
Framework of synthesising residential energy load profile



Weighted proportion (Wepro) model



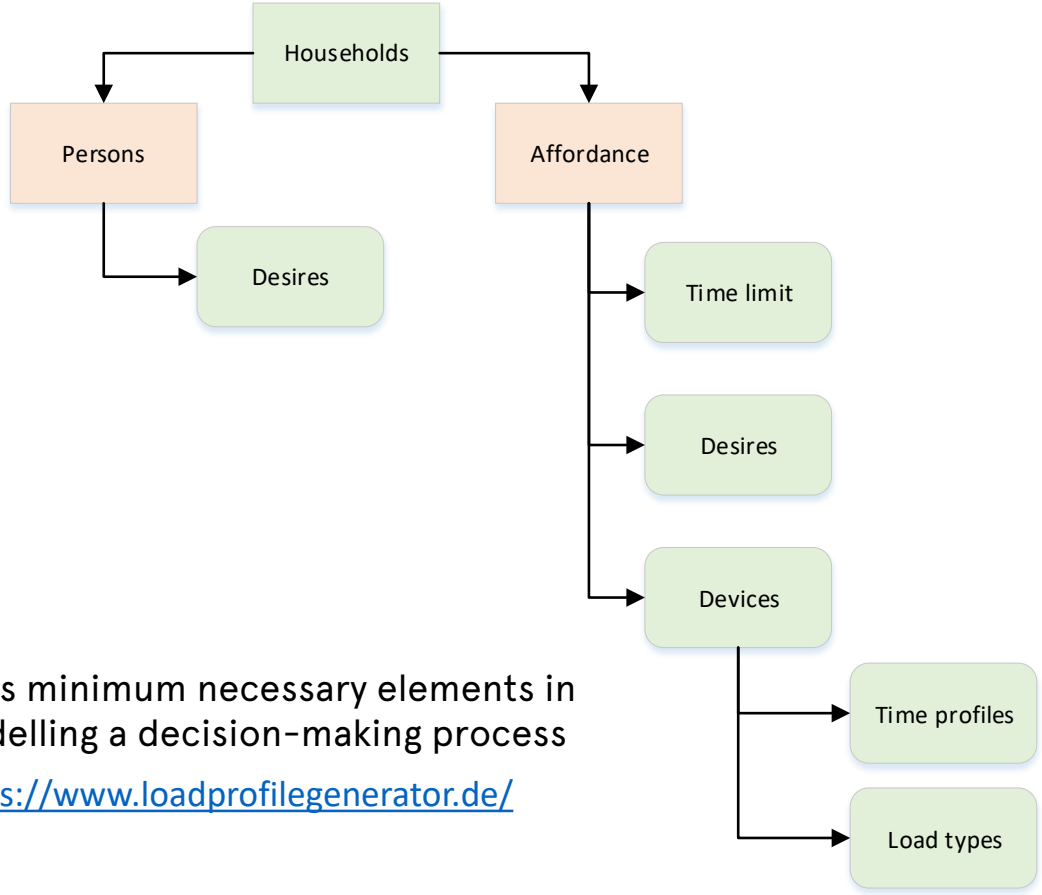
City's profile



Household's profiles in Load profile generator

Household load profile generator

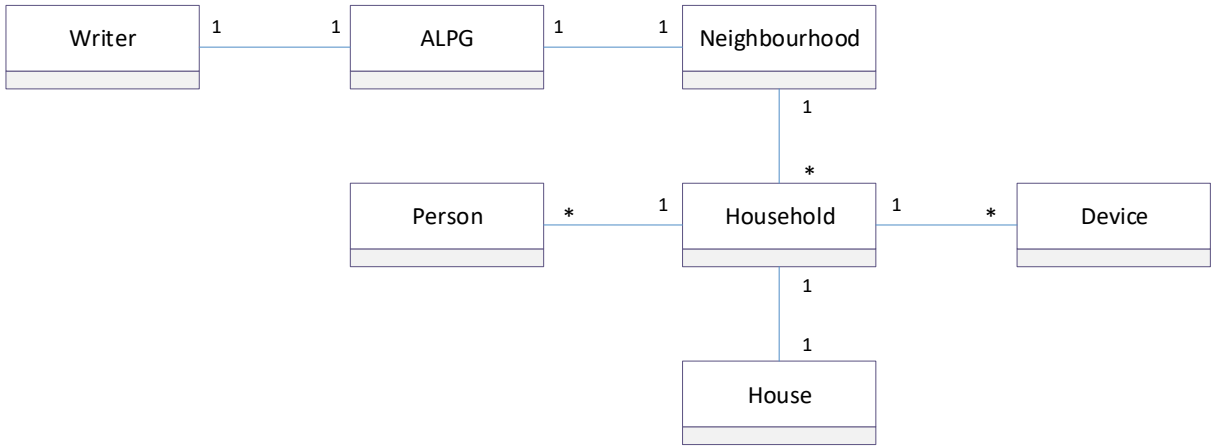
LPG, Noah Pflugradt – Bern University of Applied Sciences



LPG's minimum necessary elements in modelling a decision-making process

https://www.loadprofilegenerator.de/

ALPG, TU Twente



ALPG's class diagram

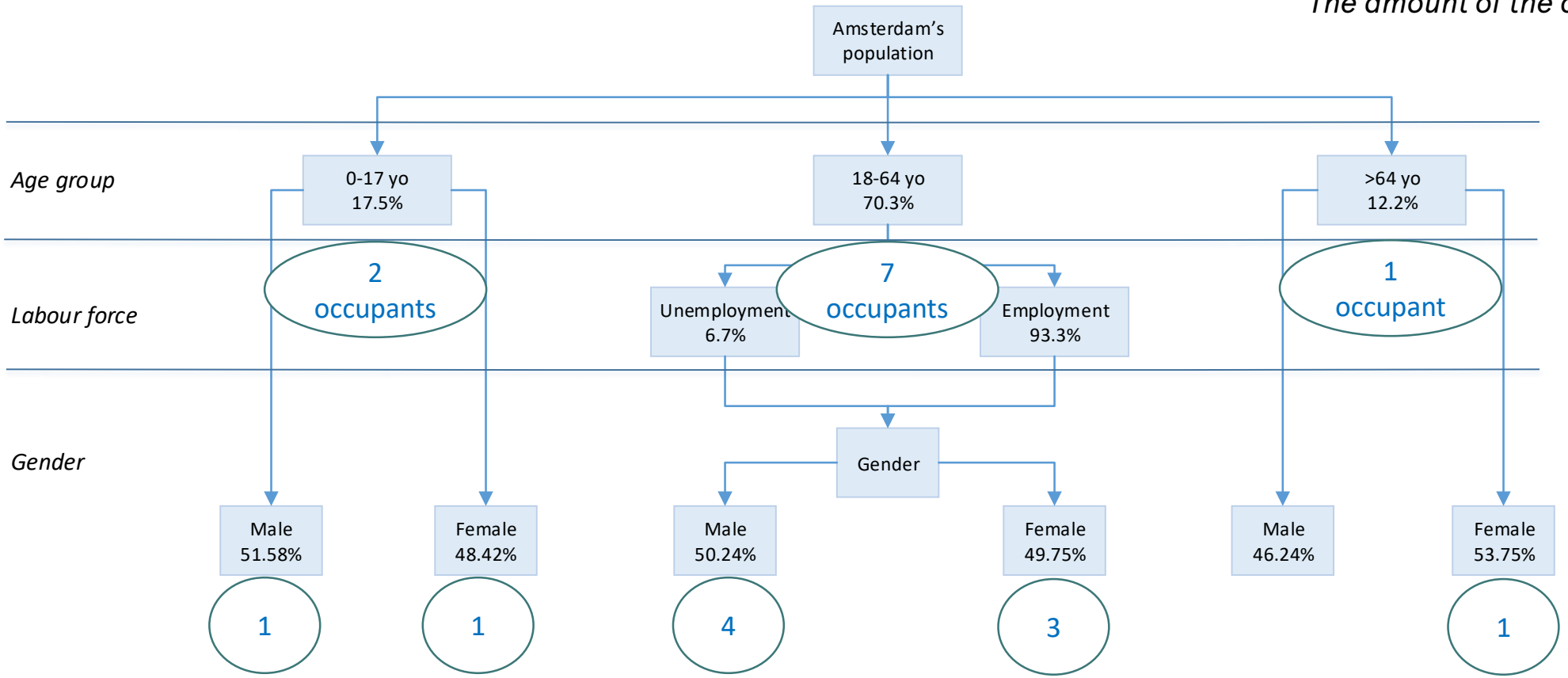
https://www.utwente.nl/en/eemcs/energy/profile_generator/

https://github.com/GENETX/alpg

Results

Application of the model to Amsterdam's case study

The amount of the occupants: AG and Gender?



