



**POLITECNICO**  
MILANO 1863

# **Transport Decarbonization Policy in the Lombardy Region**

## **Transportation Planning**

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### **Group Members #12:**

Amirhassan Darvishzade

Amirhossein Esmaili

Solmaz Ghasemzadeh

Elif Nur Dogan

Luca Sforzin

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# Motivation and Objectives



- **Motivation:**

There is a big problem in terms of pollution related to passenger transportation in Europe, especially in **Italy**. Decarbonizing transport is essential to address this issues.

We aim to mitigate the adverse effects of gas emissions, improve urban air quality and reduce our dependence on fossil fuels.

This initiative not only protecting the environment, but also enhances the quality of life by fostering a more sustainable region.



- **Objective:**

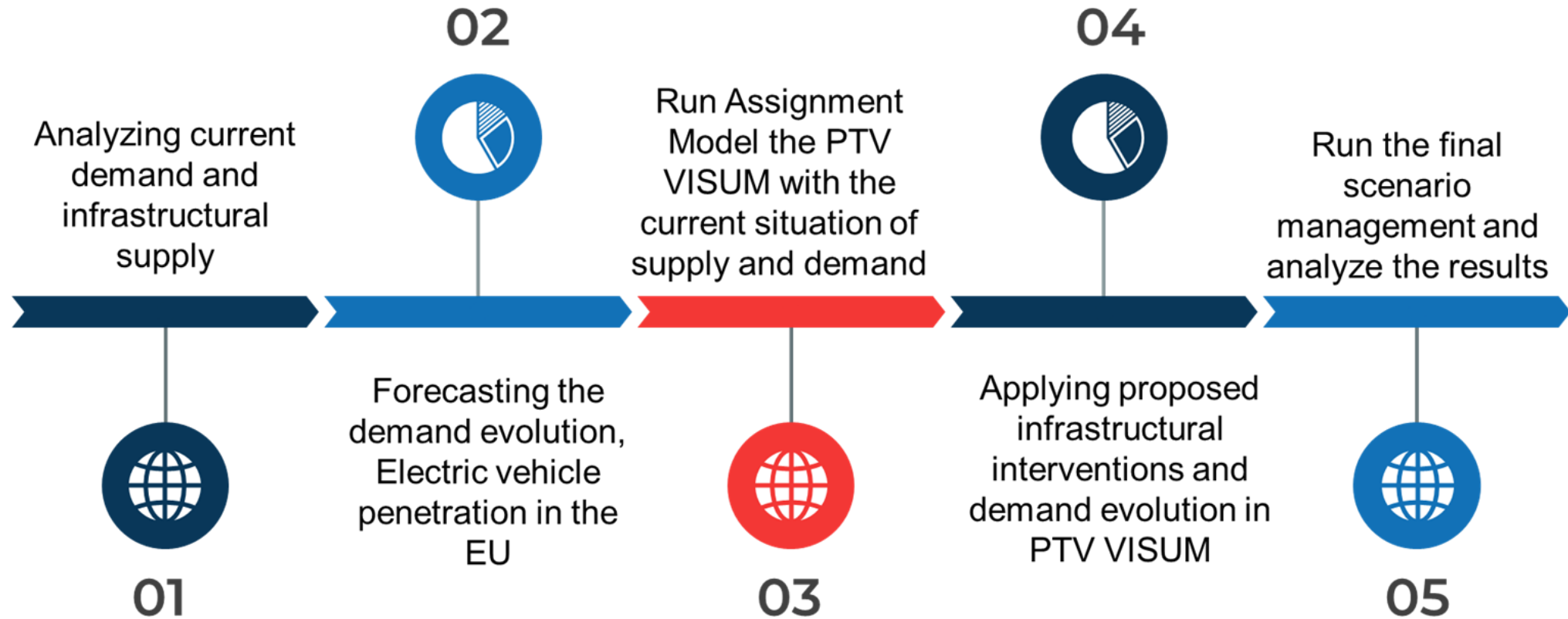
Assessment of transport policies to reduce the environmental burden of transport in **Lombardy** region.

These policies can be based on:

1. **Infrastructure investments**
2. **Increasing penetration of electric vehicles for CO<sub>2</sub> reduction**



# Methodology



# A Brief Summary of Documents



## Policies:

The National Recovery and Resilience Plan (NRRP) aims to reform the mobility system to enhance environmental sustainability and social equity. Key initiatives include:

1. **Increasing Local Public Transport:** Updating and decarbonizing public transport vehicles.
2. **Decreasing Polluting Transport Demand:** Developing cycle paths, promoting electric micro-mobility, and enhancing intermodality.
3. **Promoting Electric Passenger Cars:** Establishing a public network of fast-charging points.
4. **Shifting Transport Modes:** Moving passenger and freight transport from cars and planes to rail, expanding high-speed rail links, and upgrading cross-peninsula connections.



## Targets:

Given its high share of total EU greenhouse gas emissions, achieving the EU's target of at least a 55% reduction in greenhouse gas emissions by 2030 and climate neutrality by 2050 necessitates more ambitious policies to reduce transport's reliance on fossil fuels.



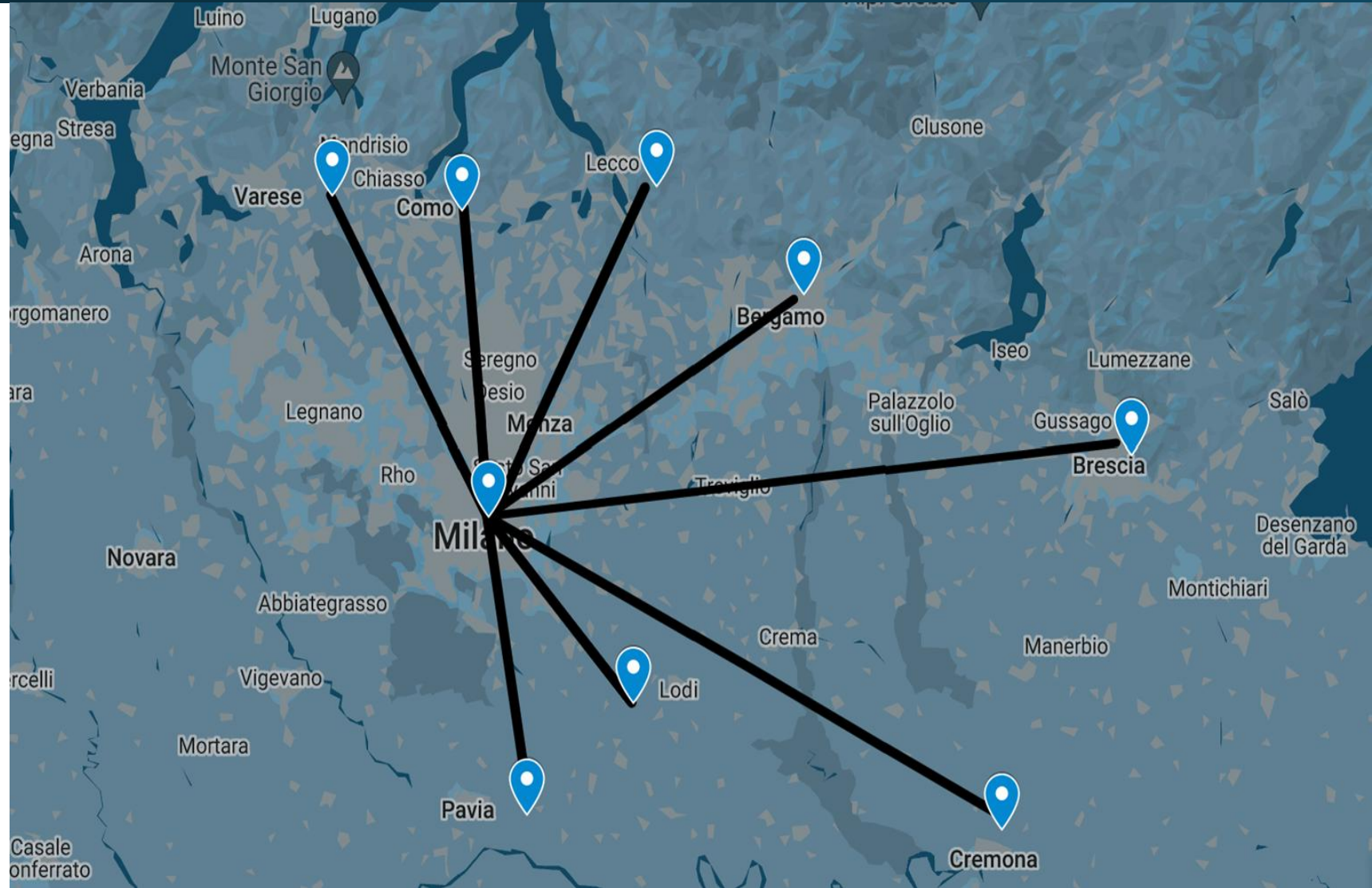
# Current situation

## The overall top 3 most trip-generated places are:

- Milan 4900
- Brescia 2650
- Milano Brera 2100

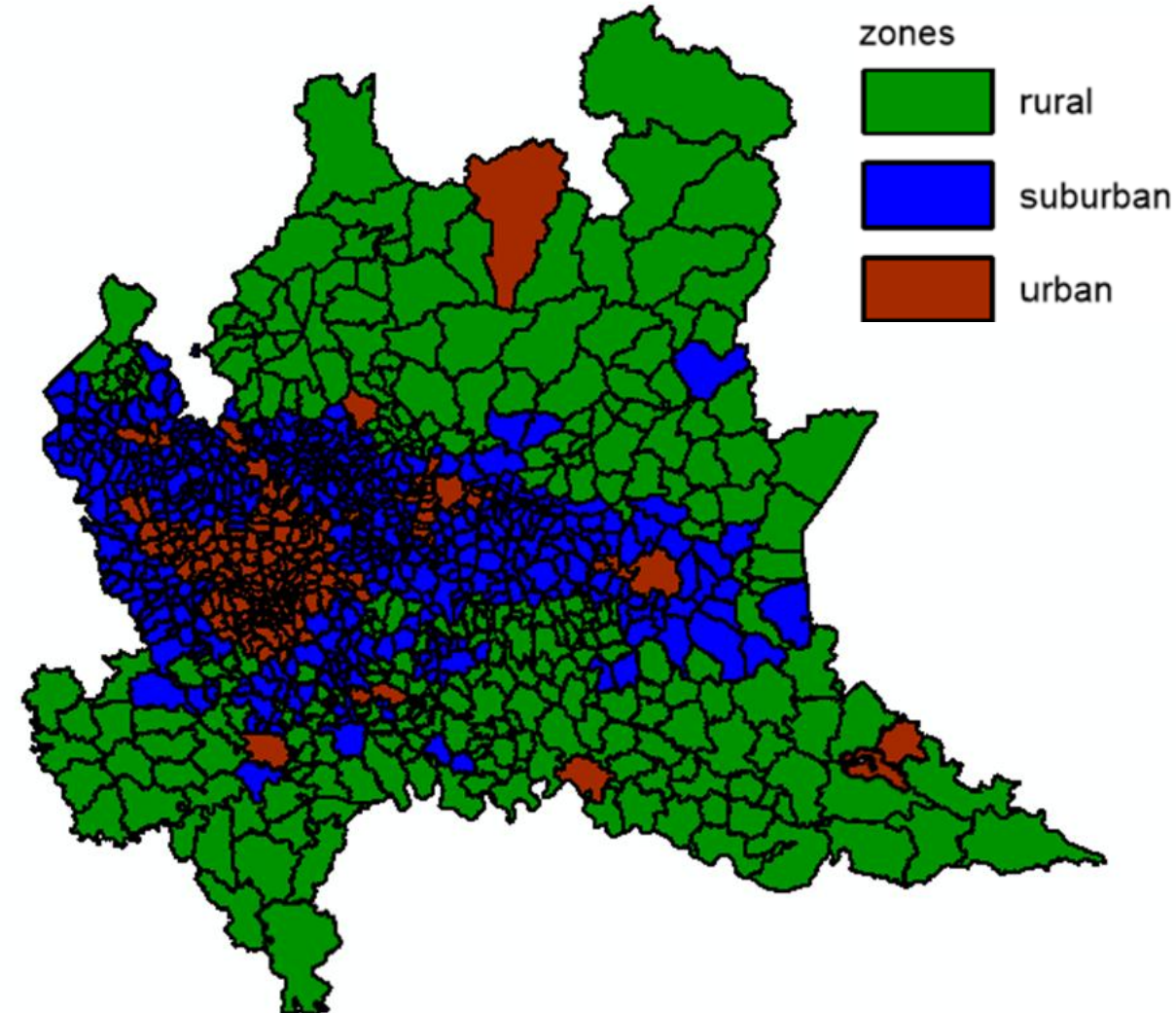
## The overall top 3 most trip-attracted places are:

- Milan 9100
- Brescia 7700
- Bergamo 4750



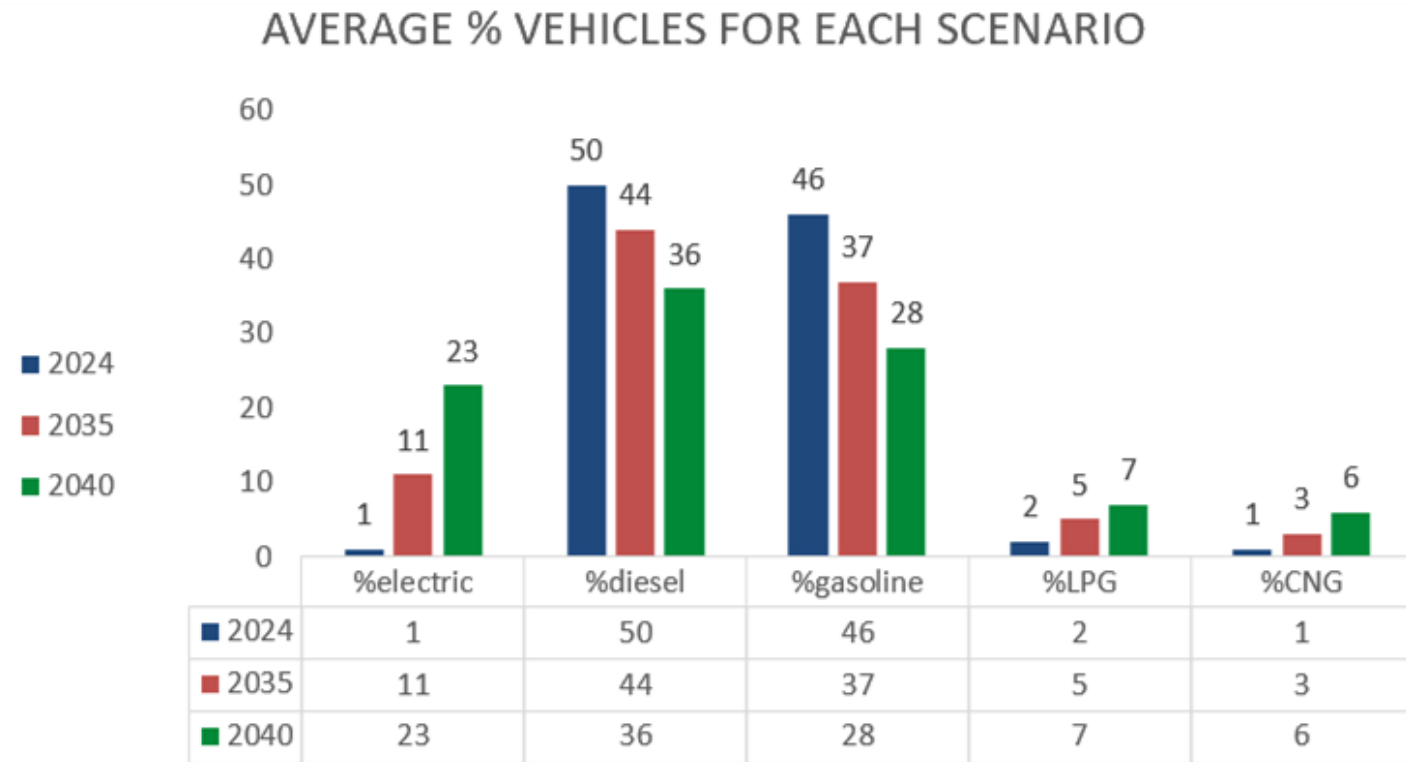
# Zone Segmentation

- To have a better analysis, we split the region into 3 main categories using population density:
  - **URBAN** (over **1500** people **per km<sup>2</sup>**)
  - **SUBURBAN** (from **300** to **1500** people **per km<sup>2</sup>**)
  - **RURAL** (under **300** people **per km<sup>2</sup>**)
- Finally we manually checked and changed some tags as **Sondrio** or **Lecco**, that were considered Rural and updated to **Urban**.



# Vehicle Types and Proportions per Scenario

- The **actual scenario** sees a high proportion of diesel and gasoline vehicles (50%-46%) compared to electric (1%).
- **Future scenarios** show the decrease of fossil fuel vehicles and the increase of electric vehicles, which will bring a significant reduction on CO<sub>2</sub> emissions.

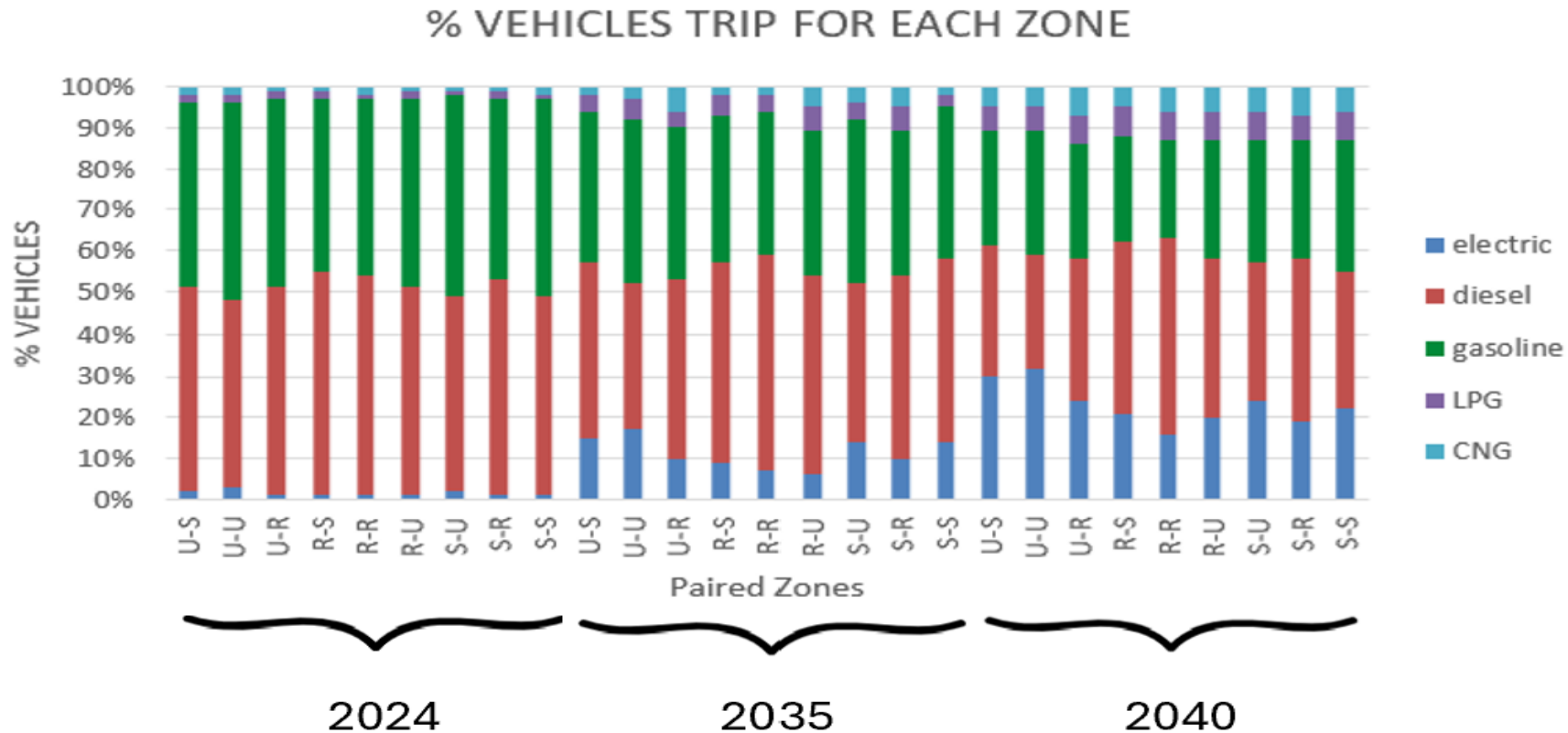


EU Reference Scenario 2020 report



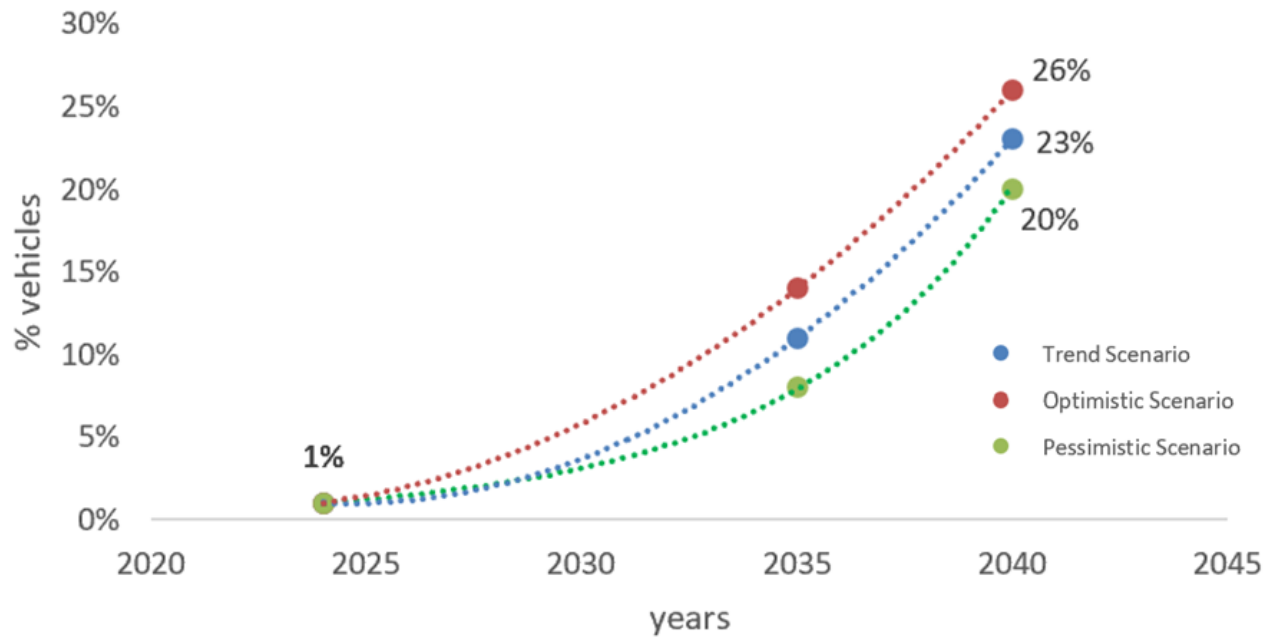
# Proportions of Vehicle Types in each Pair-Zone

In order to decrease the emissions, we have made an estimate to forecasting the possible future situation for the trip on each zone. Given this, we have paired all the trips that can be made from zone to zone.



