CHANGE

CITIZEN ACTIONS ON CLIMATE CHANGE AND ENVIRONMENT

# Preliminary carbon and environmental footprint results of the iCHANGE project


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**Task force on emission inventories &projections**
**Expert Panel on Projections - 9 May 2022 Oxford (UK)**

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## I-CHANGE - Horizon 2020 Innovation Action project

**I-CHANGE main objective is to raise awareness on the impacts of climate change and related natural hazards, through direct collection of environmental and socio-economic data with novel and user-friendly tools (sensors, monitoring devices, simplified models, data resources)**

**The promotion of a co-designed learning approach will improve citizen knowledge of climate change related harmful impacts and help citizens understand how their own behavioural and consumption shift towards sustainable patterns can make a difference**

**The project, funded by European Union's Horizon 2020, started in November 2021 and running for 3,5 years**

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# Overall concept of I-CHANGE?

## *How behavioural change of individuals is possible through citizen science initiatives and citizen tailored information and communication technologies (ICT)*

**Based on the idea that citizens and the civil society have a crucial role in the definition of environmental protection and climate action, the I-CHANGE project employs a co-creation Living Lab approach that connects citizens and science to foster the transition towards more sustainable patterns**

**Empowerment through knowledge** acquired through hands-on participation in the monitoring and assessment

**Understanding the role and the impact of individual choices** (behaviour, lifestyle and consumptions) in daily life and its consequences on the environment

**Improvement of data usability and interoperabilit y** through a dedicated Environmental Data Hub

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## Eight interactive Living Labs (LLs)

### with citizen science and environmental monitoring activities

**Through co-designed and personalised tools, citizens learns about climate change and environmental hazards science and understand how their own behaviour can affect climate change as well as how they can reduce their carbon and environmental footprint through changes in their everyday life**

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# Living Labs Citizen Science Monitoring

## *Devices for monitoring and observation activity within the citizen science framework*

- **The amateur meteorologists**
- **Mobile survey forms**
- **Low-cost sensors**
- **MeteoTracker**

MeteoTracker


Mobile App

Acronet

Smart Citizen Kit

Weather station

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# Enhancing monitoring opportunities through citizen science (WP3)

- To organize citizen science initiatives in the LLs to raise awareness on climate action and to motivate the citizen engagement by improving the environment observations
- To create a distributed European network of sensors for environmental monitoring
- To calculate the environmental and carbon footprint associated to individual lifestyle
- To evaluate the effects of consumption and personal behaviors
- To raise awareness of human impacts of daily habits and motivate the engagement of citizens
- To raise citizens' awareness of the occurrence of extreme events and their exposure to them in a climate change context
- To evaluate the environmental and socio-economic impacts of I-CHANGE solutions in LLs hosting cities through a quali-quantitative, ad hoc-developed, methodology

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## Behavioral changes: carbon & environmental footprint

**Exploring behavioral changes through numerical simulations (Task 3.1)**

**Benchmarking behavioral changes: apportionment of carbon and environmental footprint (Task 3.2 )**

**Exploring the impacts of behavioral changes on the mitigation of climate change: impacts on extreme events (Task 3.3)**

- **Modeling of behavioral changes (T3.1)**
- **Co-created scenarios (LLs activities)**

→

**GHGs, SLCFs and APs Emissions and reductions (T3.2)**

→

- **Raise awareness & motivate engagement in the LLs**
- **GHGs and APs concentrations (T3.3)**

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# Carbon and Environmental footprint task

- setup of methodologies for carbon and environmental footprint model following the "emission inventory" approach
- development of a specific computer model ($E^2$GovCmty) to support detailed calculations
- evaluation of emissions of GHGs and other climate forcers such as black carbon and methane, energy consumption and waste production
- evaluation of air pollutants and Short-Lived Climate Forcers (SLCFs) emissions
- evaluation of environmental footprint (including energy consumption and waste production)

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# Evaluation of emissions and CF in LLs area

## Emissions and CF are evaluated in LLs area using an integrated approach

**Collect and elaborate emissions and projections from regional and/or national emission inventory**

**Integrate emissions and projections or the activities directly involved in the LLs framework (for example road traffic)**

**LLs area actual and scenario emissions and CF**

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# air pollutants and Short-Lived Climate Forcers (SLCFs) emission factors

- The emissions of air pollutants and SLCFs are evaluated using emission factors from EMEP/EEA Guidebook and/or national emission factors
- The following indirect SLCFs emissions are computed: methane (CH4), nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), and ammonia (NH3), black carbon (BC)
- PM2,5 is speciated in aerosols consist of sulphate, nitrate, ammonium, carbonaceous aerosols, mineral dust.

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# carbon footprint

carbon footprint is evaluated following an emission inventory approach using both:

- Standard" emission factors (emissions will be evaluated using methodologies and emission factors from 2006 and 2019 IPCC Guidelines for National Greenhouse Gas Inventories and specific activity level)
- LCA (Life Cycle Assessment) emission factors, which take into consideration the overall life cycle of the energy carrier

$CO_2$ equivalent emissions include emissions of $CH_4$ and $N_2O$ using the the Global Warming Potential with 100 year time horizon (1 t CH4 = 21 Mg CO2-eq, 1 t N2O = 310 Mg CO2-eq)