- **Capacity model**
- **Fairness of allocation applied in LPG**

Results

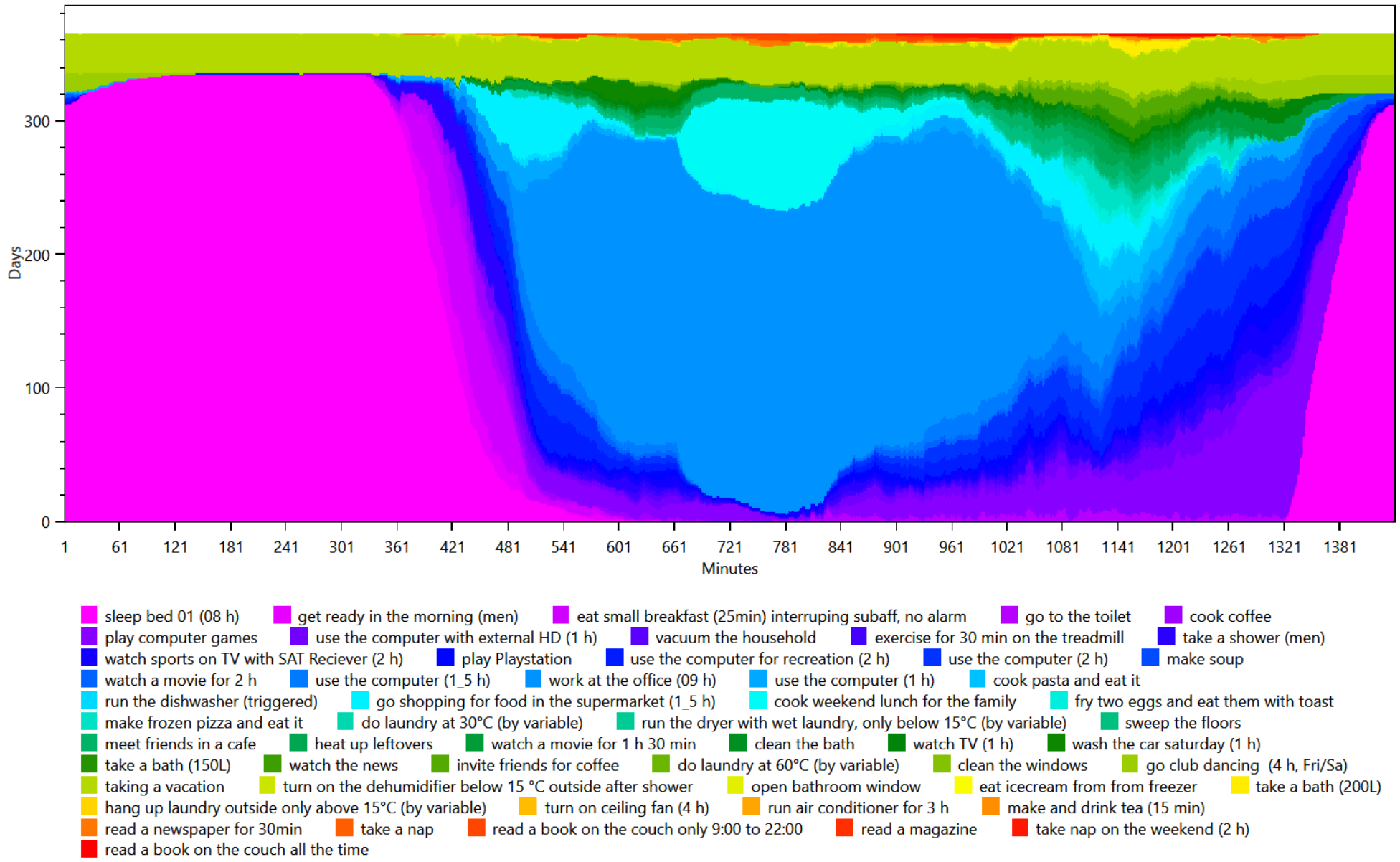
The closest profiles that reflect the city's proportion of the age groups, gender and labour force

Households profiles	Households ID in LPG	The Characters in LPG
Couple with one child, both *at work*	CHR3	Ava (40 female), Fin (43 male) and Luka (10 male)
Couple with one child, *one at work, one at home*	CHR45	Susann (45 female), Alexander (48 male) and Claudia (16 female)
Couple both *at work*	CHR1	Sami (25 male), Rubi (23 female)
Single with *work*	CHR7	Christian (23 male)
Senior at home	CHR31	Monika (68 female)

The selected LPG's pre-defined households

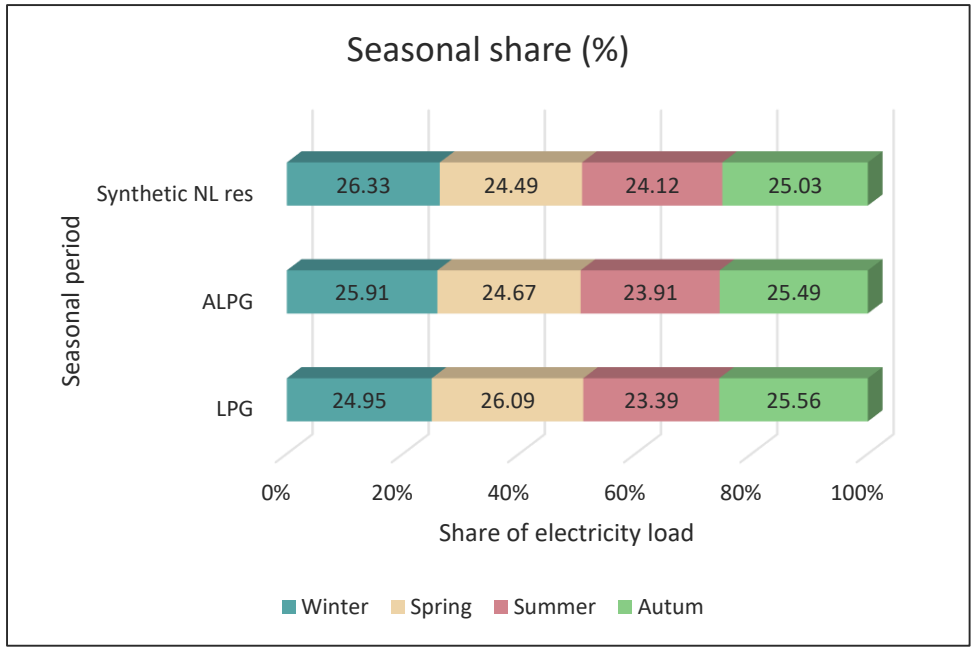
```
#Select the types of households
import households


for i in range(0,1):
        householdList.append(households.HouseholdSingleRetired())

for i in range(0,1):
        householdList.append(households.HouseholdSingleWorker())

for i in range(0,2):
        householdList.append(households.HouseholdDualWorker(False))

for i in range(0,1):
        householdList.append(households.HouseholdFamilyDualWorker(True))
```

Snipped code of the selected ALPG's pre-defined households

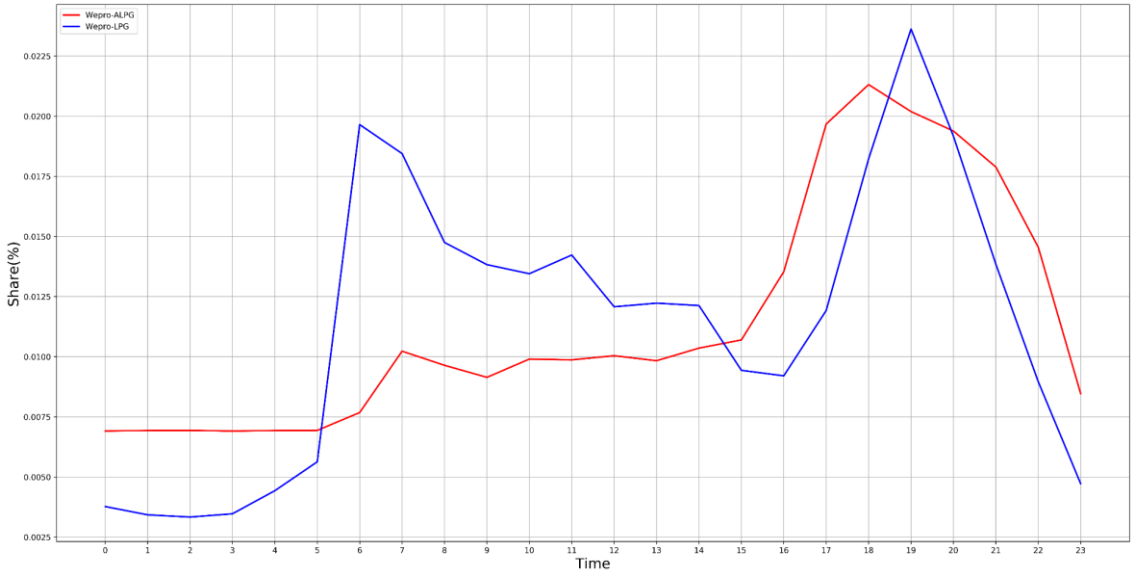


Example of activity frequency per minute of profile: *Single with work*, generated in LPG