# Scenario Forecasting

FORECASTING ELECTRIC VEHICLES



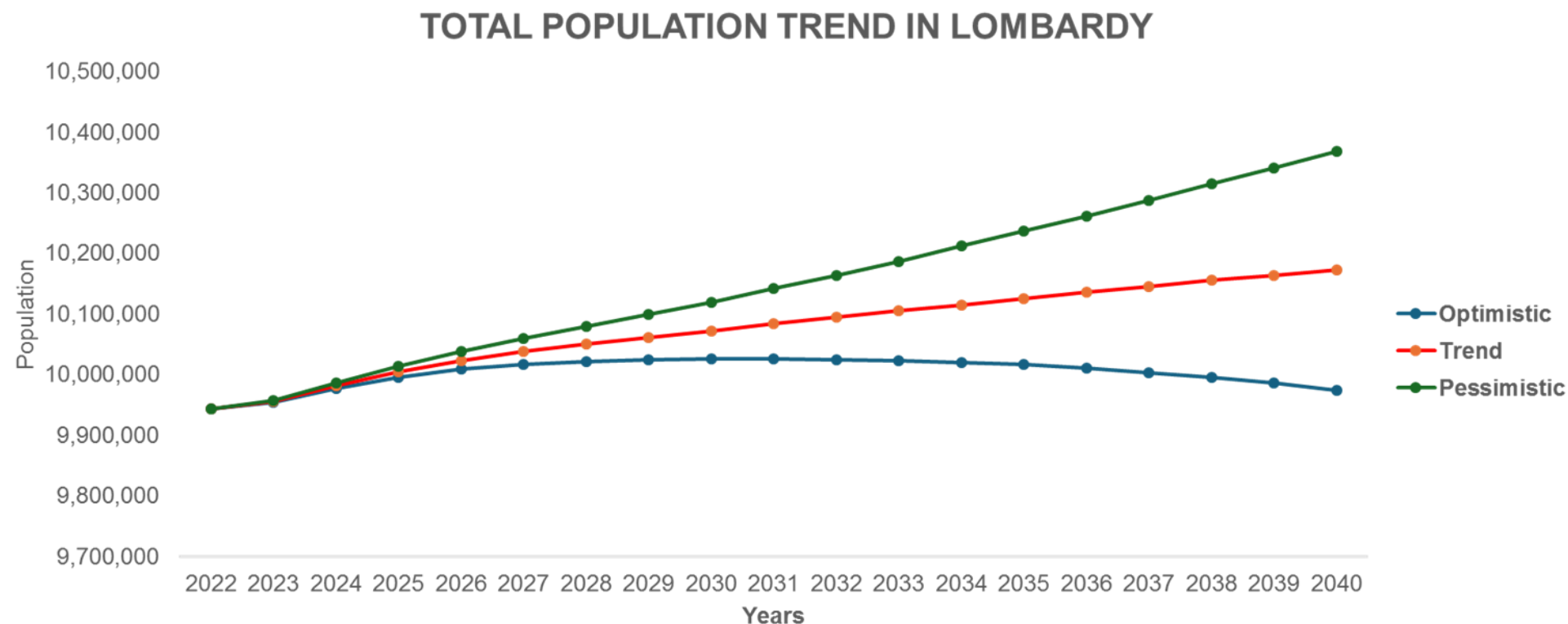
We can see the forecast of electric vehicles over the years, where from actual 1%, following the trend, we can go up to 23% by 2040.

The increase suggests a more sustainable future with reduced carbon emissions and greater energy efficiency in transport.



# Forecasting Demand Evolution

In order to plan for future demand based on the population projections, we need to know potential future demographic changes

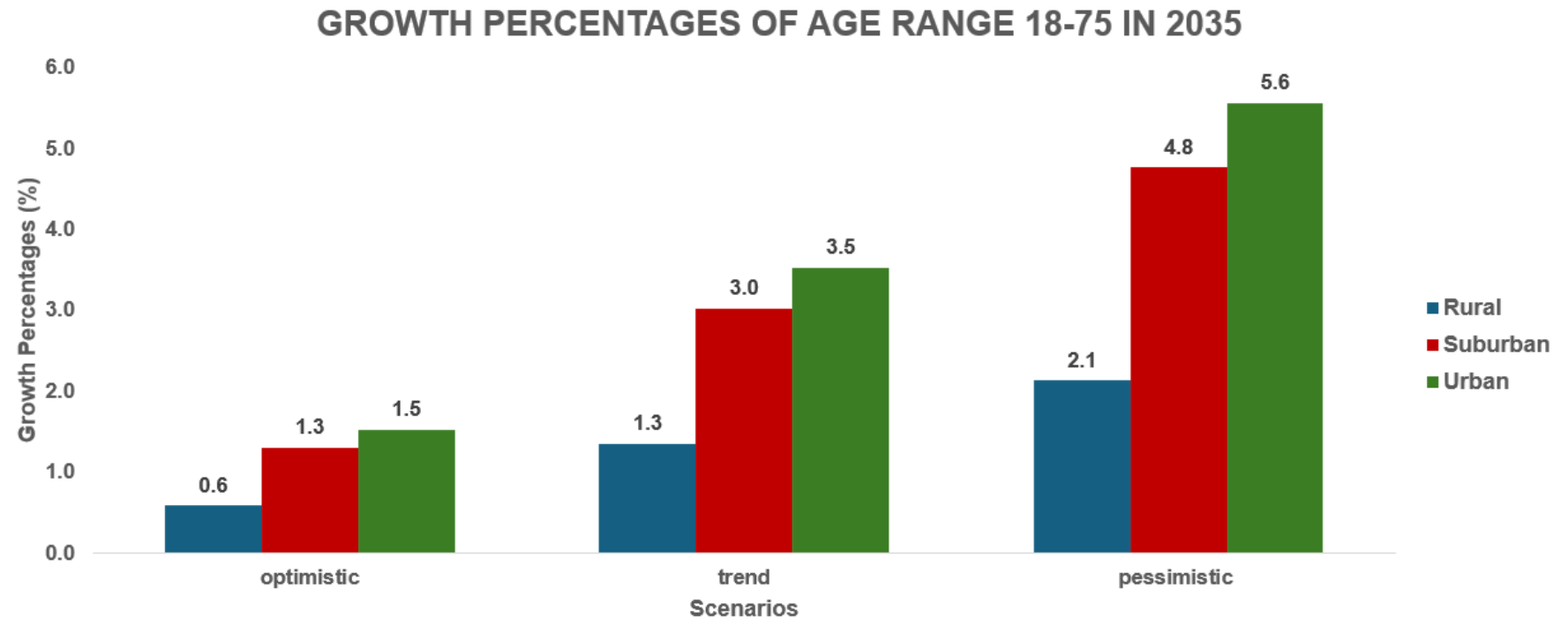


The population growth data obtained from [istat.it](https://www.istat.it)



# Forecasting Demand Evolution

The calculated growth percentages for each urban, rural, suburban area for age range 18-75



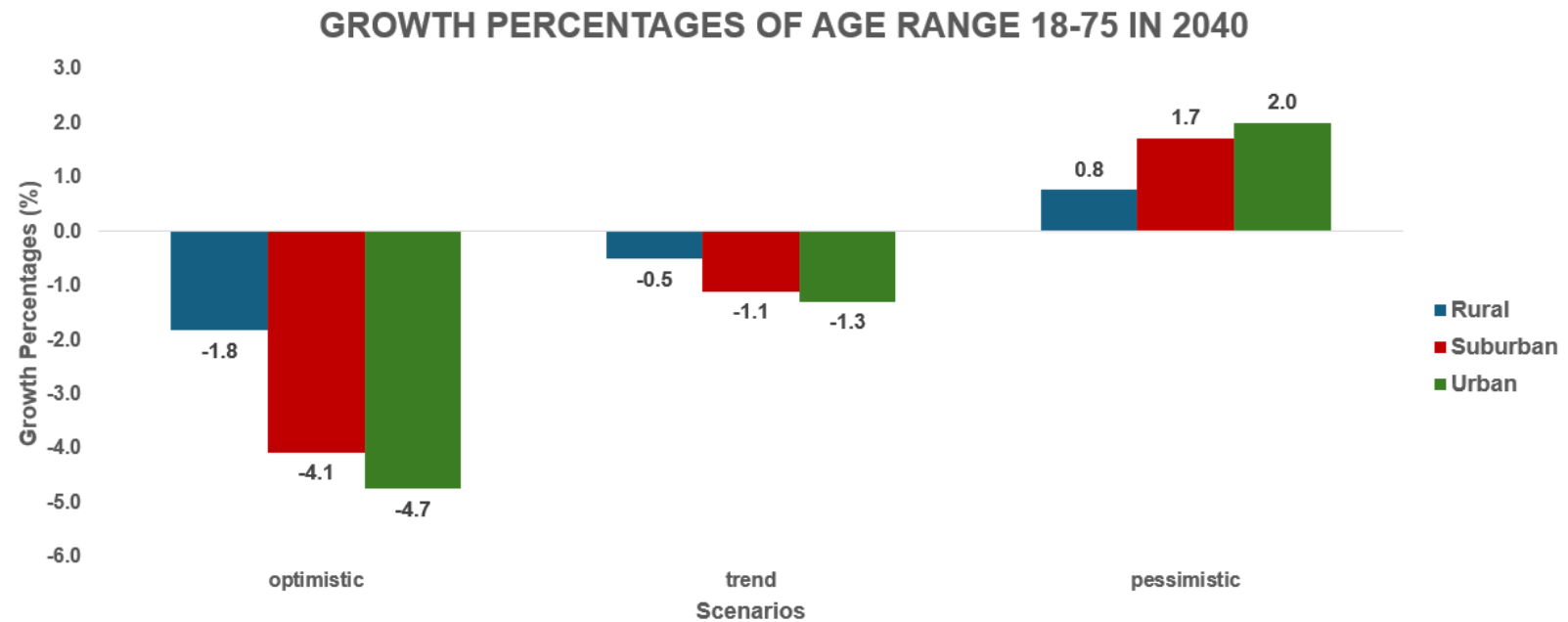
These values are used as multipliers for new OD matrices