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# $CO_2$ Emission factors

| Fuel | Standard Emission Factors [1] [Mg CO2/MWh] | Standard Emission Factors [2] [Mg CO2eq/MWh] | LCA Emission Factors [3] [Mg CO2-eq/MWh] |
|---|---|---|---|
| Motor Gasoline | 0.249 | 0.250 | 0.299 |
| Gas oil, diesel | 0.267 | 0.268 | 0.305 |
| Residual Fuel Oil | 0.279 | 0.279 | 0.310 |
| Anthracite | 0.354 | 0.356 | 0.393 |
| Other Bituminous Coal | 0.341 | 0.342 | 0.380 |
| Sub-Bituminous Coal | 0.346 | 0.348 | 0.385 |
| Lignite | 0.364 | 0.365 | 0.375 |
| Natural Gas | 0.202 | 0.202 | 0.237 |
| LPG | 0.227 | 0.227 | 0.281 |
| Municipal Wastes (non-biomass fraction) | 0.330 | 0.337 | 0.330 |
| Municipal Wastes (biomass fraction) | 0 | 0.007 | 0.106 |
| Industrial Wastes | 0.515 | 0.522 | 0.522 |
| Wood° | 0 – 0.403 | 0.007 – 0.410 | 0.017 – 0.416 |
| Plant oil° | 0 – 0.287 | 0.001 – 0.302 | 0.182 – 0.484 |
| Biodiesel° | 0 – 0.255 | 0.001 – 0.256 | 0.156 – 0.411 |
| Biogas/Greengas° | 0-0.197 | 0-0.197 | 0,087-0.284 |
| Solar°° | 0 | 0 | 0.04 |
| Geothermal°° | 0 | 0 | 0,05 |
| Hydroelectric°°° | 0 | 0 | 0,006 |
| Wind°°° | 0 | 0 | 0,01 |

[1] IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy

[2] Calculated using the the Global Warming Potential (GWP) with 100 year time horizon: 1 Mg CO2 = 1 Mg CO2-eq; 1 t CH4 = 21 Mg CO2-eq, 1 t N2O = 310 Mg CO2-eq

[3] European Reference Life Cycle Database (ELCD) Release 3.2. LCA data sets of key energy carriers, materials, waste and transport services of European scope (2015)

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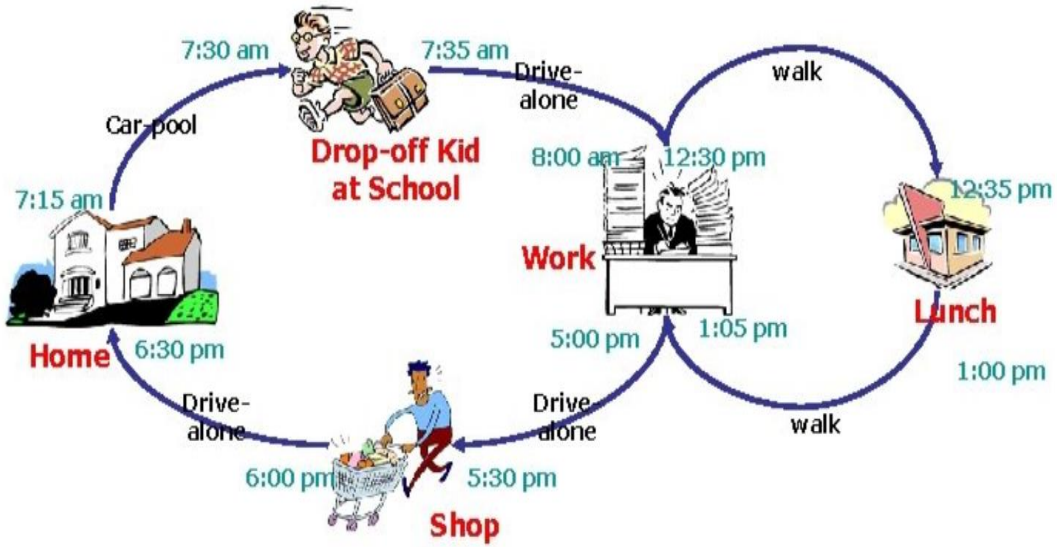
# LLs road traffic study

## Activity-Based simulation Model

- Predict schedules of individual mostly in relation to travel for out-of-home activities
- Translating schedules in terms of traffic on the road network