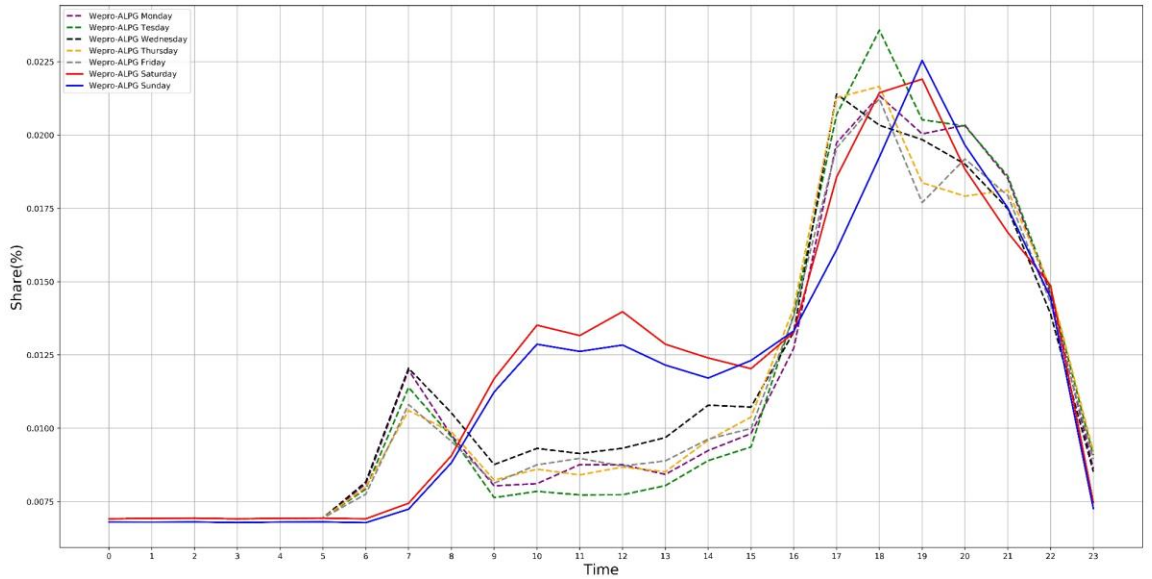
Results



Hourly average share (%) in a year



Hourly average share (%) based on the days



Challenges and limitations

Challenges:

- Data collection of some high-resolution datasets
- Data pre-processing can be a time-consuming process

Limitations:

- Validation with measured-city's representative data due to privacy issues, cost and size of the city's residential data.
- The model depends on the external household profile generators such as LPG and ALPG.

Conclusions

- We have developed a simplified and practical approach to model residential energy load profiles in cities or regions.
- The results between city's profile with the selected pre-defined household profiles are proportionally matched, which may represent the local characteristics through the time-division analyses.
- Wepro model is found to be more efficient in computational process of the residential sector's load profiles, given the number of households in the city that can represent the local profile.

Recommendations

- Different approaches at the city/region level:

*a. High-resolution **spatio-temporal** energy demand simulation.*
*b. High-resolution **stochastic** integrated thermal-electrical domestic demand model.*
*c. **Machine learning** direction*

- Using specific Load profile generator/simulator developed in the case study's country: e.g ALPG-TU Twente, developed with Dutch dwelling setting

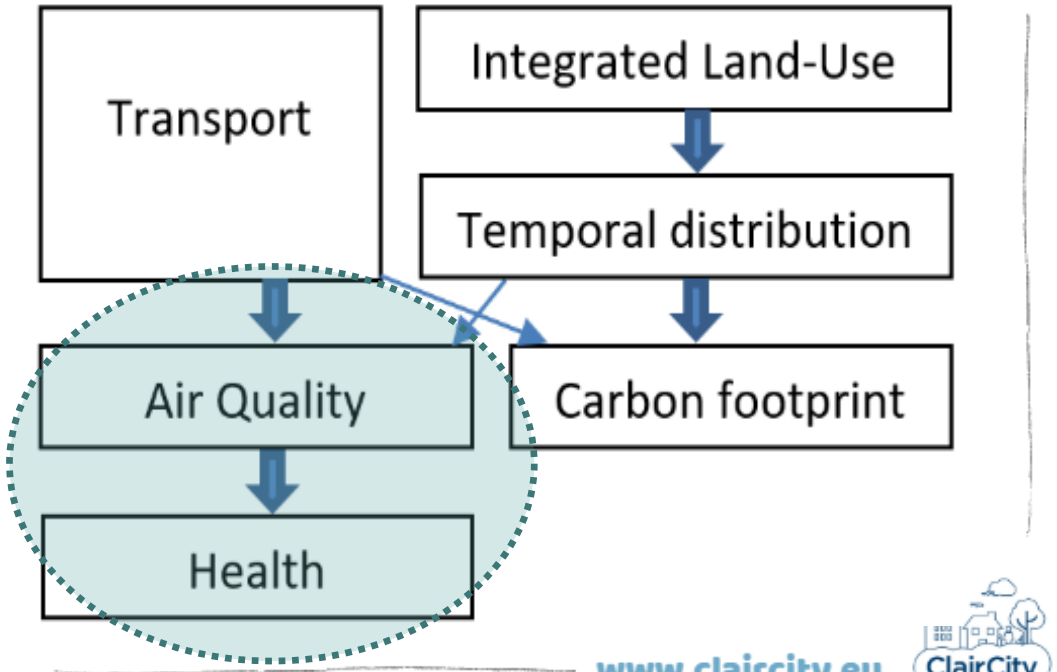
THANK YOU

This project received funding for the European Union's Horizon 2020 research and innovation programme under grant No. 689289.

Zooming in on modelling results

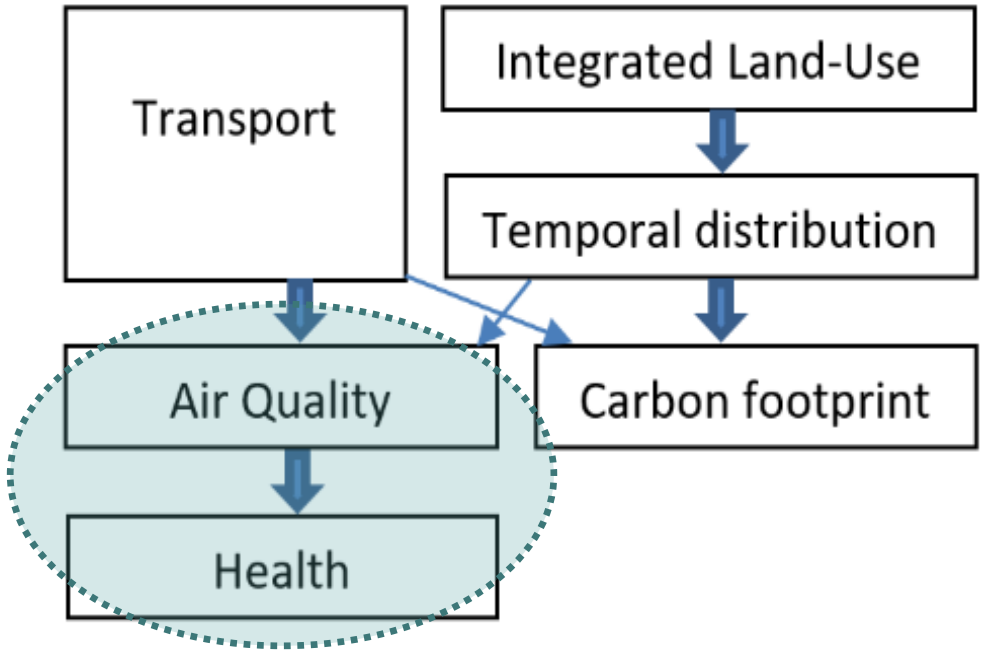
Vera Rodrigues, University of Aveiro, Portugal