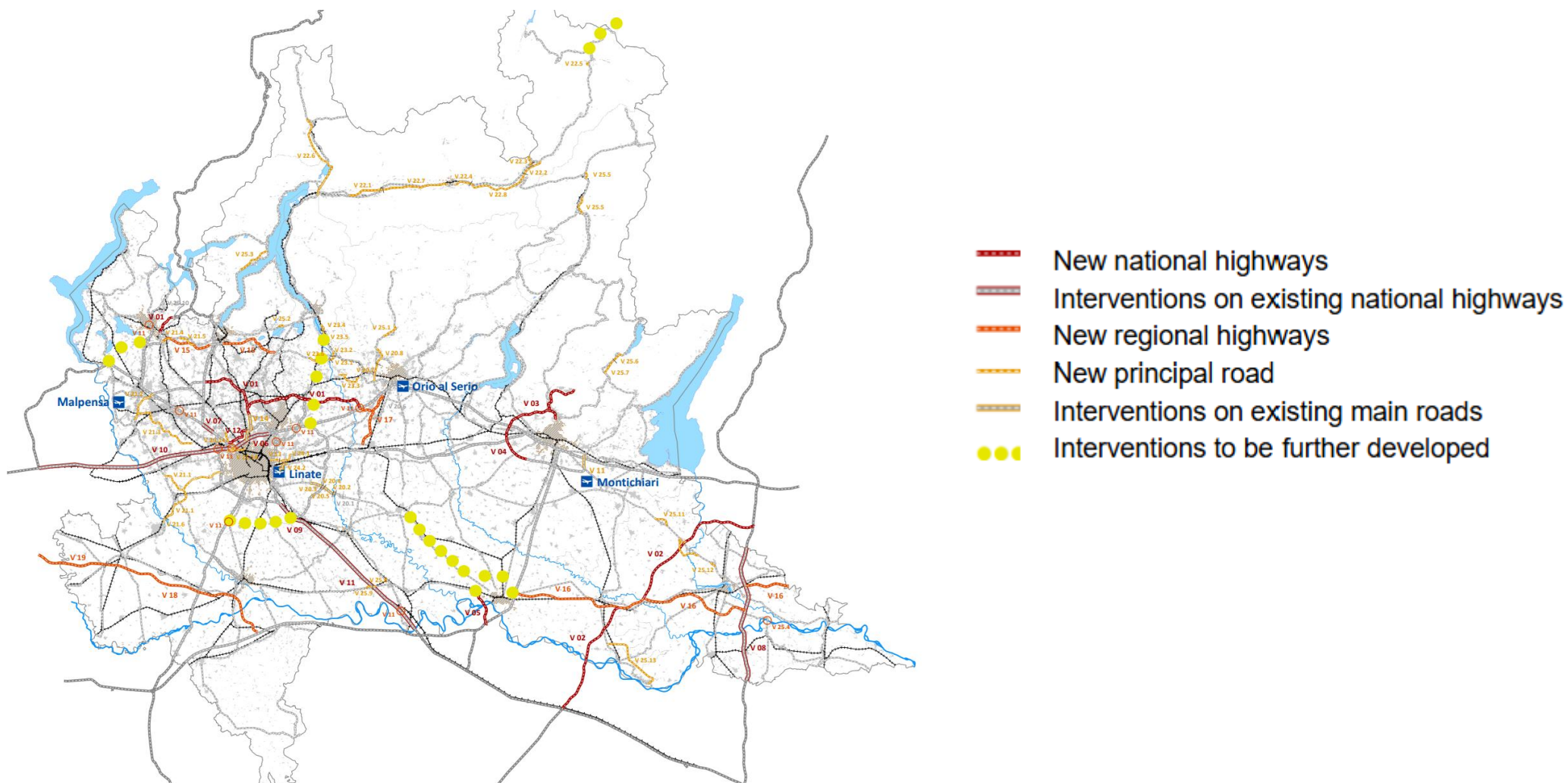
# Forecasting Demand Evolution

## Calculation steps:

- 1- The percentage of the total yearly growth attributed to each of R,S,U are found from 2021-2022 data.
- 2- The expected population growth until 2035 and 2040 for age range 18-75 is found for each of R,S,U.
- 3- Data found in step 2 is compared to the 2024 data. This way, the percentage growth values, based on 2024, for each of R,S,U in themselves are found.
- 4- The values found in step 3 are used as multiplication factors for new OD matrices.



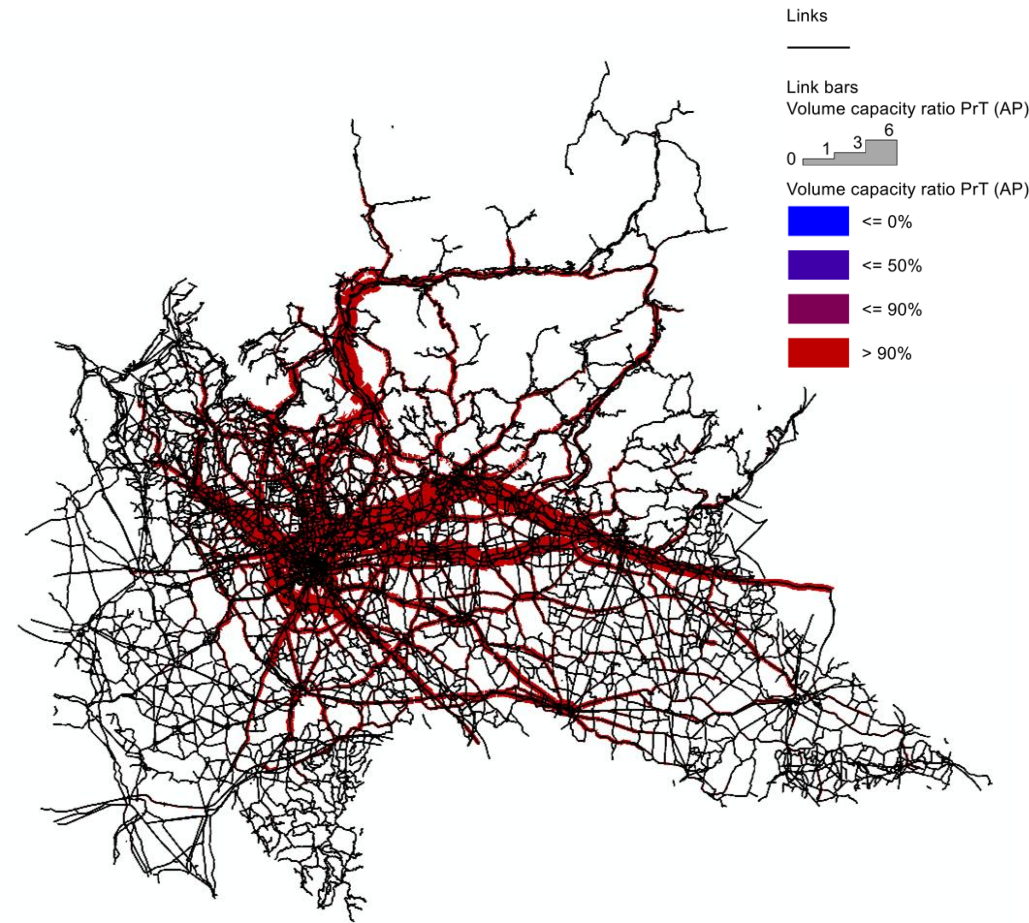
# Map of New Interventions



# Performing Assignment Model

## Calculation Steps:

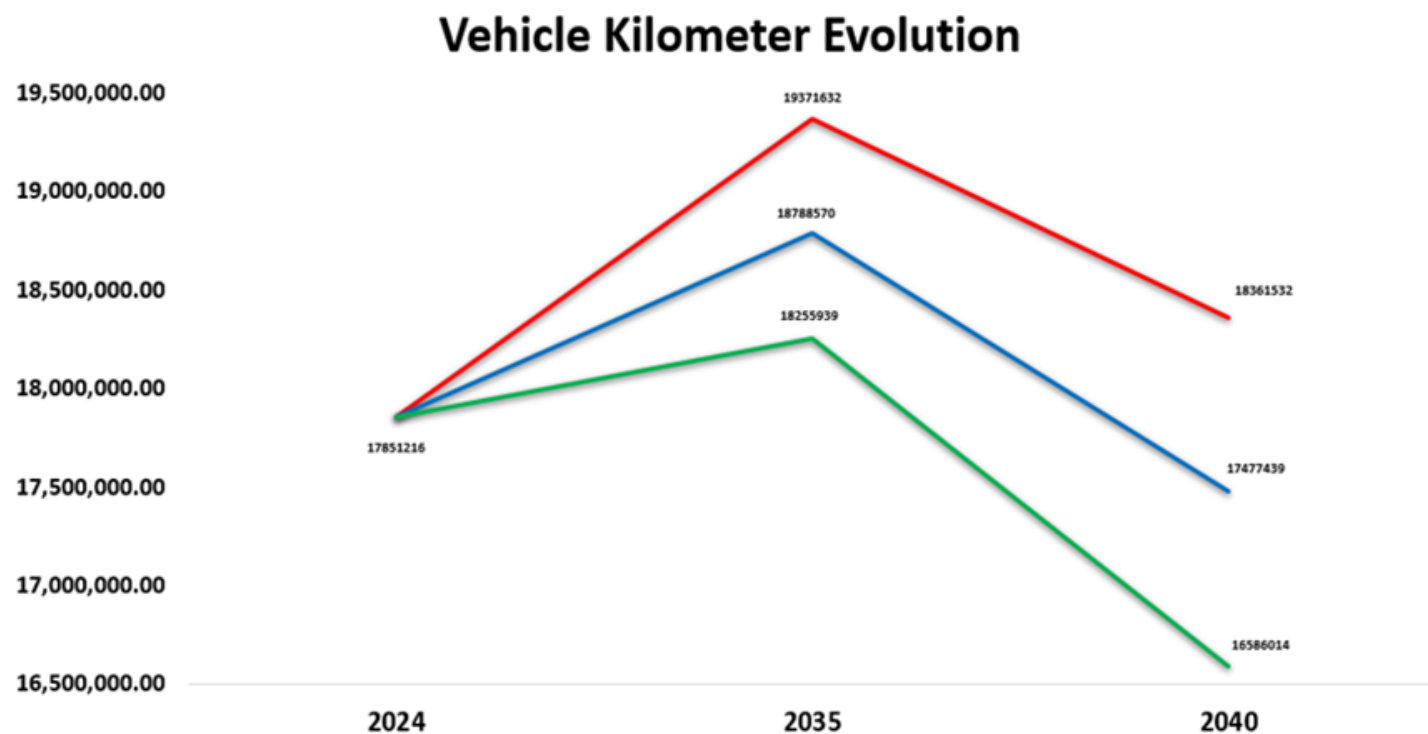
1. At first, interventions are applied through the software and 3 main scenarios (Optimistic, Average Trend, Pessimistic) are defined for the years **2035** and **2040**.
2. changes in demand in the following years have applied and new **OD** matrices created in the software.
3. Assignment Model performed and results (**total veh-km**) exported from the software and **vehicle types** and their **percentages** are also considered.
4. After zone segmentation, CO2 emission calculations are performed and the overall result is presented in the graphs:
5. Also emissions are analysed for the city of **Milan**.