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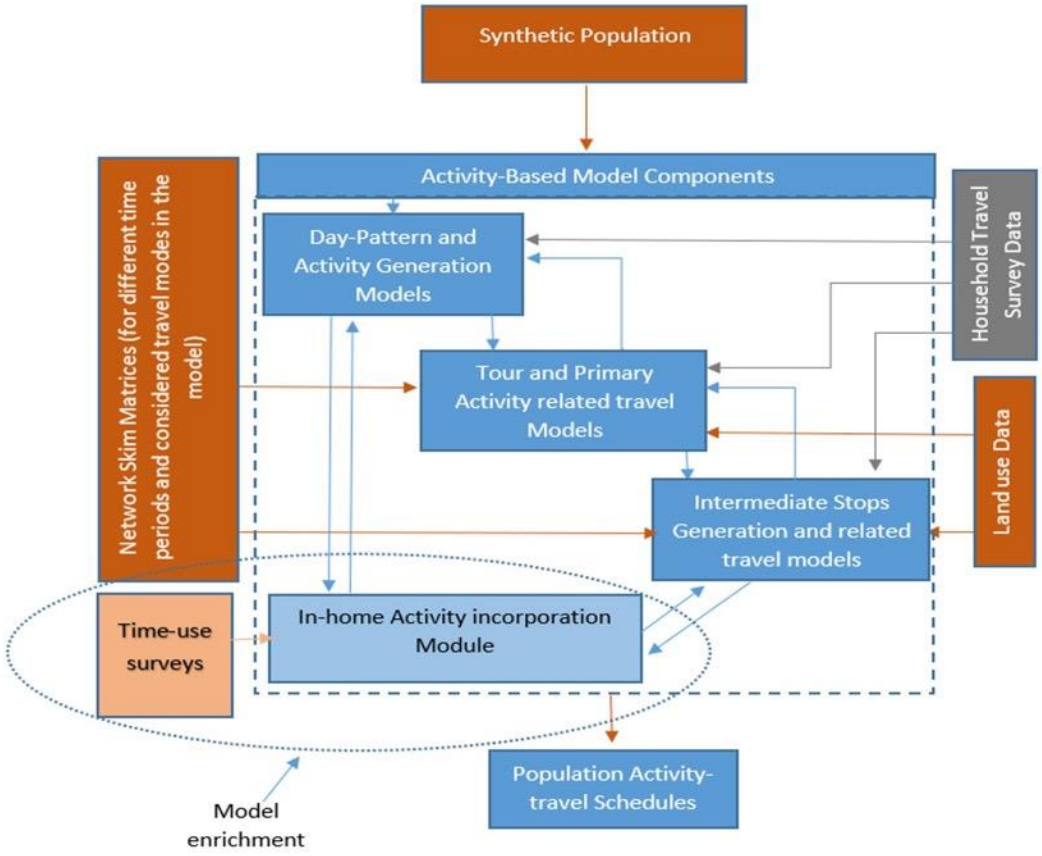
# Traffic model




## In-home activity types considered:

- Sleep, including night sleeps and daytime naps.
- Personal maintenance, such as personal care, eating/drinking, grooming.
- Household maintenance, such as general household activities, house cleaning, caring for household members.
- Leisure, such as relaxing, socializing, watching TV, Exercising, and hobbies/games.
- Discretionary activities, such as religious/spiritual and volunteer activities.
- Mandatory activities, including work and school related activities.

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# E²GovCmty model

## E²GovCmty model has been finalized to evaluate carbon footprint greenhouse gases and pollutants emissions

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# Bologna LL traffic case study


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# Bologna LL traffic scenarios

- **Base case**
- **Scenario 1 Provision of bicycle infrastructure in identified areas**
  - it is assumed that city authorities will enhance the overall bicycle infrastructure (which includes the provision of bike lanes segregated from road traffic) wherever possible
  - all "residential/ service/ living streets" roads would have speed limits reduced to 30 km/hr
- **Scenario 2 Introducing Low Emission Zone LEZ**
  - Vehicles running on EURO IV standards (diesel vehicles) or above are allowed in this zone, this rule is not applicable for individuals who are living already in the demarcated zone (LEZ in charge from 1-1-2024)
  - Buses are also allowed regardless of their Euro standard
  - Light heavy vehicles are also subject to this policy
  - Vehicles running on petrol are allowed

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# Bologna base case emission estimates

- 46,652 links categorized as urban, extraurban and highway based on speed limit on the road
- Traffic simulations for the peak hours and day scaled to annual mileage with typical factors
- Emission factors for all pollutants and GHs from national ISPRA emission inventory 2020; in the following table a selection for $NO_X$ and computed CF from original GHGs EFs

| | Urban | | Rural | | Highway | |
|---|---|---|---|---|---|---|
| Category | NOx | CO2eq | NOx | CO2eq | NOx | CO2eq |
| Passenger Cars (PC) | 0,445 | 240,2 | 0,291 | 144,8 | 0,334 | 151,0 |
| Light Duty Vehicles (LDV) | 0,986 | 328,8 | 0,758 | 201,5 | 1,338 | 260,4 |
| Heavy Duty Vehicles (HDV) | 5,656 | 974,1 | 2,657 | 629,3 | 2,154 | 659,1 |
| Buses | 6,436 | 1.095,1 | 3,675 | 715,8 | 2,418 | 604,1 |
| Motorcycles | 0,083 | 116,3 | 0,114 | 97,0 | 0,186 | 117,1 |

https://fetransp.isprambiente.it/#/

- In scenario 2 a reduction of 13% of the NOx emissions is applied to the links in LEZ considering share of diesel urban emissions in Bologna and 25% reduction in diesel PC-LDV