Citizens at the Centre



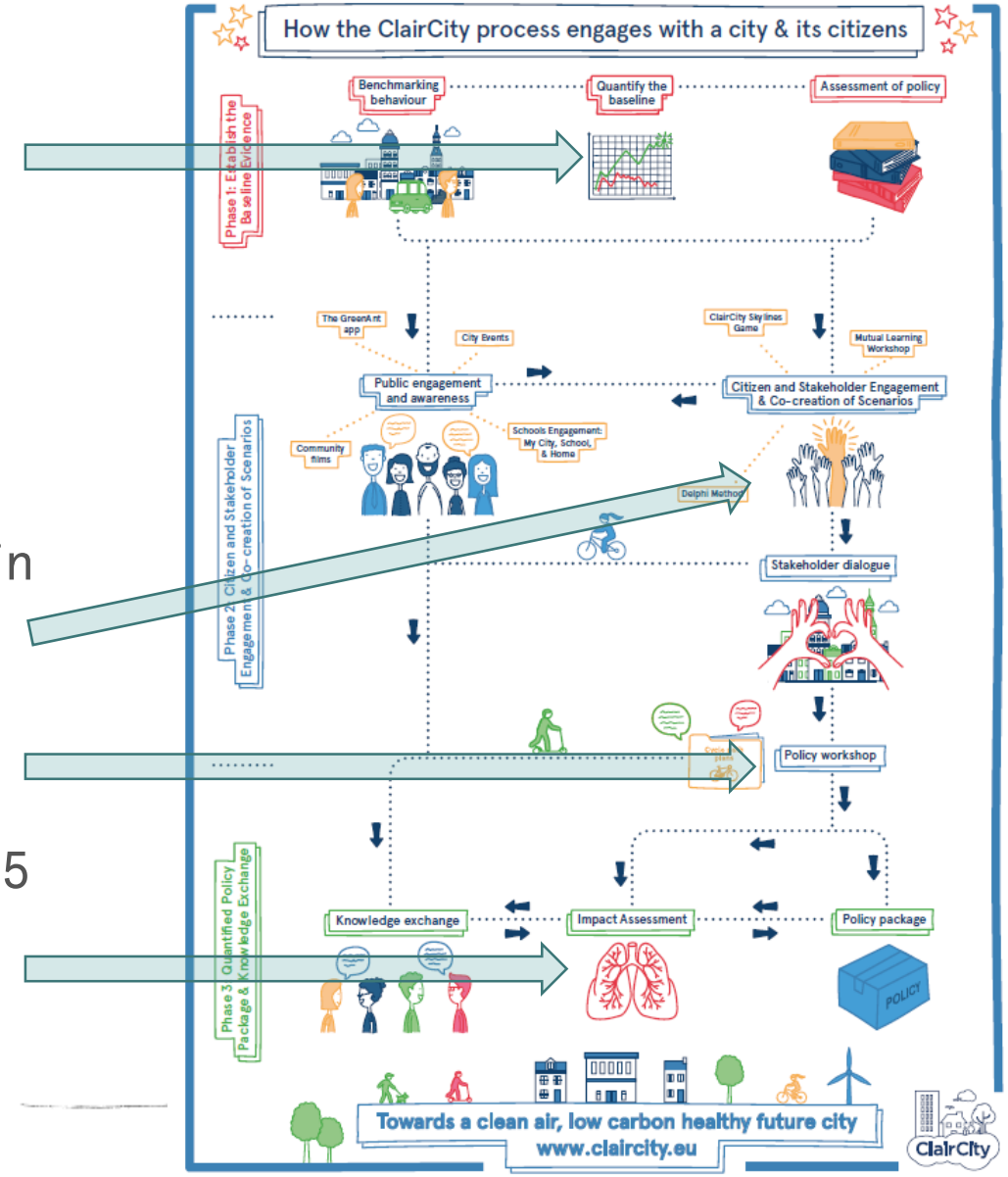
Modelling in ClairCity

- Air quality modelling
  - At mesoscale using the WRF-CAMx model
  - At urban scale using the 2nd generation Gaussian model URBAIR
    - Background concentrations
    - Adjustment procedure
  - Source apportionment
- Population exposure
- Health assessment
  - Estimating mortality health outcomes and the years of life lost due to exposure to air pollution in a given population



Modelling in ClairCity – Assessment process

- Baseline development (2015) + verification
- Establish Business as Usual (BaU) assumptions leading to emission and air quality estimates for 2025, 2035 and 2050
- Scenario assessment in 2 steps
  - Collecting input from citizens and stakeholders in Stakeholder Dialogue Workshops ("SDW") scenario's – explorative in nature.
  - Feedback process leading to a single scenario definition in the Policy Workshop ("PW")
  - Emission and air quality estimates for 2025, 2035 and 2050 for the Unified Policy Scenario ("UPS")

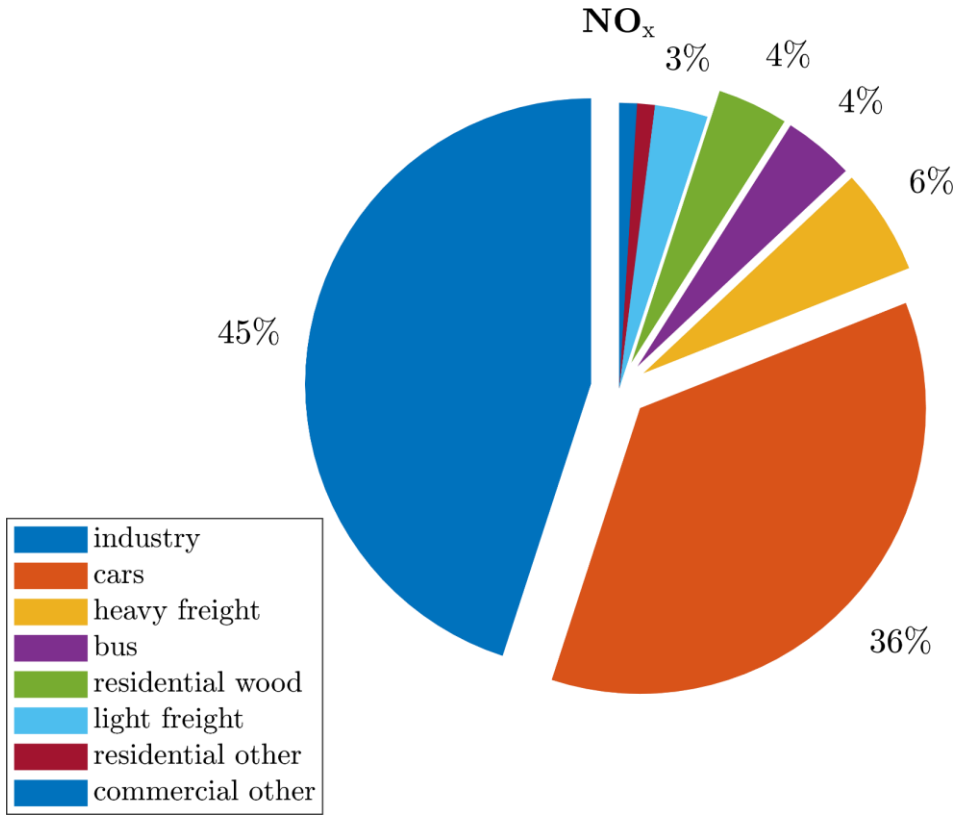


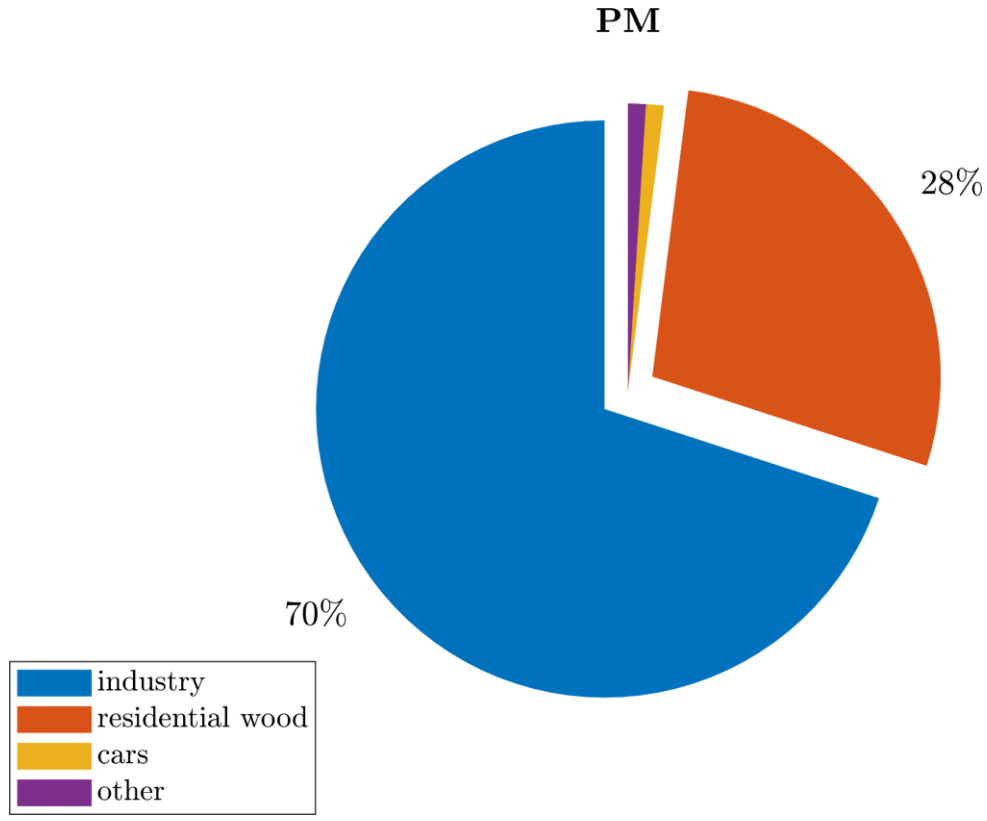
Modelling outputs of ClairCity

- Unified Policy Scenario for the Aveiro region – measures:
  - Public transport fares reduced by 50% by 2021
  - 100% public transport journeys on schedule with all urban areas catered for by 2025
  - 50% modal shift from private cars to active travel and public transport by 2025
  - 100 km of new/ renewed pedestrian routes by 2025
  - 10% ban of diesel cars and 25% HGVs in urban centres by 2025
  - 10% commuters work from home 1 day/week by 2030
  - Reduce industrial emissions by 15% by 2030
  - Replace 15% public transport flees with zero-emission vehicles by 2030
  - 300 km of new urban cycle lanes and 200 new cycle parking spaces by 2035
  - Transform 100% of current parking spaces to free for EVs by 2035