Assignment Model Result for current situation



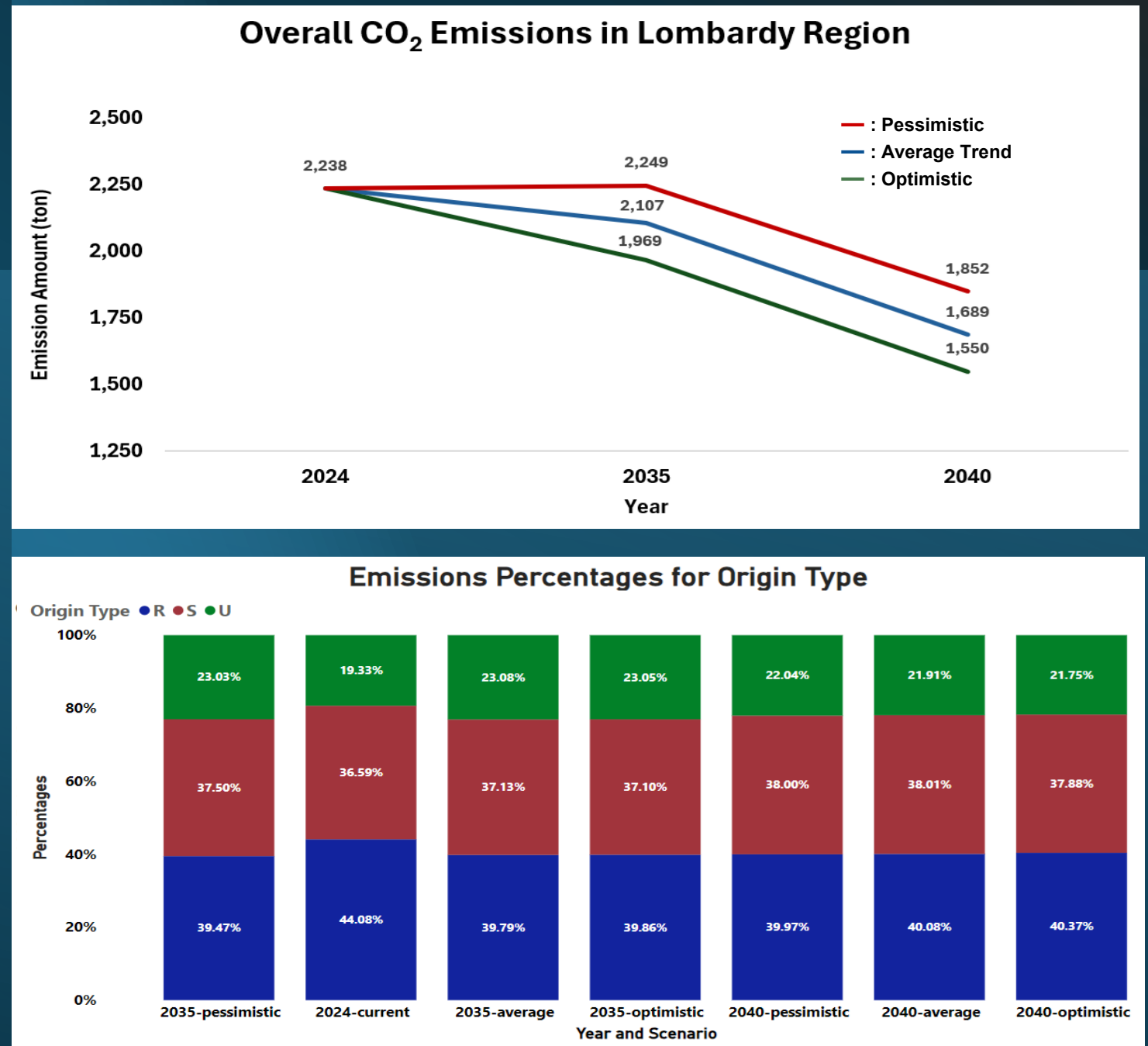
# Effects of infrastructural interventions and demand evolution



- There is a huge reduction in time travel, even the pessimistic 2040 scenario's time travel is less than 2035 optimistic.
- The vehicle km is following an upward trend due to an increase of demand while it experiences a decrease for the year 2040

# CO<sub>2</sub> Emissions Key Results:

- Results are presented for each pair zones and almost have a decremental trend in for average scenario in the following years.
- The most decreasing in terms of percentage is for U-U (around 50%)
- Significant changes have made for R-R (-110 ton) and R-U (-130 ton) in terms of value.
- Reductions in S-R and S-U are almost constant and had not significant changes, it requires to think about other plans and interventions.

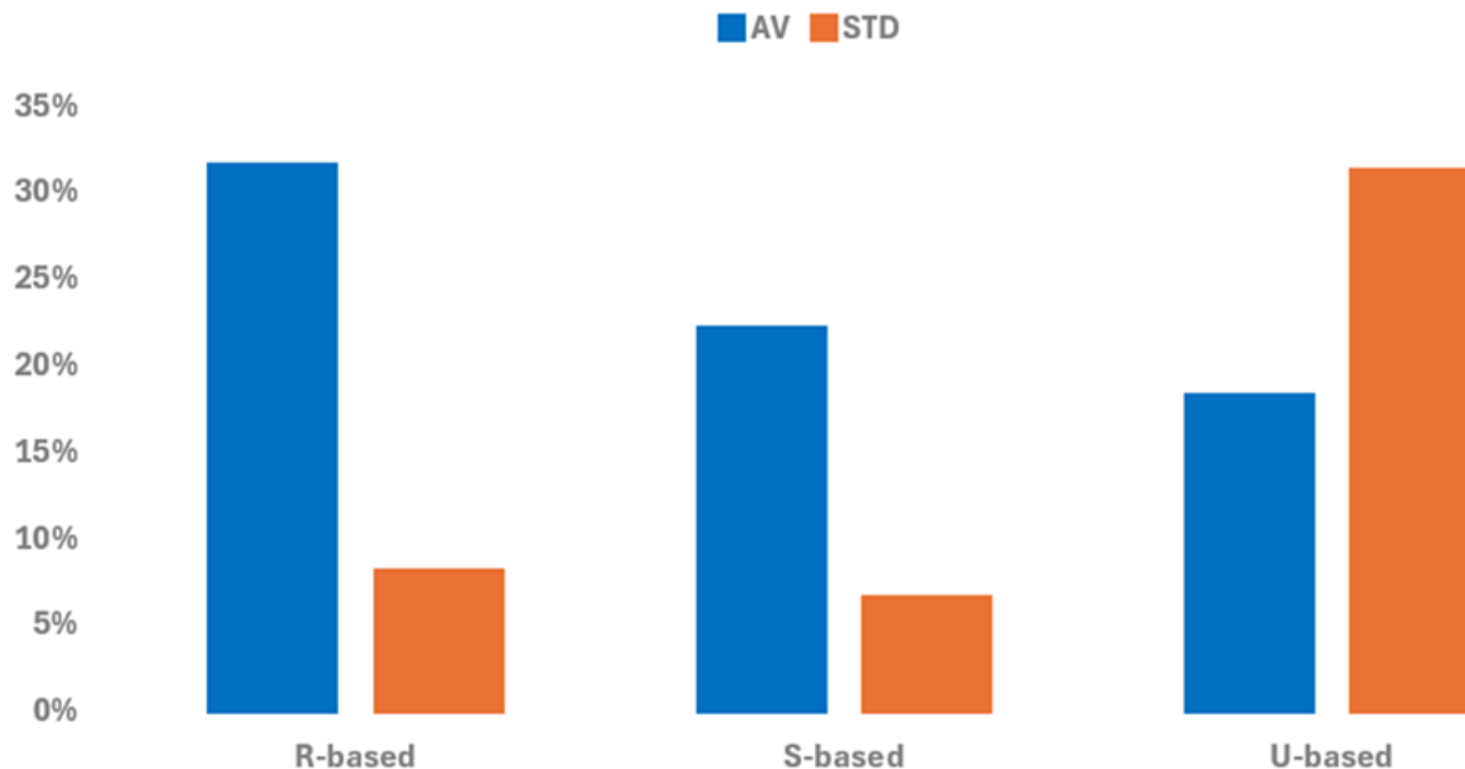


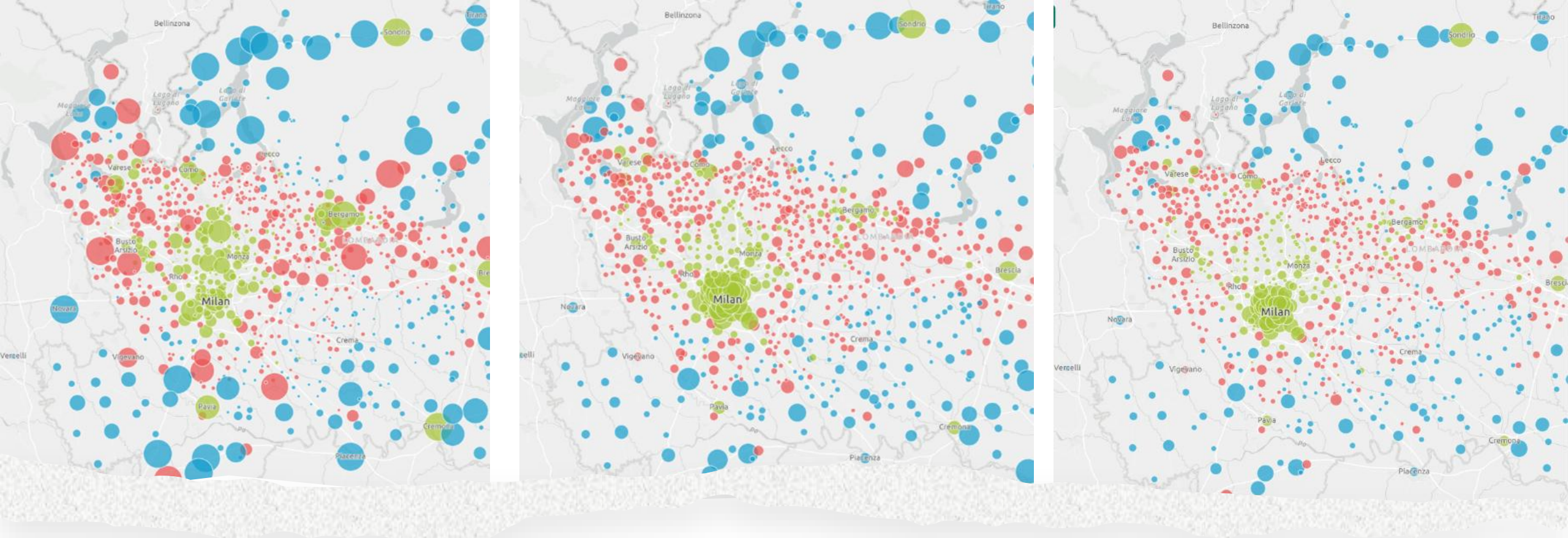
# CO2 Reduction based on Zones

Most reduction: U-U (54%)

Least reduction: U-S (-2%)