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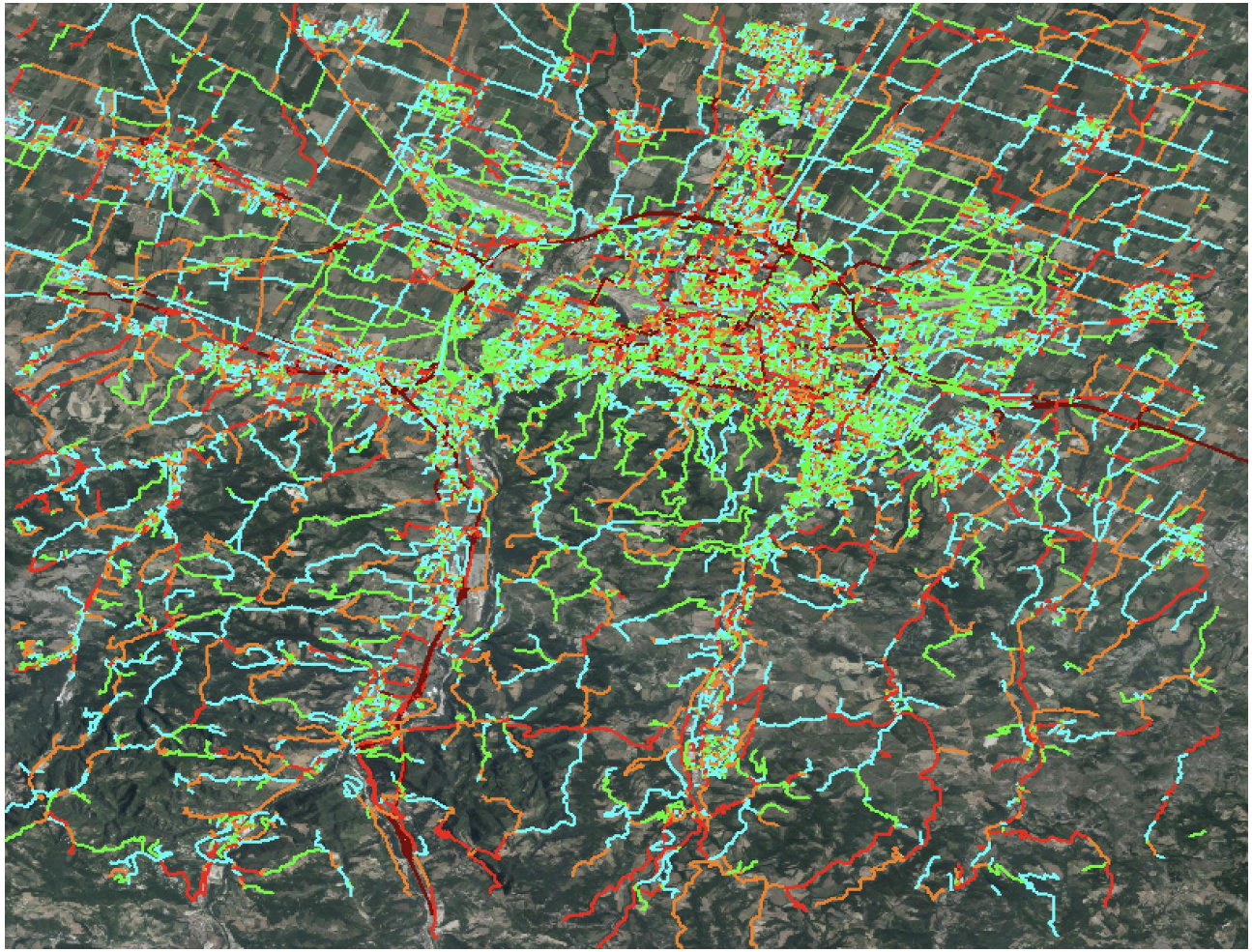
# Bologna NOx Base Case map




**Hourly values for Peak hour and May month**

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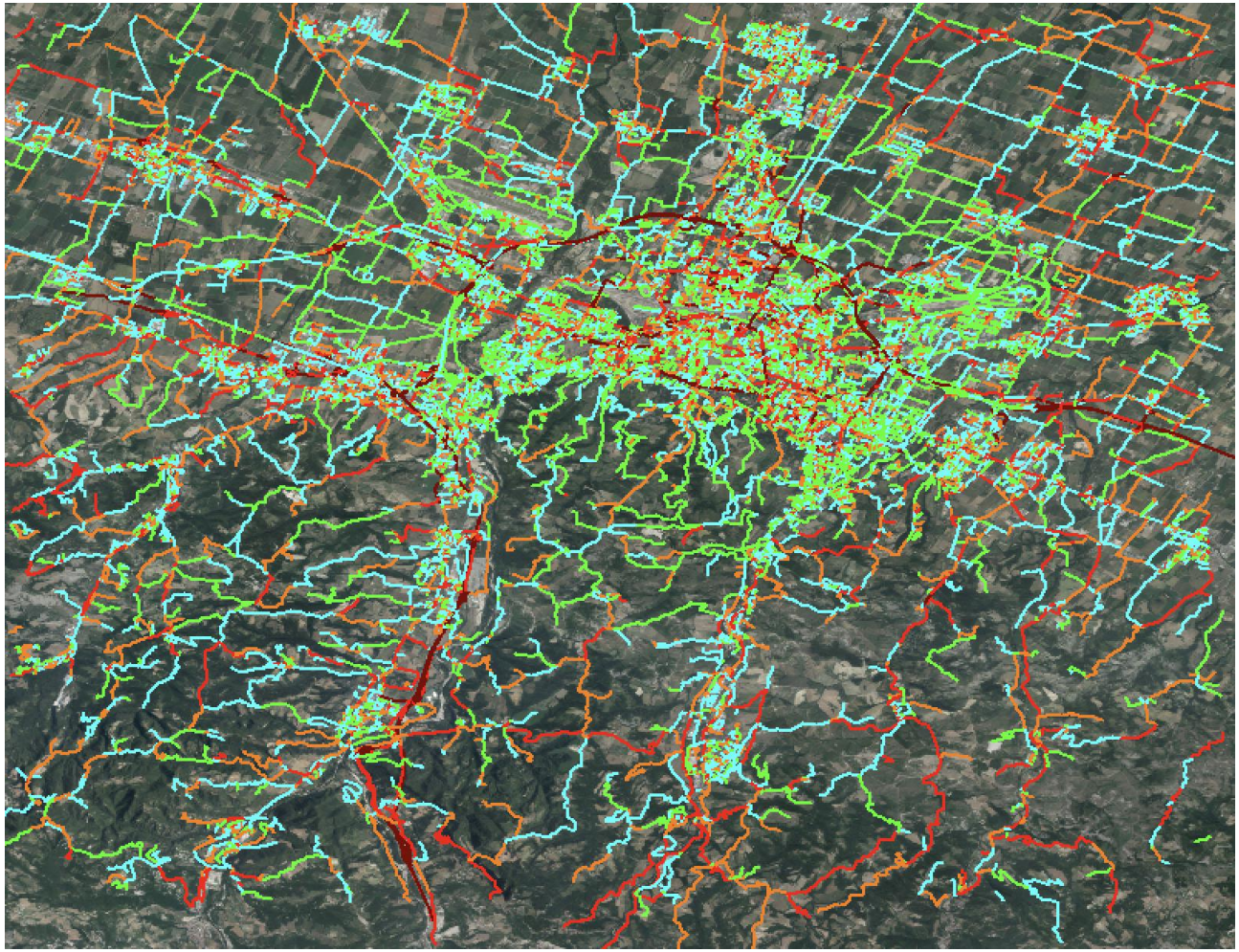
# Bologna NOx Scenario 1 map