Modelling outputs of ClairCity

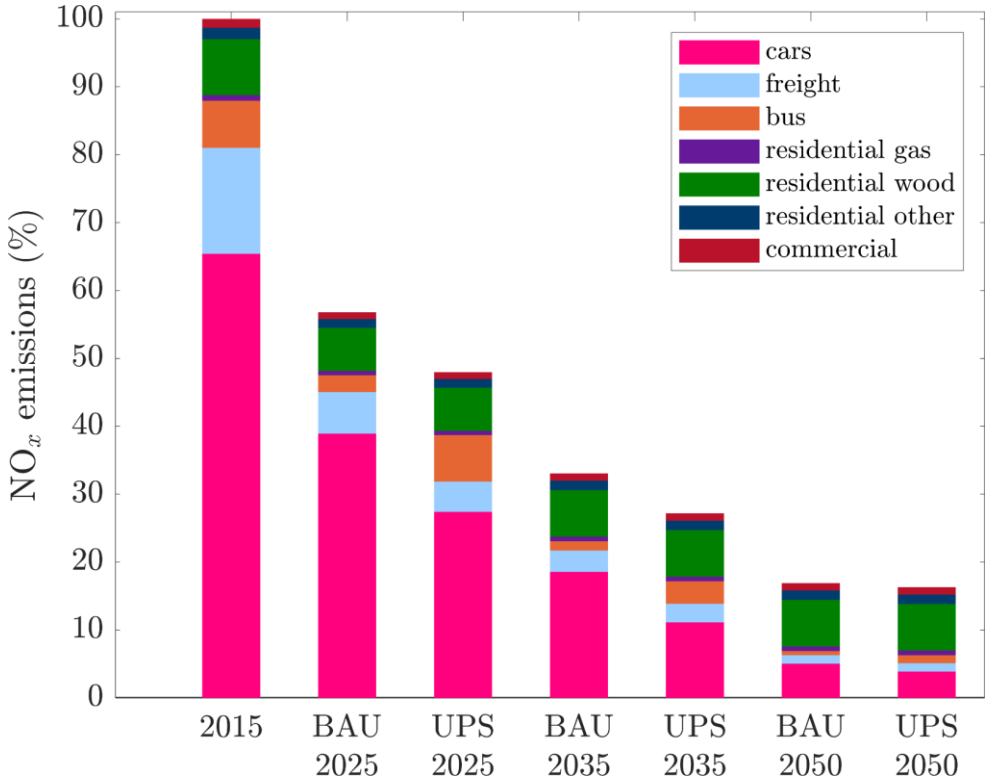
- NO_x and PM emissions in 2015
- Transport, industrial, residential and commercial sectors

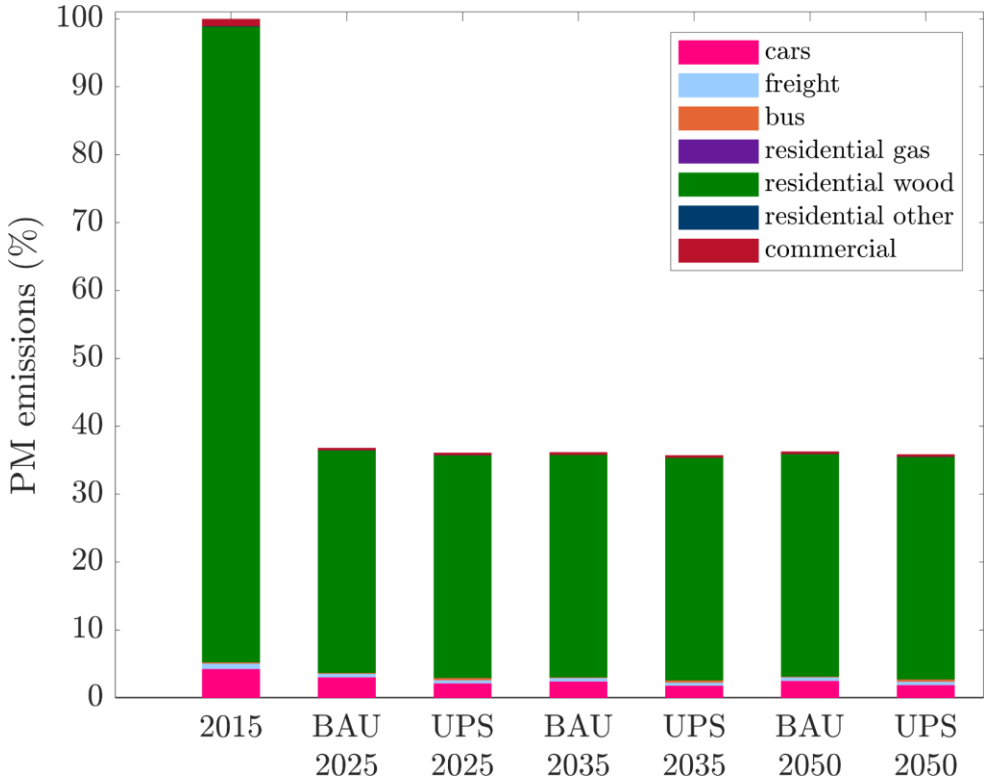




Modelling outputs of ClairCity

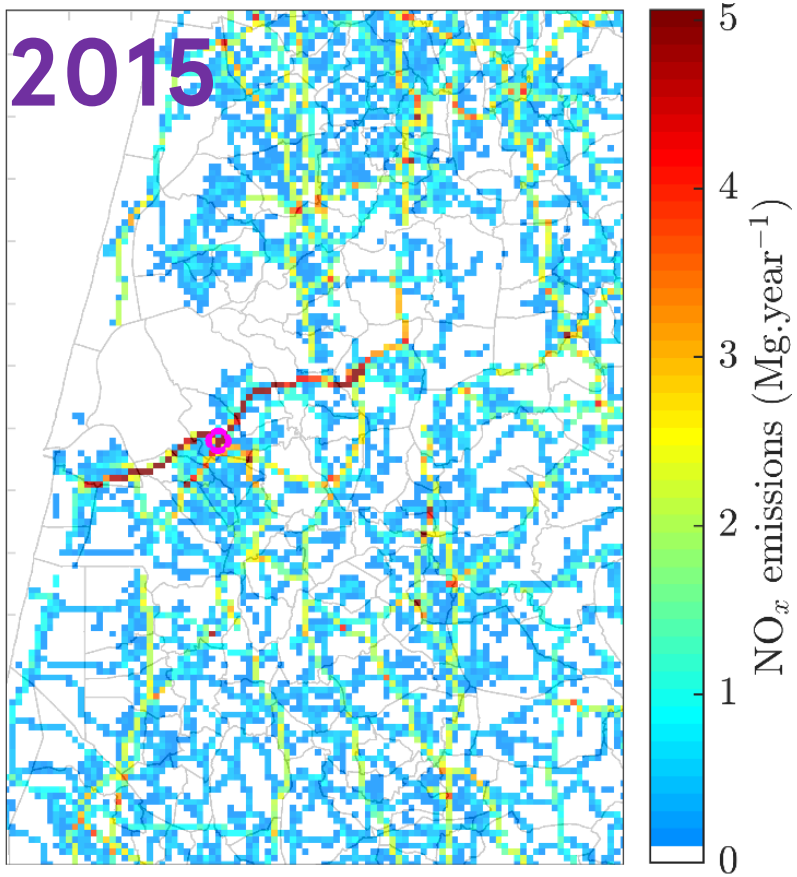
- Trend of PM and NO_x emissions in the UPS, compared to the BAU