## Zone-based Average CO2 Emission Reduction





## Average Trend Emission Results in Lombardy Region for the years 2024, 2035, 2040



2024

**Current:**  
2238 (ton)

2035

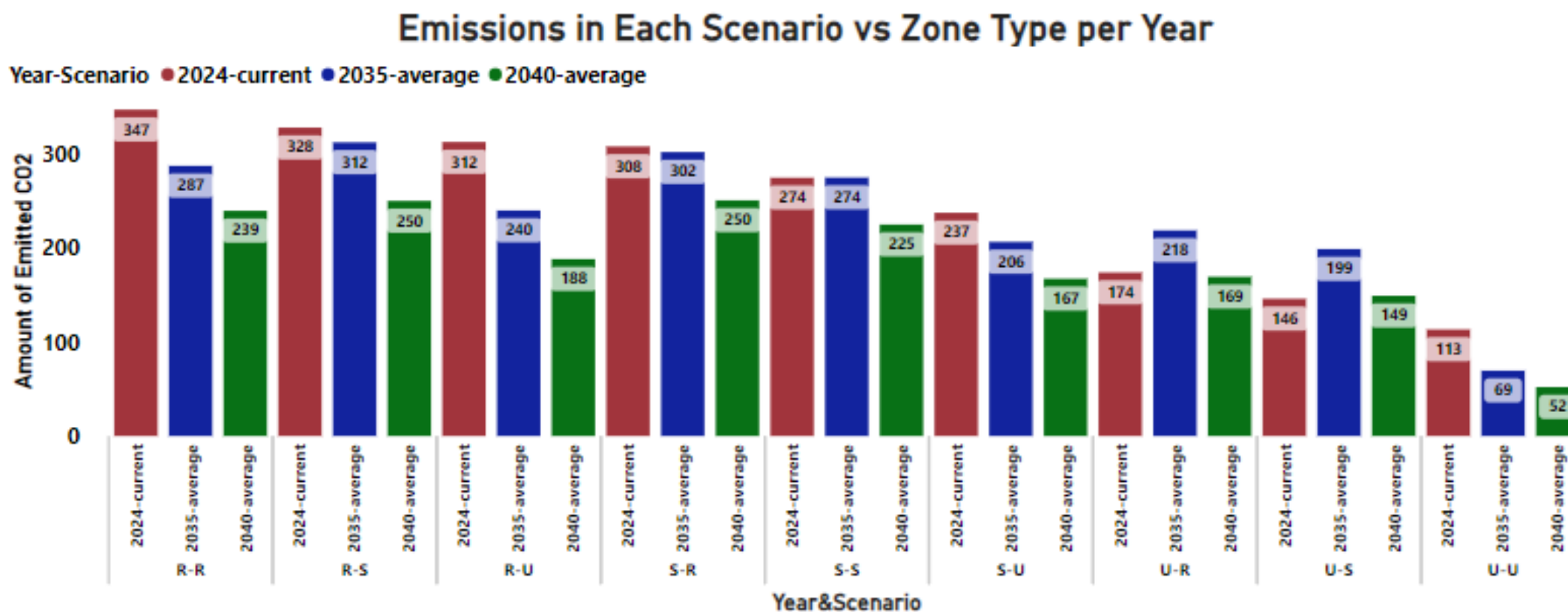
**Optimistic:** 1969 (-12% ↓)  
**Average:** 2107 (-6% ↓)  
**Pessimistic:** 2249 (0% ↓)

2040

**Optimistic:** 1550 (-31% ↓)  
**Average:** 1689 (-25% ↓)  
**Pessimistic:** 1852 (-17% ↓)

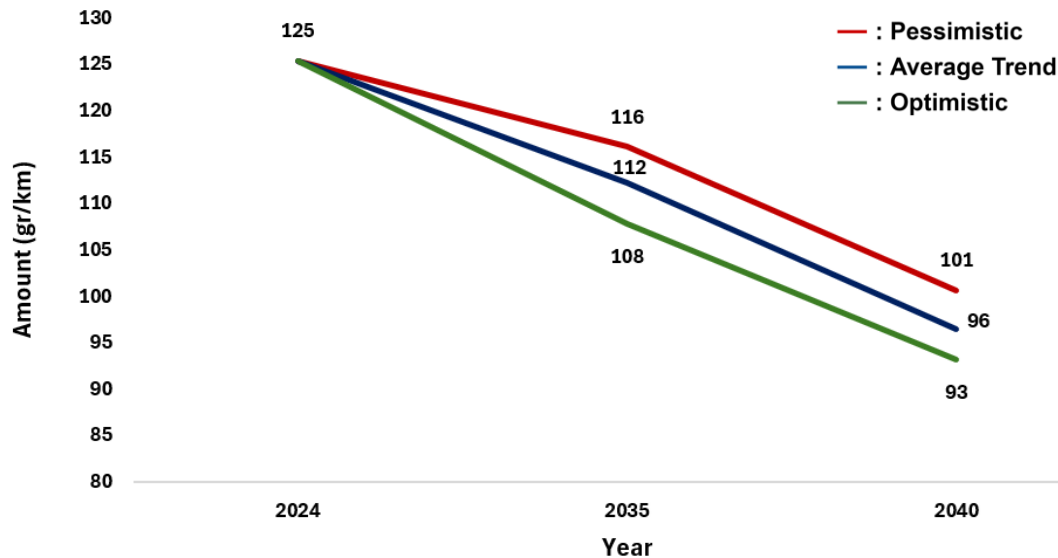


# CO<sub>2</sub> Emission Results in Lombardy Region



# CO<sub>2</sub> Emission Results: Equivalent Emission Factor

Equivalent Emission Factor (gr/km)



## Key Results:

1. equivalent emission factor calculated by weighted average of emissions over the amount of kilometer have passed in each scenario:

$$E = \frac{\sum C * L * E}{\sum L}$$

- C: car types (%)
- L: length (km)
- E: emission factor for each car type

2. the values show that the intervention of EVs have made reduction in overall emission factor, which the values have decremental trend over the years and scenarios.

3. the more the value smaller, the less the emission will be released.

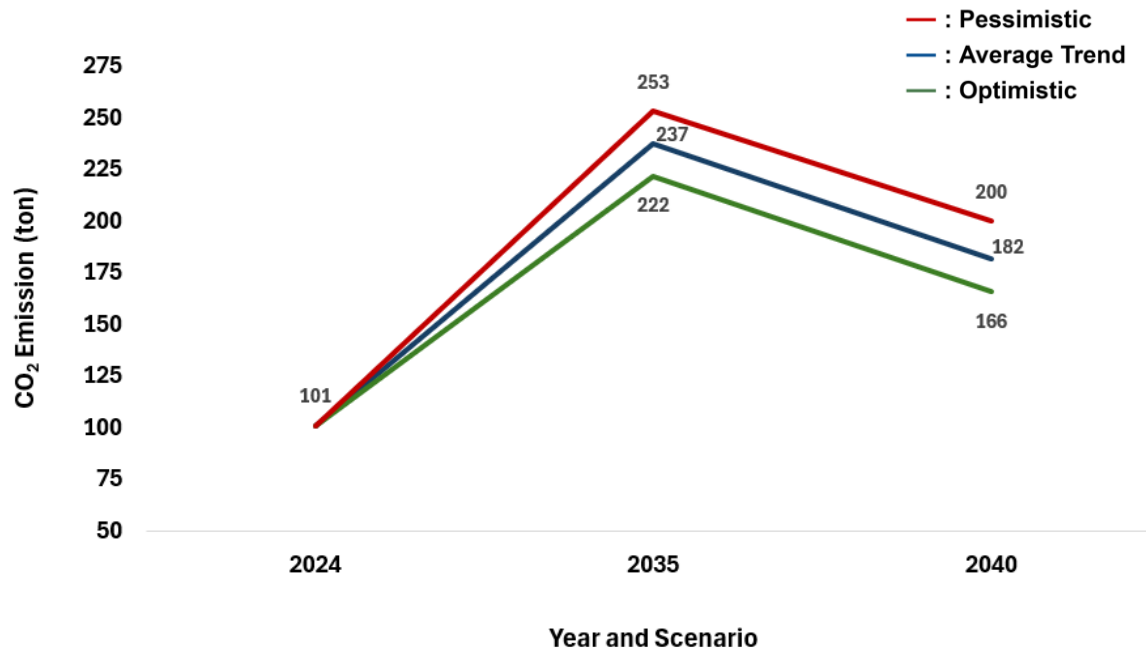
Scenario Type

| Year and Scenario | Pessimistic | Average | Optimistic |
|-------------------|-------------|---------|------------|
| 2035              | -7%         | -11%    | -14%       |
| 2040              | -20%        | -23%    | -26%       |



# CO<sub>2</sub> Emissions Results in the City of Milan

CO<sub>2</sub> Emissions in the City of Milan



## Key Results:

1. The emission results are just for **47** zones in Milan which is around **10%** of total emissions in Lombardy region.
2. Emission in the city of Milan rise and falls in the years 2035 and 2040 respectively, because of the increasing in demand in the following years.
3. Despite of increasing electric vehicles in Milan, emissions are also increasing. (increasing in demand)

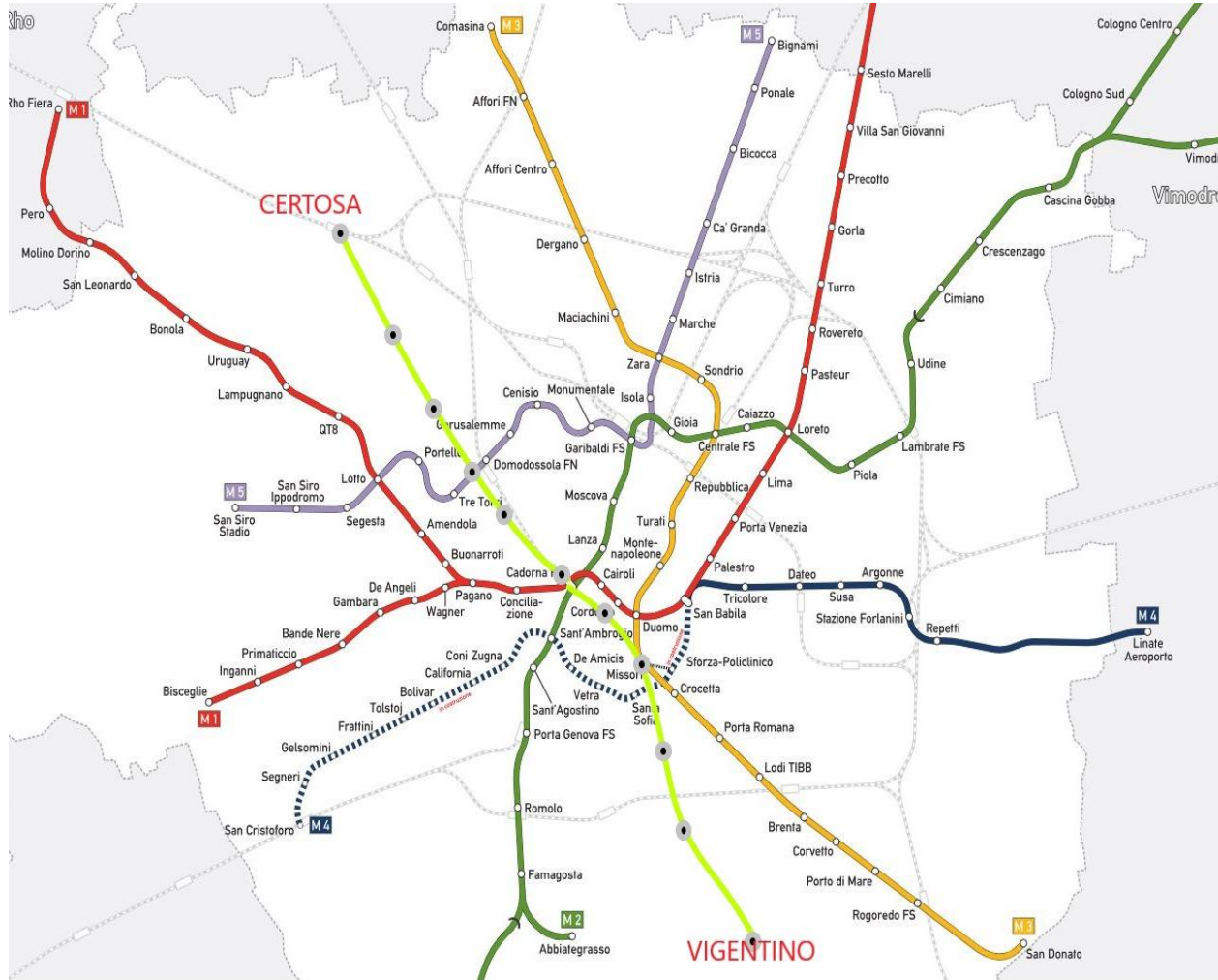
Changes in CO<sub>2</sub> Emissions in the City of Milan

| Year and Scenario | Scenario Type |         |            |
|-------------------|---------------|---------|------------|
|                   | Pessimistic   | Average | Optimistic |
| 2035              | 151%          | 135%    | 120%       |
| 2040              | 98%           | 80%     | 64%        |