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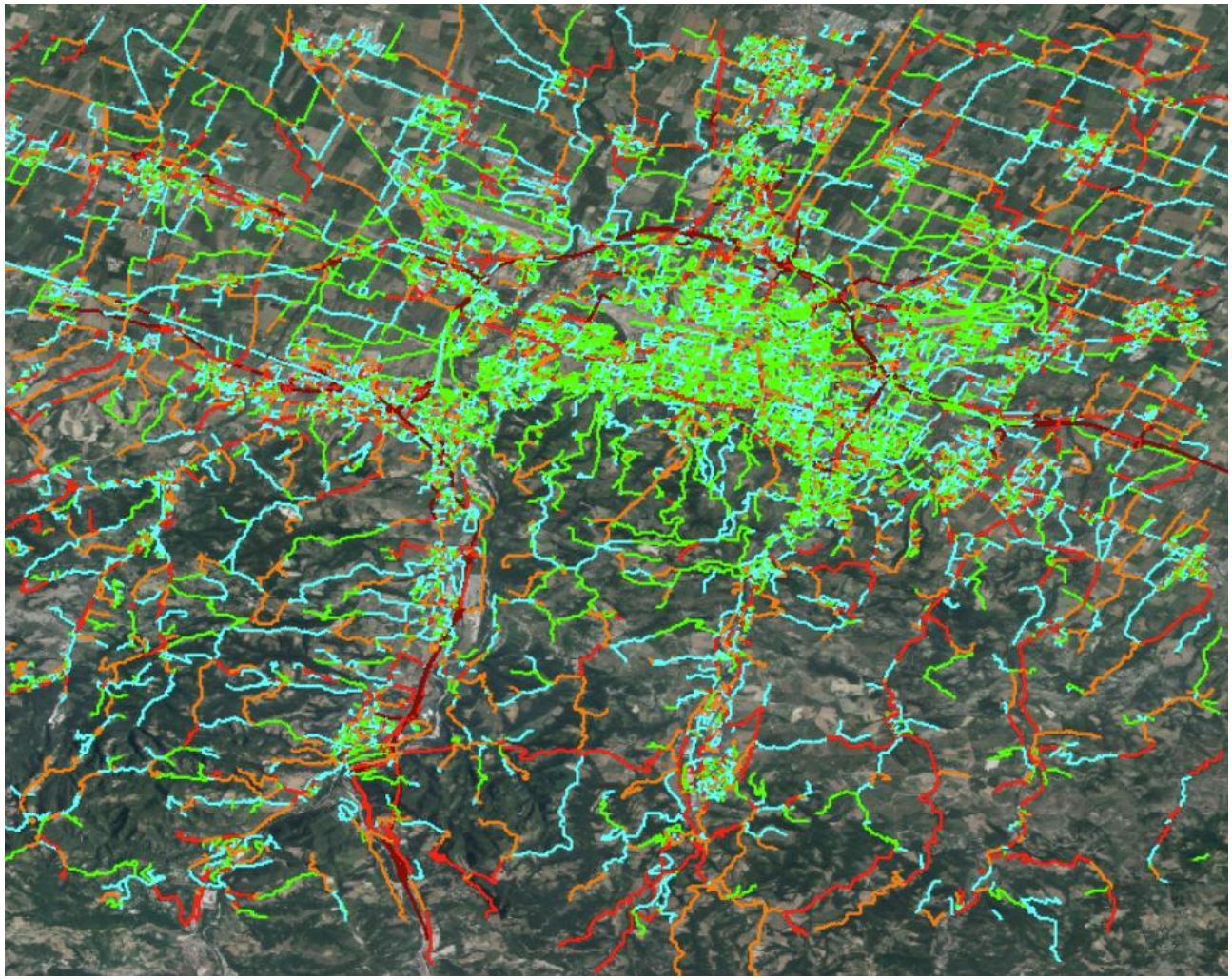
# Bologna NOx Scenario 2 map