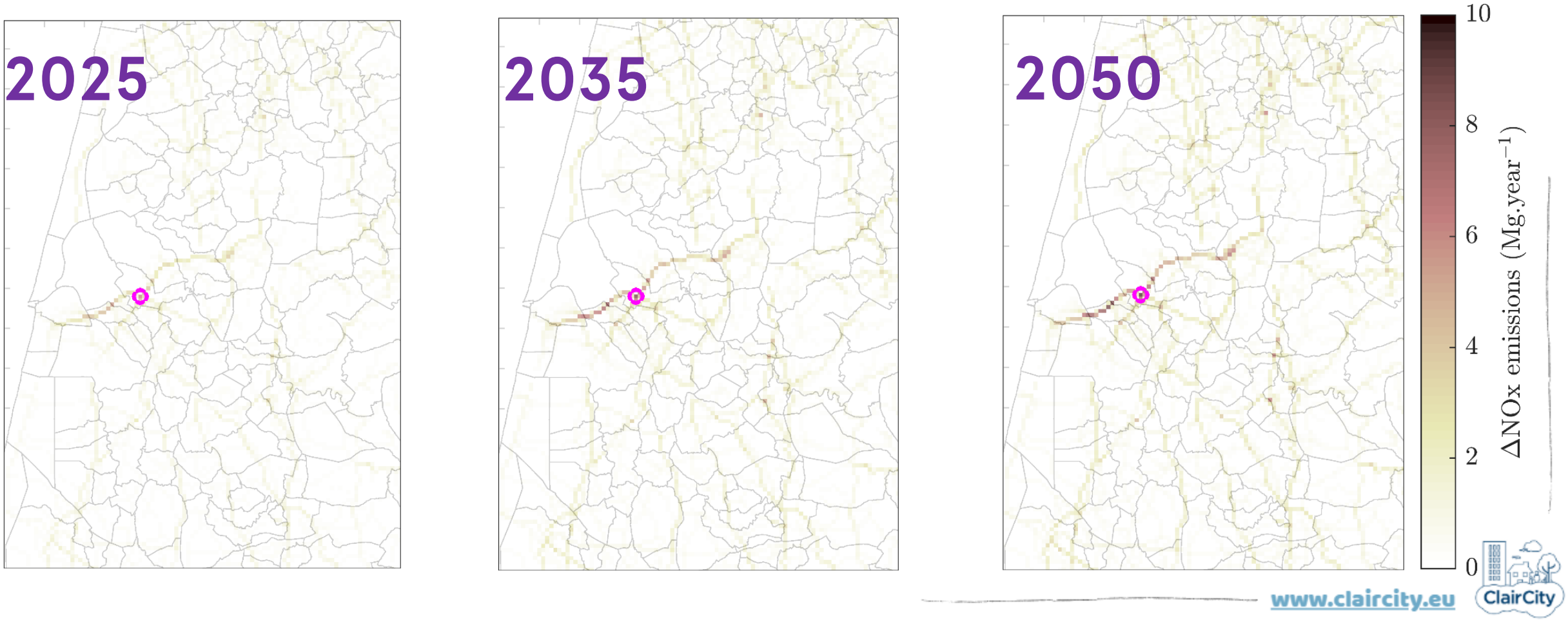
Modelling outputs of ClairCity

- NO_x emissions from transport in 2015



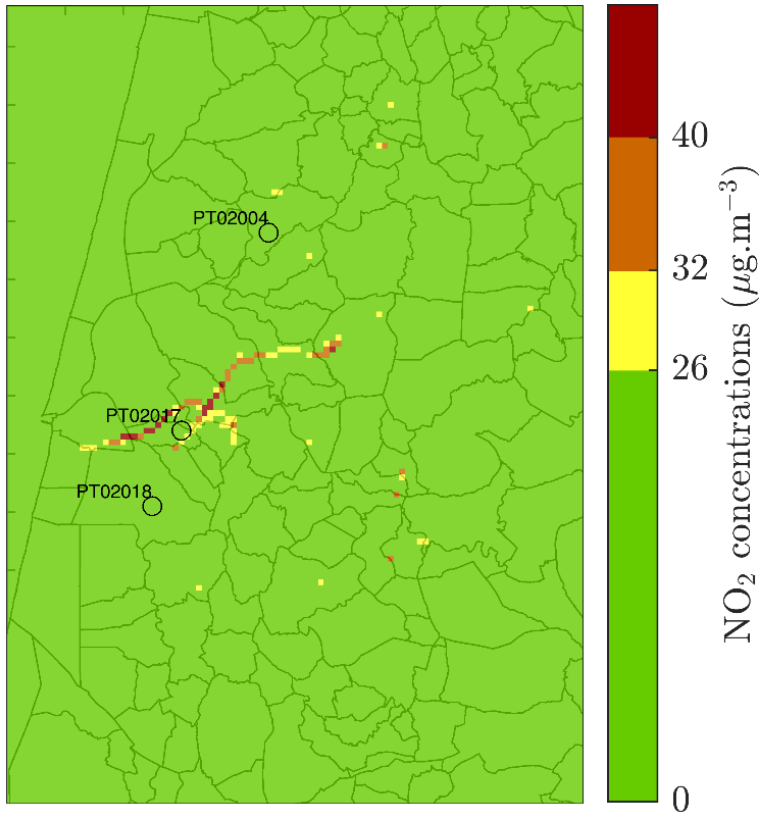
Modelling outputs of ClairCity

- Reductions of NO_x emissions from transport with the UPS scenario compared to 2015



Modelling outputs of ClairCity

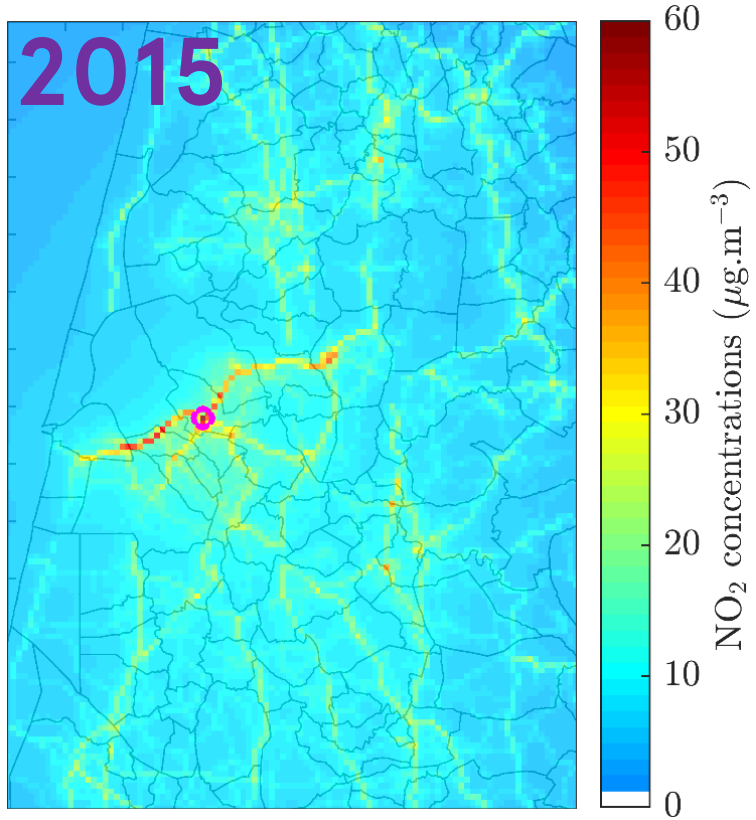
- Air quality modelling verification



Station	NO_2 ($\mu g.m^{-3}$)	NO_2 ($\mu g.m^{-3}$)	Contribution by sector for the corresponding cell (%)		
Station type	measurements	simulation	Transport	Industrial	Com. and Res.
Suburban industrial	13.5	20.1	90.2	9.1	0.7
Urban traffic	23.1	16.7	87.4	11.0	1.6
Suburban background	13.5	10.2	87.4	10.1	2.5