Changes in Vehicle Kilometer in the City of Milan

| Year and Scenario | Scenario Type |         |            |
|-------------------|---------------|---------|------------|
|                   | Pessimistic   | Average | Optimistic |
| 2035              | 176%          | 168%    | 160%       |
| 2040              | 162%          | 150%    | 137%       |

# Suggestion for CO<sub>2</sub> Emission in the City of Milan



## Suggestion!

1. The demand in the **city of Milan** will increase in all scenarios for both years **2035** and **2040**, consequently, emissions will be increased.
1. Construction of new metro line will be helpful to tempt people use the public transport.
1. Starting from “**Certosa**” to “**Vigentino**”, shown in the “**highlighted line**”.

| Year Scenario    | CO2 Emission (ton), Milan | Changes |
|------------------|---------------------------|---------|
| 2024-current     | 101                       | -       |
| 2035-average     | 237                       | 135%    |
| 2035-optimistic  | 222                       | 120%    |
| 2035-pessimistic | 253                       | 151%    |
| 2040-average     | 182                       | 80%     |
| 2040-optimistic  | 166                       | 64%     |
| 2040-pessimistic | 200                       | 98%     |

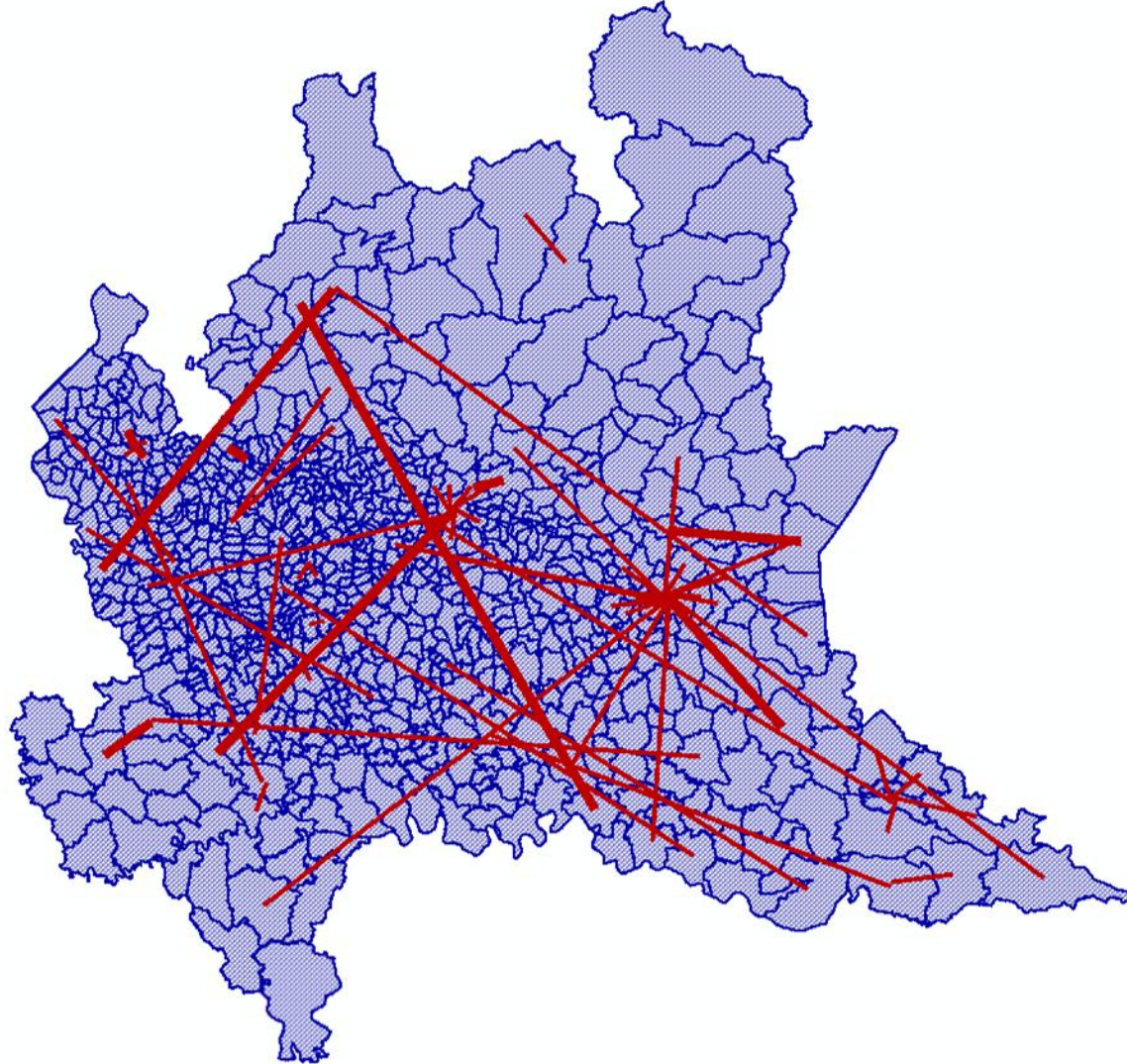


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**THANK YOU**

# BACKUP SLIDES

Desired lines map



# Interventions During the Years

- V 01 Completamento Sistema Viabilistico Pedemontano Lombardo (Pedemontana)
- V 02 Collegamento autostradale Brennero-La Spezia (Ti.Bre.)
- V 03 Raccordo autostradale della Valtrompia (Brescia-Lumezzane)
- V 04 Tangenziale Sud di Brescia (Corda Molle-SP19)
- V 05 Bretella A21 – Castelvetro Piacentino e terzo ponte sul Po
- V 06 Potenziamento autostrade esistenti (A4 – Quarta corsia dinamica – tratta urbana MI)
- V 07 Potenziamento autostrade esistenti (A8 – Quinta corsia Lainate-Milano)
- V 08 Potenziamento autostrade esistenti (A22 – Terza corsia Verona-Modena)
- V 09 Potenziamento autostrade esistenti (A1 – Quarta corsia Milano-Lodi)
- V 10 Potenziamento autostrade esistenti (A4 – ammodernamento Novara Est-MI)
- V 11 Potenziamento autostrade esistenti (altri investimenti in corso di inserimento nelle convenzioni autostradali in aggiornamento o nuove proposte)
- V 12 Completamento Tangenziale Nord di Milano/Rho-Monza
- V 13 Viabilità speciale di Segrate: svincolo di Lambrate e viabilità di accesso al centro intermodale
- V 14 Terza Corsia Milano-Meda
- V 15 Autostrada Regionale Varese-Como-Lecco
- V 16 Autostrada Regionale Cremona-Mantova
- V 17 Interconnessione autostradale tra Sistema Viabilistico Pedemontano e autostrada Brescia-Bergamo-Milano (IPB)

## AdP Valtellina

- V 22.1 Variante Cosio-Tartano
- V 22.2 Variante di Tirano - stralcio prioritario (tangenziale di Tirano)
- V 22.3 Variante di Tirano - completamento
- V 22.4 Completamento Tangenziale di Sondrio
- V 22.5 Variante di Bormio per S. Lucia
- V 22.6 Riqualfica Gera Lario-Chiavenna (SS 36)
- V 22.7 Variante Tartano-Sondrio
- V 22.8 Variante Tresivio-Stazzona
- Lecco-Bergamo
- V 23.1 Variante di Cisano Bergamasco (primo lotto)
- V 23.2 Variante di Cisano Bergamasco (secondo lotto)
- V 23.3 Collegamento Calusco d'Adda - Terno d'Isola
- V 23.4 Variante Vercurago
- V 23.5 Variante Calolziocorte
- V 23.6 Collegamento Olgiate Molgora - Ponte di Brivio - Pontida in variante a S.S. 342

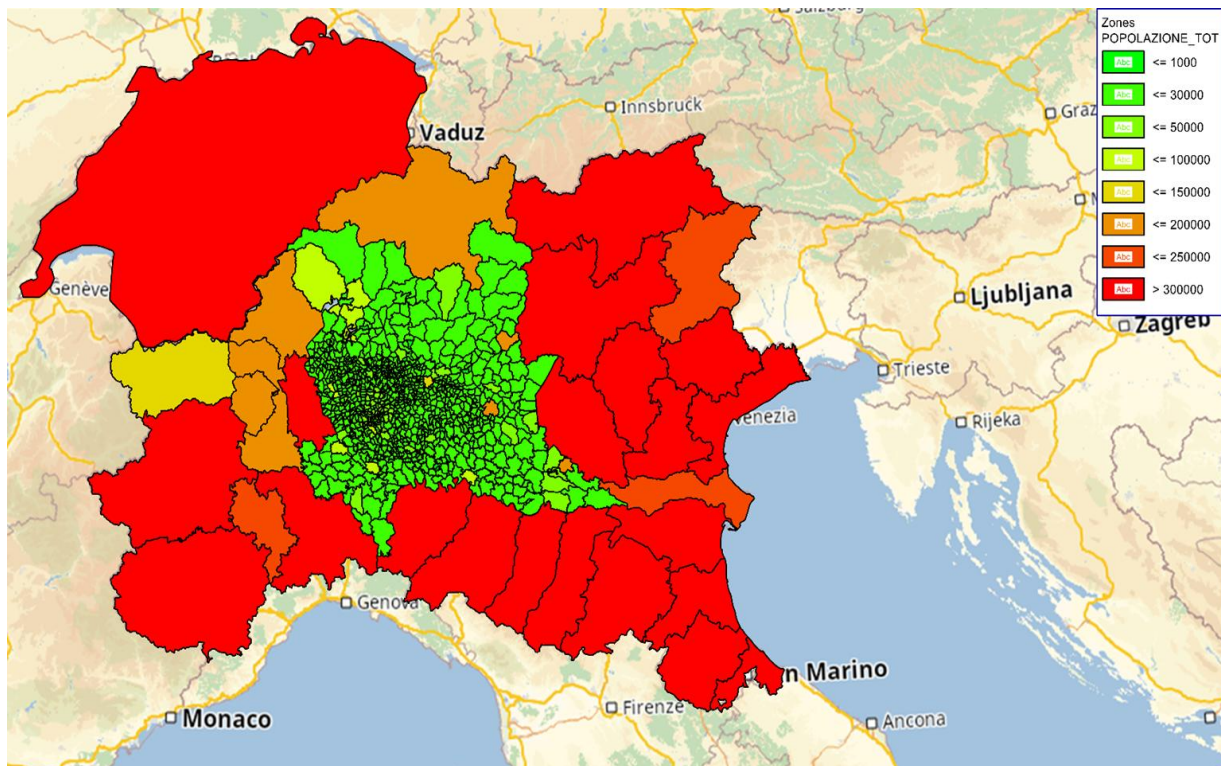
- V 18 Autostrada Regionale Broni-Mortara
- V 19 Raccordo Autostradale Interregionale Mortara/Stroppiana/A26
- AdPQ Grande Viabilità
- V 20.1 Riqualfica ex S.S. 415 "Paullese" - Dovera - Spino d'Adda (2° lotto CR)
- V 20.2 Riqualfica ex S.S. 415 "Paullese" - Nuovo ponte sull'Adda (3° lotto CR)
- V 20.3 Riqualfica ex S.S. 415 "Paullese" - SP 39 - TEM (2° lotto 1° stralcio tratta A)
- V 20.4 Riqualfica ex S.S. 415 "Paullese" - TEM - Zelo Buon Persico (2° lotto 1° stralcio tratta B)
- V 20.5 Riqualfica ex S.S. 415 "Paullese" - Zelo Buon Persico - Spino d'Adda (2° lotto 2° stralcio)
- V 20.6 Tangenziale sud di Bergamo - 1° tratto Stezzano-Zanica
- V 20.7 Tangenziale sud di Bergamo - 2° tratto - Treviolo-Paladina
- V 20.8 Tangenziale sud di Bergamo - 3° tratto - Paladina-Villa d'Almé
- AdPQ Malpensa
- V 21.1 Collegamento Milano-Magenta con variante di Abbiategrasso e riqualfica S.S. 494
- V 21.2 Variante S.S. 341 "Gallaratese" e bretella di Gallarate
- V 21.3 Variante S.S. 33 Rho-Gallarate
- V 21.4 Peduncolo di Veduggio Olona
- V 21.5 S.S. 342 - Variante di Solbiate-Olgiate Comasco
- V 21.6 Nuovo ponte sul Ticino a Vigevano