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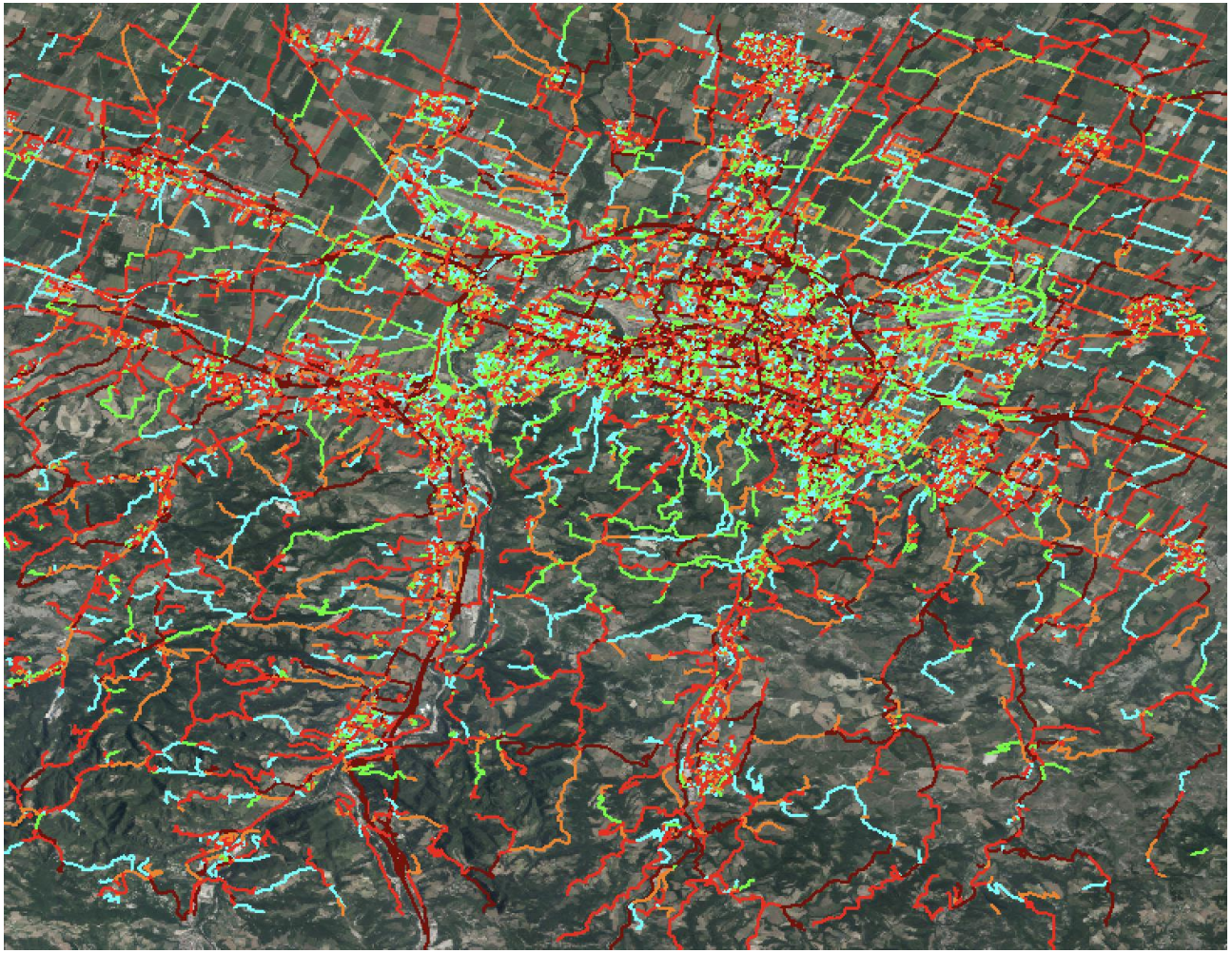
# Bologna CF Base Case map

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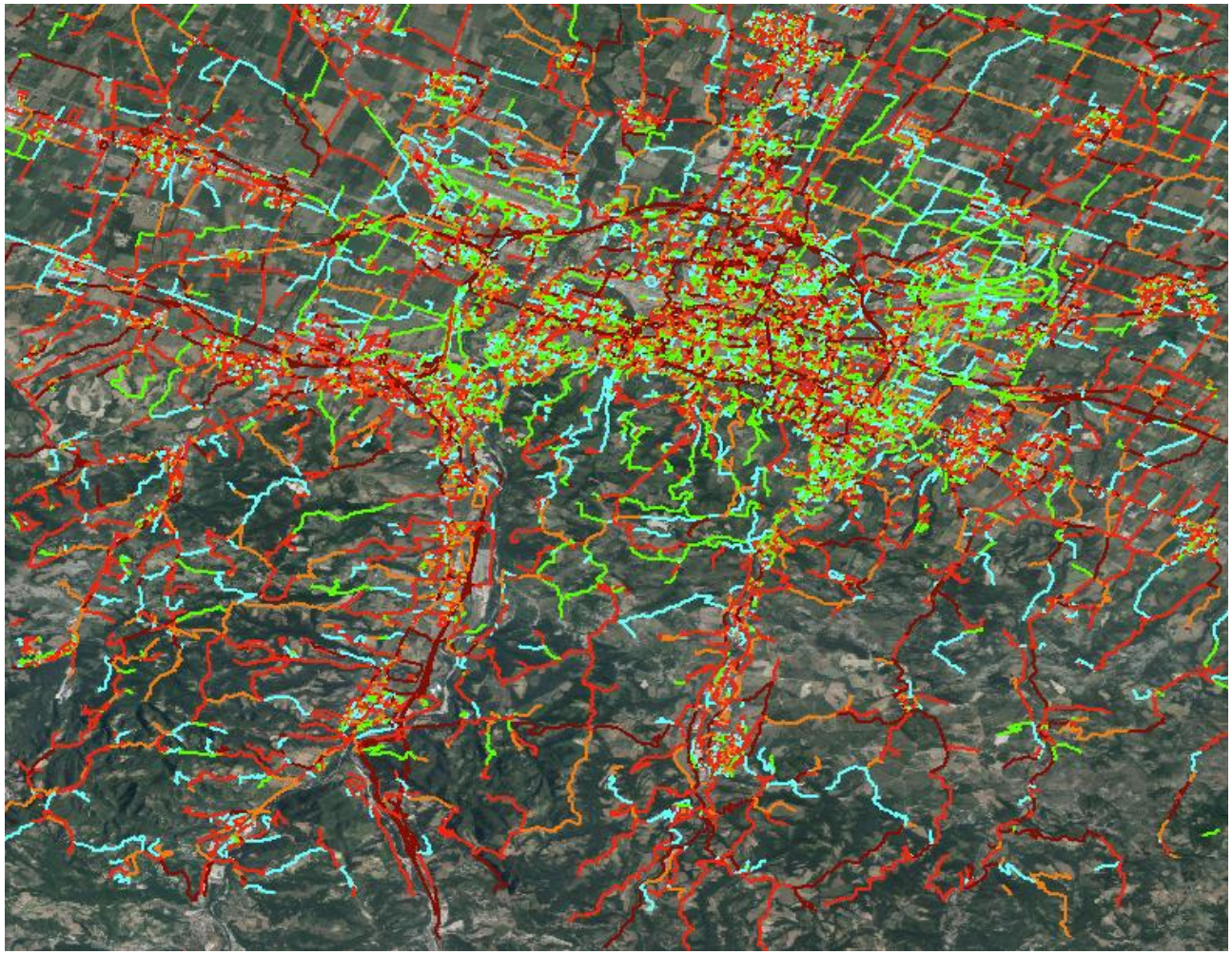


