I risultati del progetto SUCCESS

Gli impatti dei CCC sulla logistica del settore delle costruzioni nei cantieri pilota di Lussemburgo, Parigi, Valencia e Verona

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En&Tech

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 633338.

Simulation and Optimization

- Collect data (material flows) from real pilots
- Map process
- Provide city-wide scenarios for the next three years
- Design and select optimization models
- Apply simulation for a quantitative evaluation of the solutions
- Measure Environmental/Social/Economical KPIs

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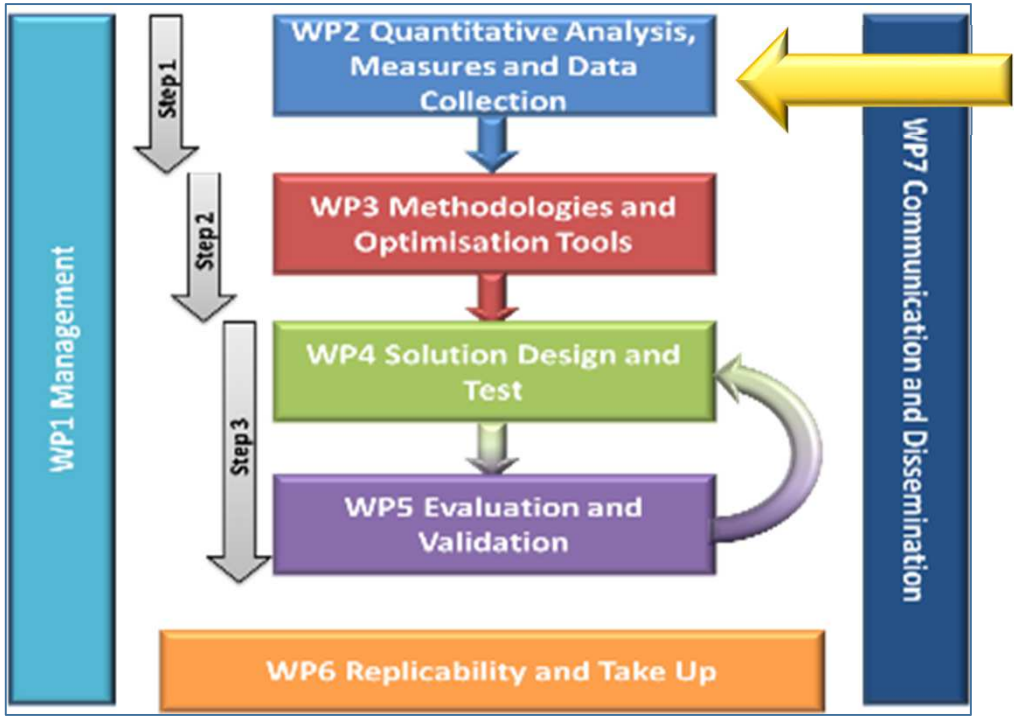
Project structure



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Strength points

- Results based on a **large** and detailed **database** of real data
- Application of stochastic **mathematical models** to manage uncertainty and select «best» decision
- Application of **numerical simulation** for a detailed evaluation of the impact