## Sistema viabilistico comparto Dogana Segrate e Linate Idroscalo

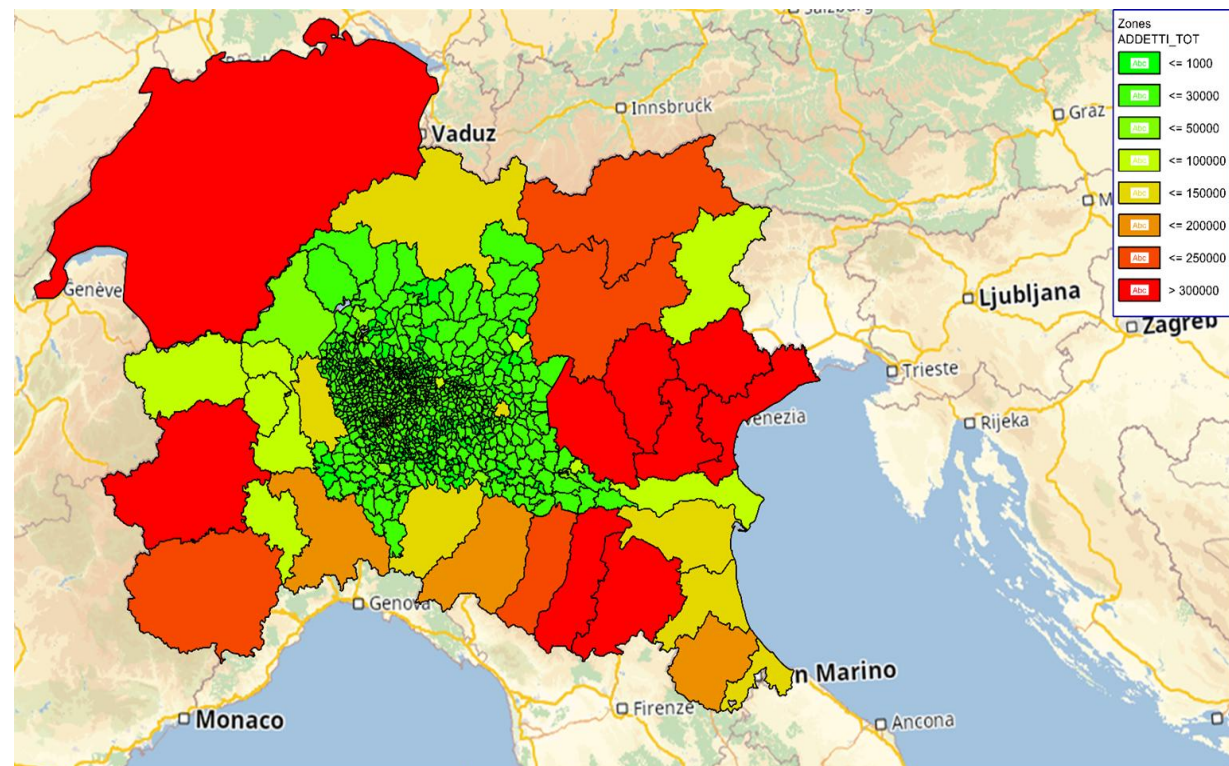
- V 24.1 "Cassanese bis"
- V 24.2 Potenziamento SP "Rivoltana"
- Altri interventi stradali
- V 25.1 SS 470 Variante di Zogno
- V 25.2 SS 639 Variante di Pusiano
- V 25.3 SS 340 – Variante alla Tremezzina
- V 25.4 Ristrutturazione Ponte di San Benedetto Po
- V 25.5 Variante alla SS 42 "del Tonale e delle Mendola"
- V 25.6 Variante ex SS 237 "del Caffaro" (tratta Vestone-Idro)
- V 25.7 Variante ex SS 237 "del Caffaro" (tratta Barghe-Vestone)
- V 25.8 ex SS 234 "Codognese": Variante di Ospedaletto (lotto 1)
- V 25.9 ex SS 234 "Codognese": Variante di Ospedaletto (lotto 2)
- V 25.10 SS 344 – Variante Arcisate-Bisuschio
- V 25.11 ex SS 236 – Variante di Guidizzolo
- V 25.12 ex SS 236 – Variante di Marmirolo (lotti 2 e 3)
- V 25.13 Gronda Nord Viadanese (lotto 2, stralcio 1)
- V 25.14 Variante ex SS 233 "Varesina"



# Socioeconomic Analysis



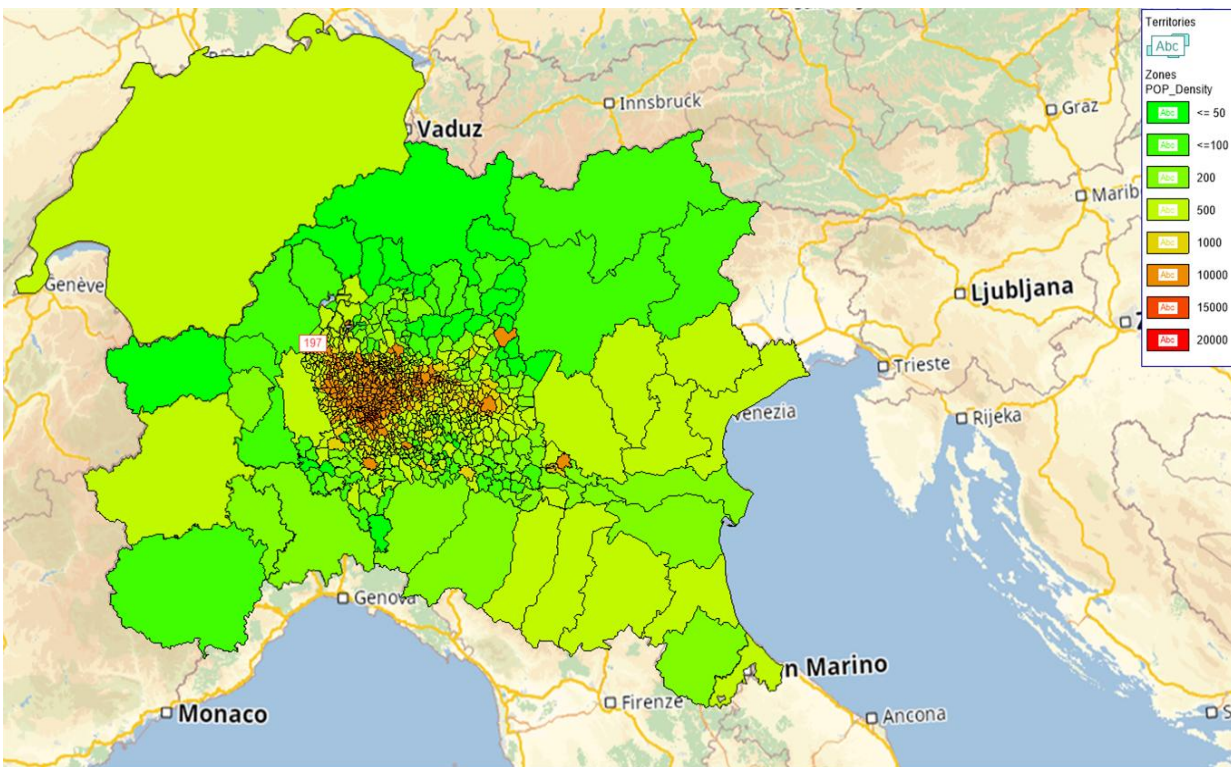
Total Population



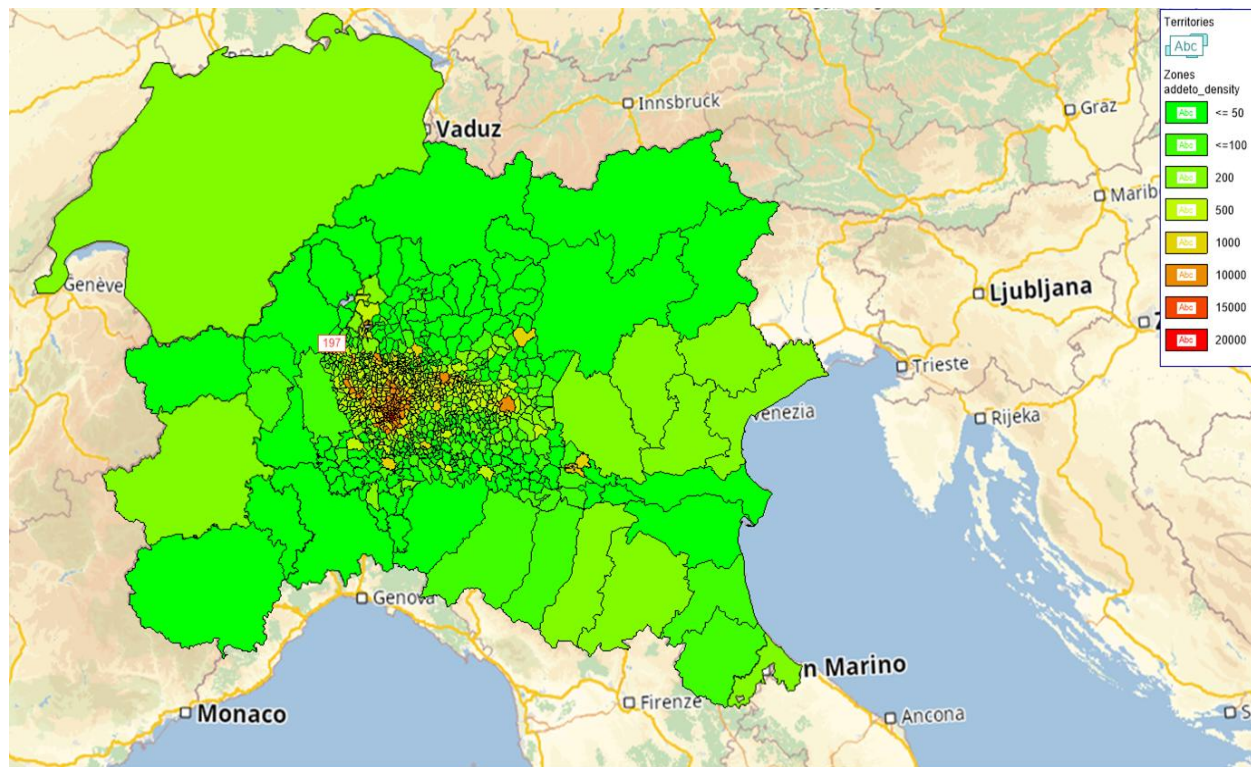
Total Employees



# Socioeconomic Analysis



Population Density



Employees Density