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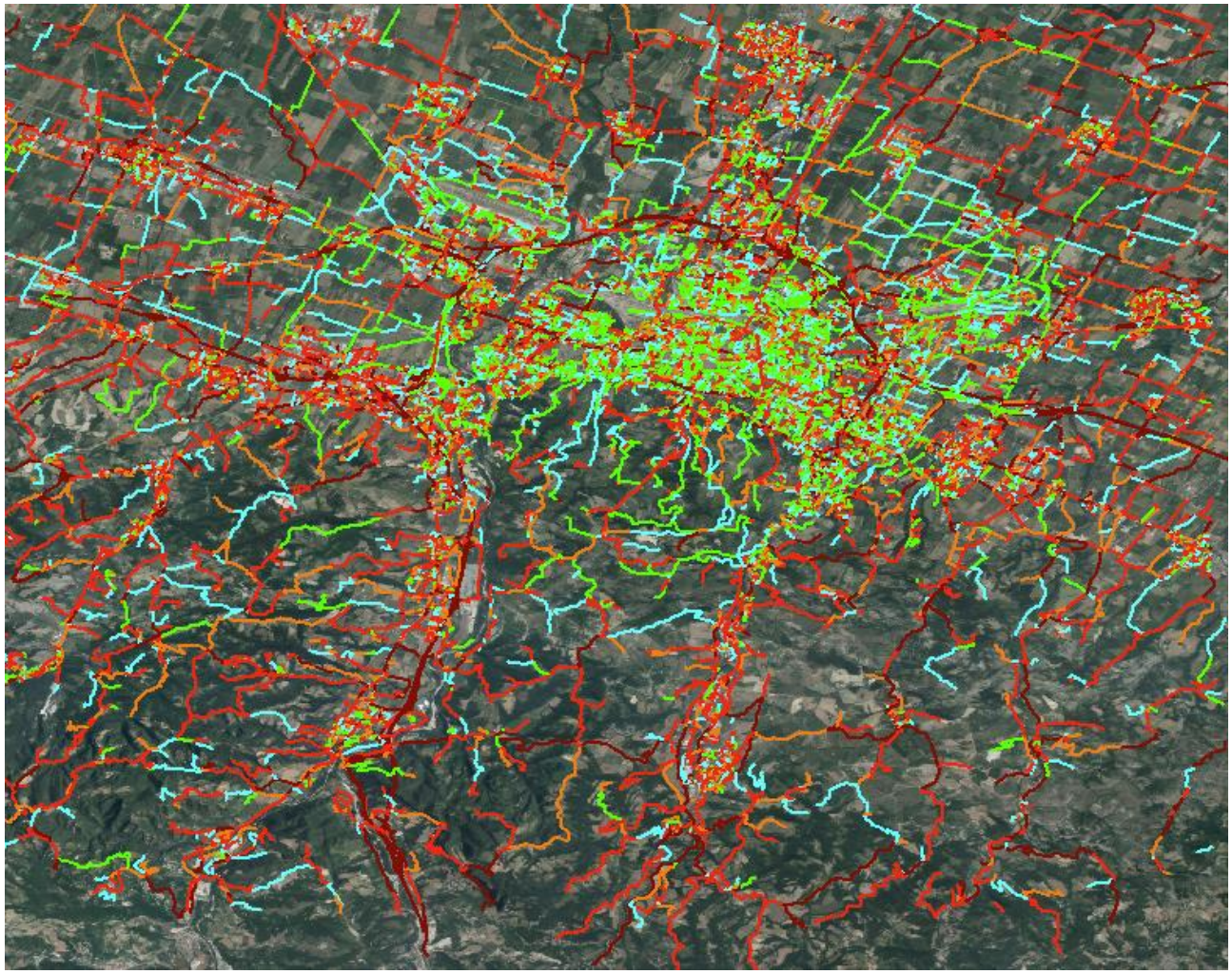