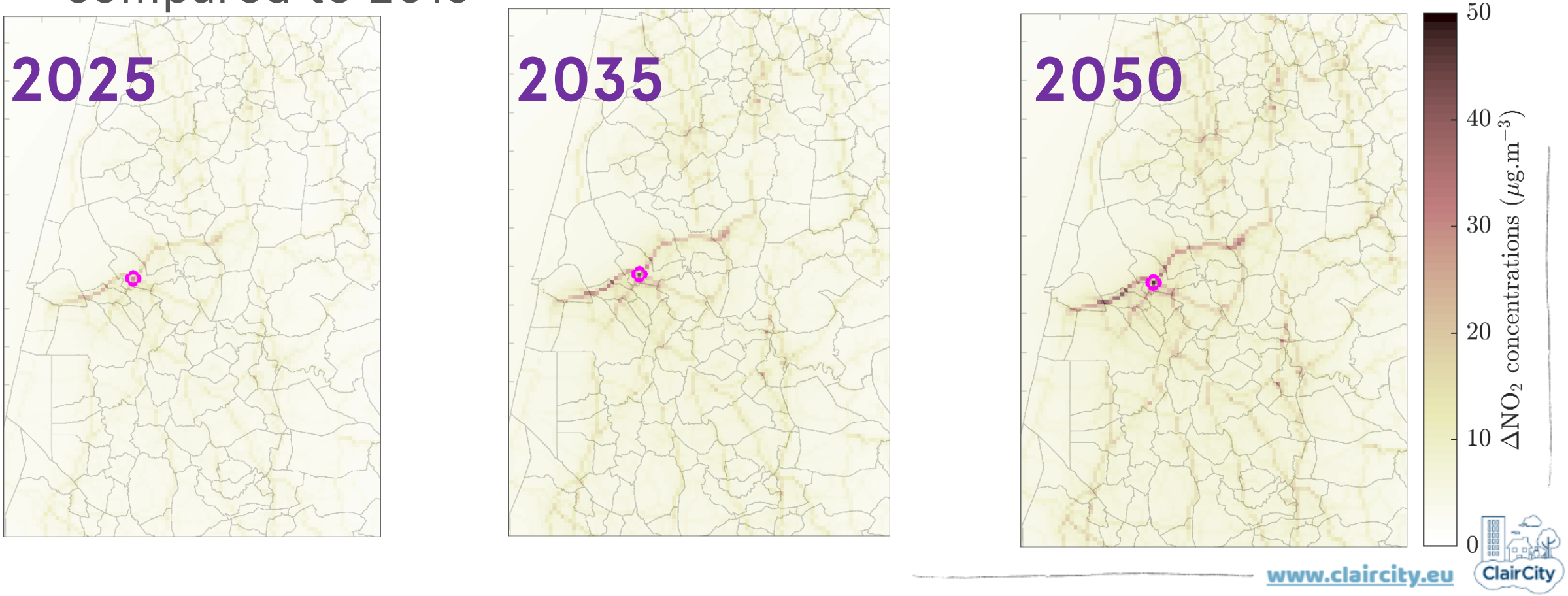
Modelling outputs of ClairCity

- NO_2 concentrations in 2015



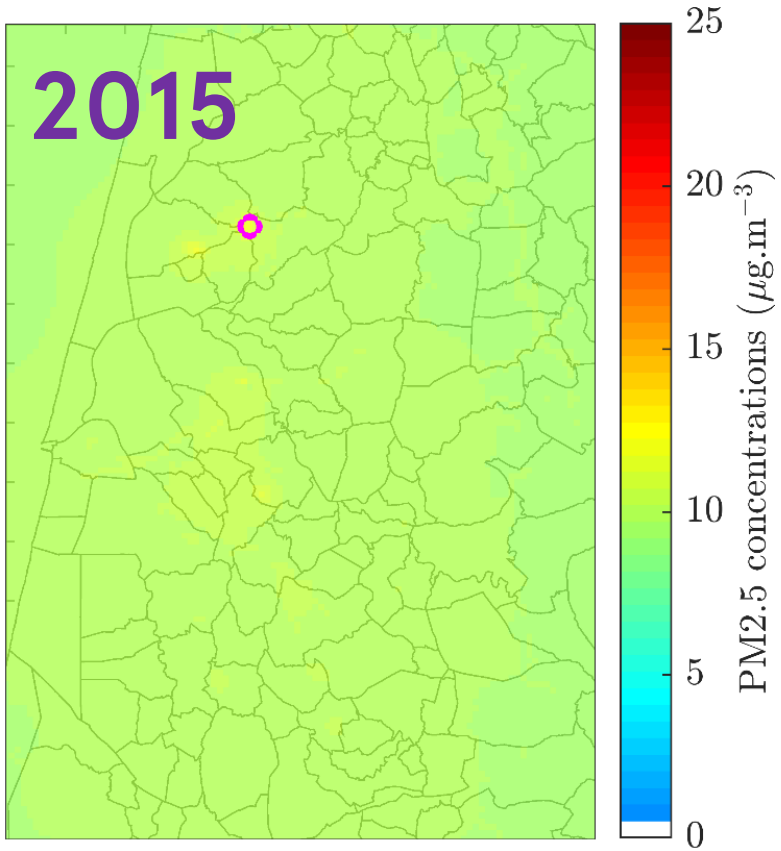
Modelling outputs of ClairCity

- Reductions in NO_2 concentrations with the UPS scenario compared to 2015



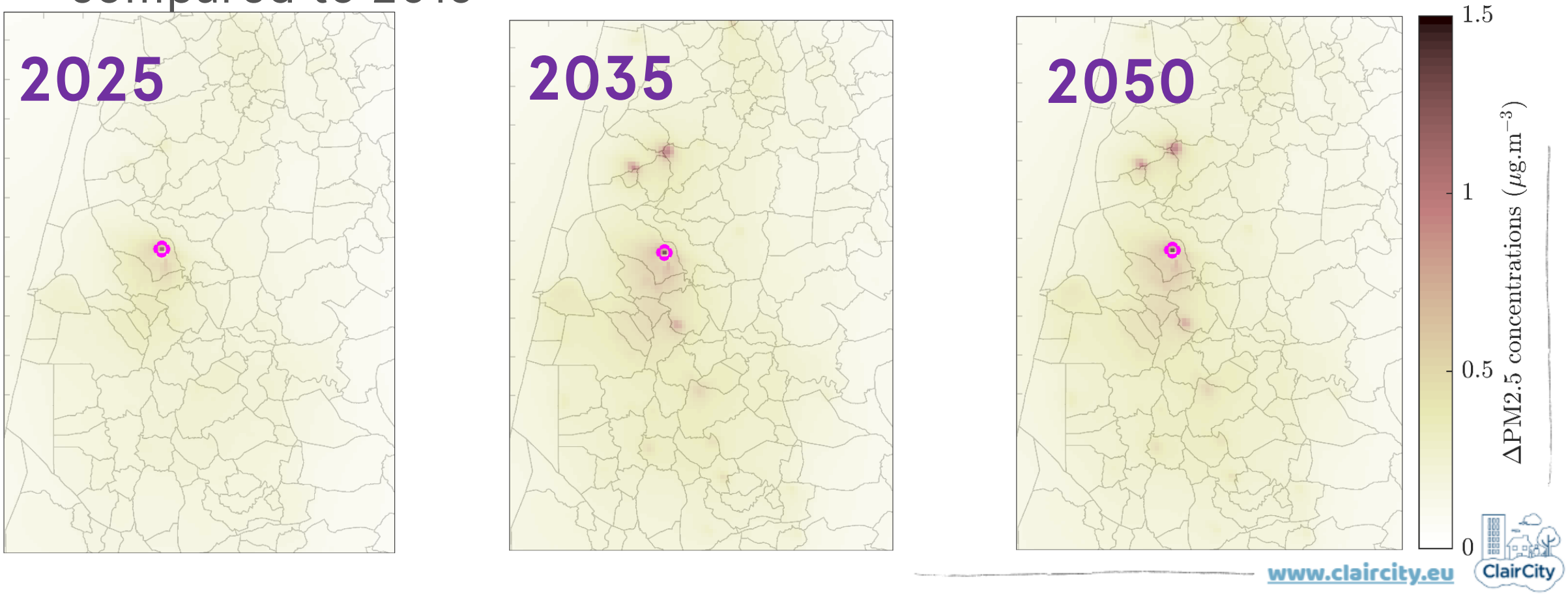
Modelling outputs of ClairCity

- $PM_{2.5}$ concentrations in 2015



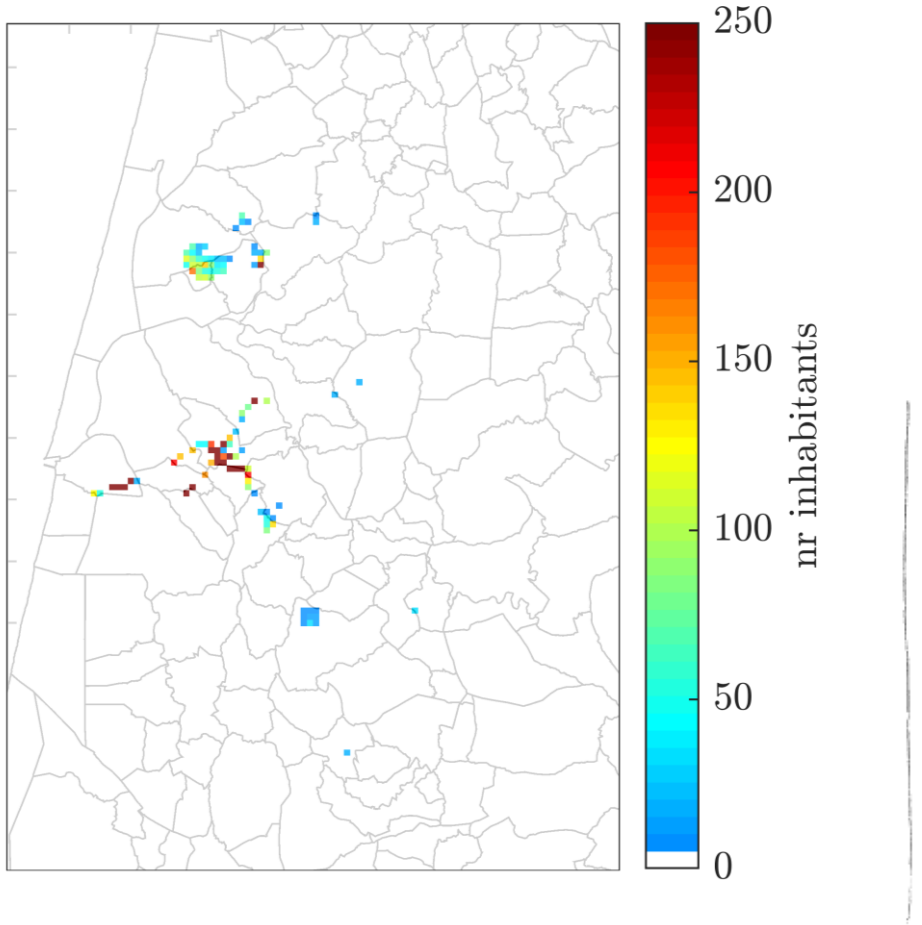
Modelling outputs of ClairCity

- Reductions of $PM_{2.5}$ concentrations with the UPS scenario compared to 2015



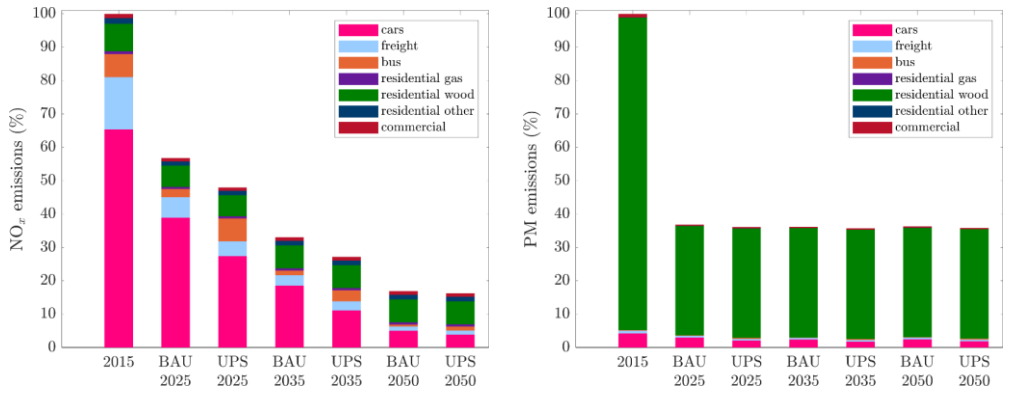
Modelling outputs of ClairCity

- Population potentially exposed to NO_2, PM_{10} and $PM_{2.5}$ concentrations
- ClairCity modelling shows that 49% of the population in the Aveiro Region was potentially exposed in 2015 to $PM_{2.5}$ concentrations above World Health Organisation (WHO) guidelines
- **In 2050**, with the implementation of the **UPS**, **1.5% of the population** in the Region will still be **exposed to $PM_{2.5}$ concentrations above WHO guidelines**



Modelling outputs of ClairCity

- Air quality will distinctly improve in the future depending on the levels of ambition set to the citizens-led scenarios
- The UPS scenario would significantly improve human health compared to the current situation and to future BAU
  - NO_2 concentrations: 10% in 2025 and 1% in 2035
  - PM10 concentrations: 2% in 2035
  - PM2.5 concentrations: 1% in 2035
- Planning of emission control measures has to target air pollutants with the highest health impact for the local population and lead to concentration reductions in areas with high population density



Health outcomes in 2015

	$PM_{2.5}$	PM_{10}	NO_2
Premature deaths	194	154	63
Years of life lost	2235	1766	720

ClairCity Modelling for you!

- Generic city model – in a modular framework (*ZENODO – link coming soon*)
- Generic city database - https://claircitydata.cbs.nl/dataset/d5-2-cities-database (*ZENODO – link coming soon*)