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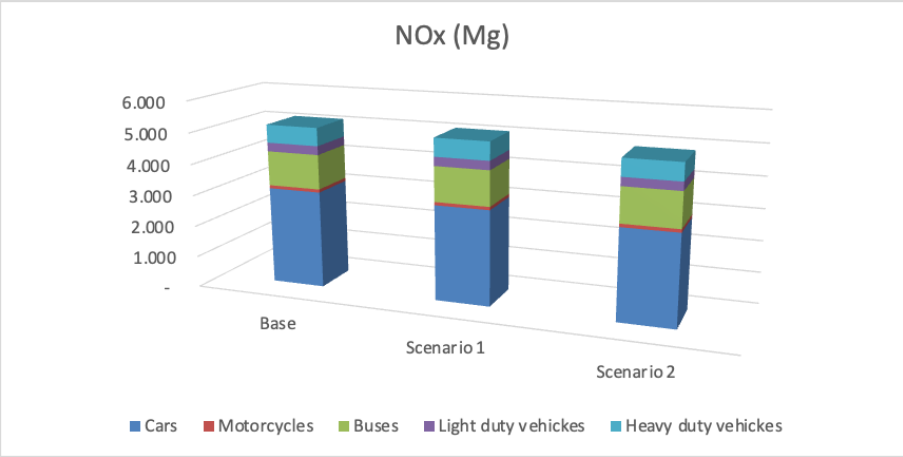
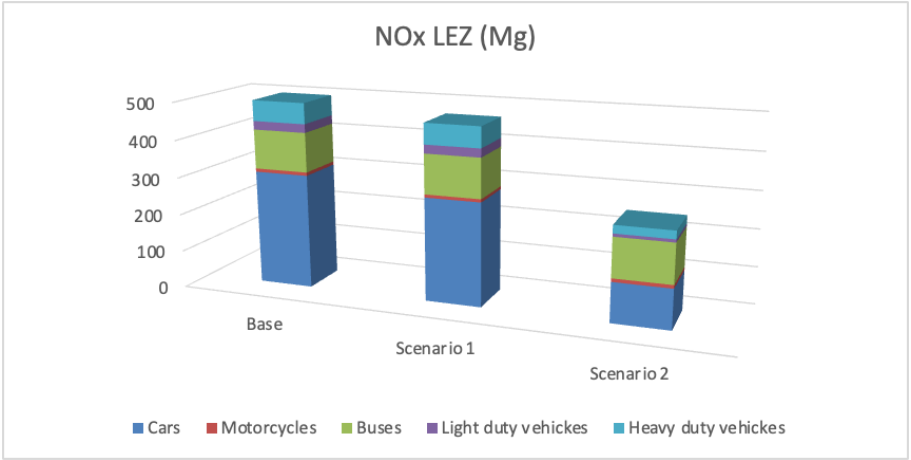
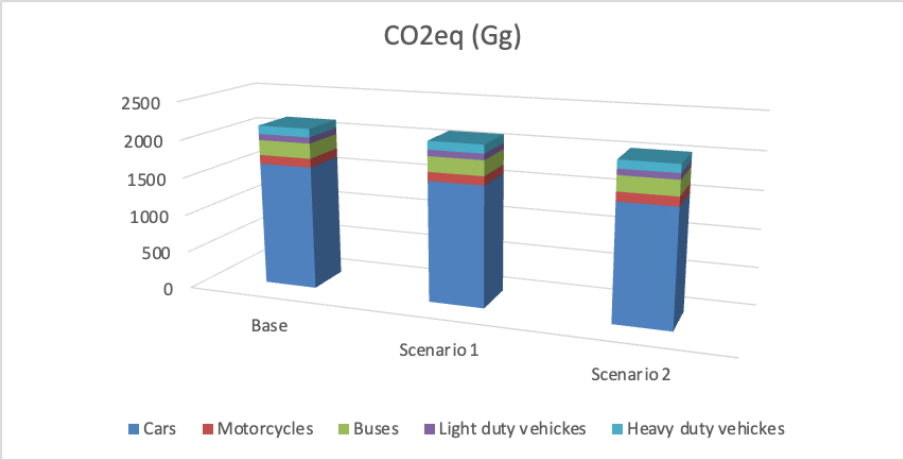
# Bologna LLs traffic NOx emissions and CF



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# Next steps

- The model developed will be applied in future to Dublin (Ireland) & Hasselt (Belgium)
- Emissions will be used in the iCHANGE project to compute GHGs and APs concentrations
- The results will support the living labs activities in citizens understanding of emissions and air quality scenarios
- E2GovCmty model will be applied to compute carbon and environmental footprint in different case studies (air pollution, waste management, extreme event characterization, ecc.)

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# Conclusions

- The case study shows the reduction of emissions and carbon footprint in alternative mobility scenarios in Bologna city (Italy)
- With regard to the national/regional dimension of the inventories it is important to understand how to deal with measures of a local nature
- These may lead to limited overall changes however the local impact (e.g. on grid) of local measures can be very important and need to be modelled in spatial disaggregation
- The impact of local measures on air quality modeling is particularly relevant in urban areas with exceeding of air quality standards

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# Thank you

## Find out more

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