- Separate implementation possible (e.g. transport only, dispersion only,...)
- Especially interesting for medium-sized cities (population: 50-100k)

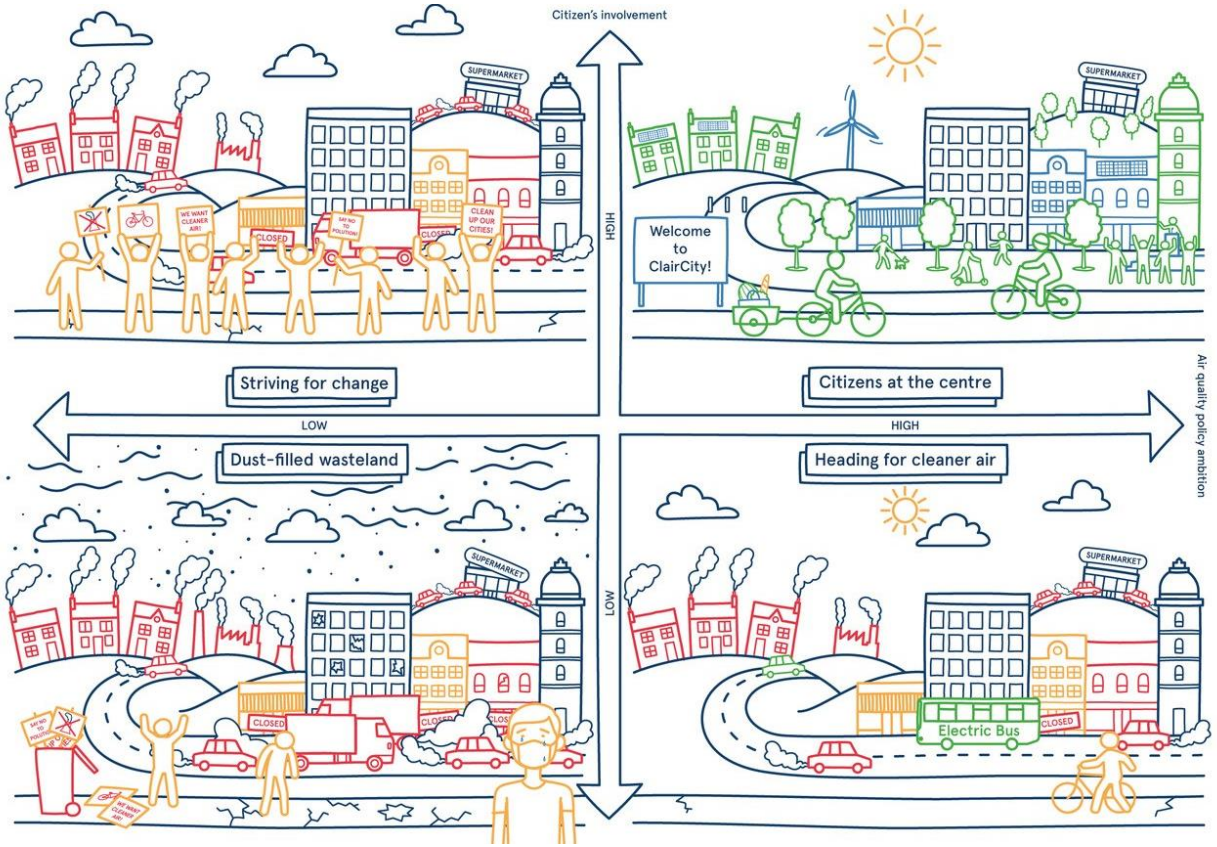
All resources:
https://zenodo.org/communities/claircity/?page=1&size=20

Q&A

Presentations and the recording will be made available after the Webinar

ClairCity is committed to the principles of Open Access. All relevant data and methodologies will be available in the coming week on our ClairCity community page on Zenodo.

What future do you want to help create?



Before you go:

Sign up to our upcoming webinars

June 25th: Citizens at the centre of air pollution and carbon reductions – lessons for policy
Coming in July: community approaches to citizen involvement
Search 'ClairCity' on Eventbrite

Check your inbox: we will email all resources discussed in due course.

Follow us on social @ClairCity
We will announce our E-learning resources, developed from these webinars, on there soon.

This project received funding for the European Union's Horizon 2020 research and innovation programme under grant No. 689289.

ClairCity

1. Trinomics B.V. (Project Coordinator - Netherlands)
2. University of the West of England, Bristol (Technical Lead - UK)
3. PBL Netherlands Environmental Assessment Agency (NL)
4. Statistics Netherlands CBS (Netherlands)
5. Technical University of Denmark (Denmark)
6. Norwegian Institute for Air Research (Norway)
7. REC Regional Environmental Centre (Hungary)
8. TECHNE Consulting (Italy)
9. Transport & Mobility Leuven (Belgium)
10. University of Aveiro (Portugal)
11. ***Municipality of Amsterdam (Netherlands)***
12. ***Bristol City Council (UK)***
13. ***Intermunicipal Community of Aveiro Region (Portugal)***
14. ***Liguria Region (Italy)***
15. ***Municipality of Ljubljana (Slovenia)***
16. ***Sosnowiec City Council (Poland)***

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