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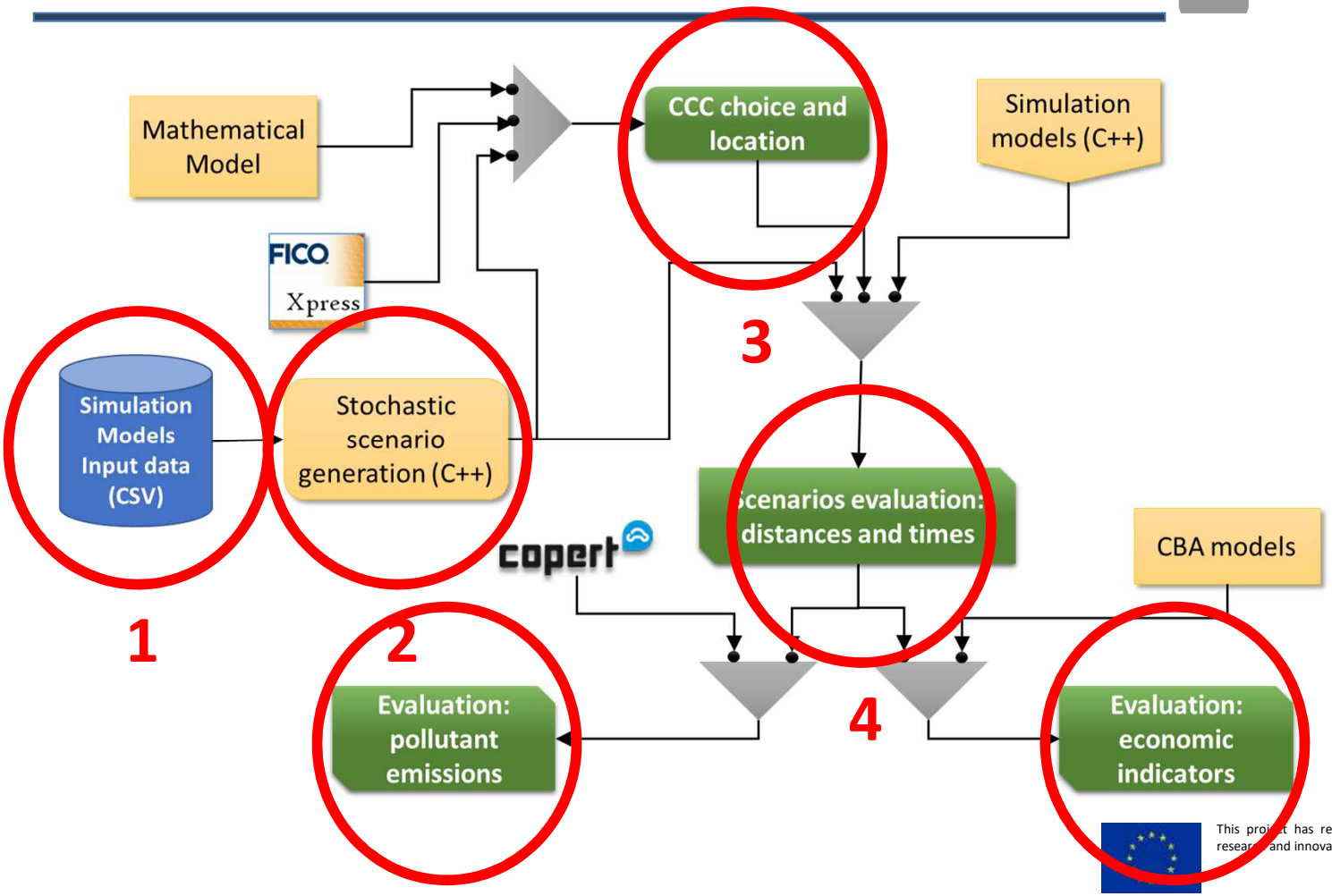
The quantitative approach



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Input data

- **On-site collection** of material flows from pilots
- Definition of material flows on the entire project, from **recorded data and planning**
- **Aggregation** in classes
- **Removal of classes** not suitable for a CCC
- Removal of materials sent with **complete trailer trucks**

Class	
Accessories	Metal
Bitumen	Paint
Bricks	Parquet
Cement	Pipes
Coating	Plants
Electrical	Plaster
Epoxi	Polystyrene
External Doors	Precasted Concrete
Fences	Roof
Fire Doors	Scaffolding
Gabions	Signals
Garden Equipment	Steel
Geotexil	Stone
Glass wool	Tar
Hydraulic	Tiles
Internal Doors	Windows
Lift	Wood

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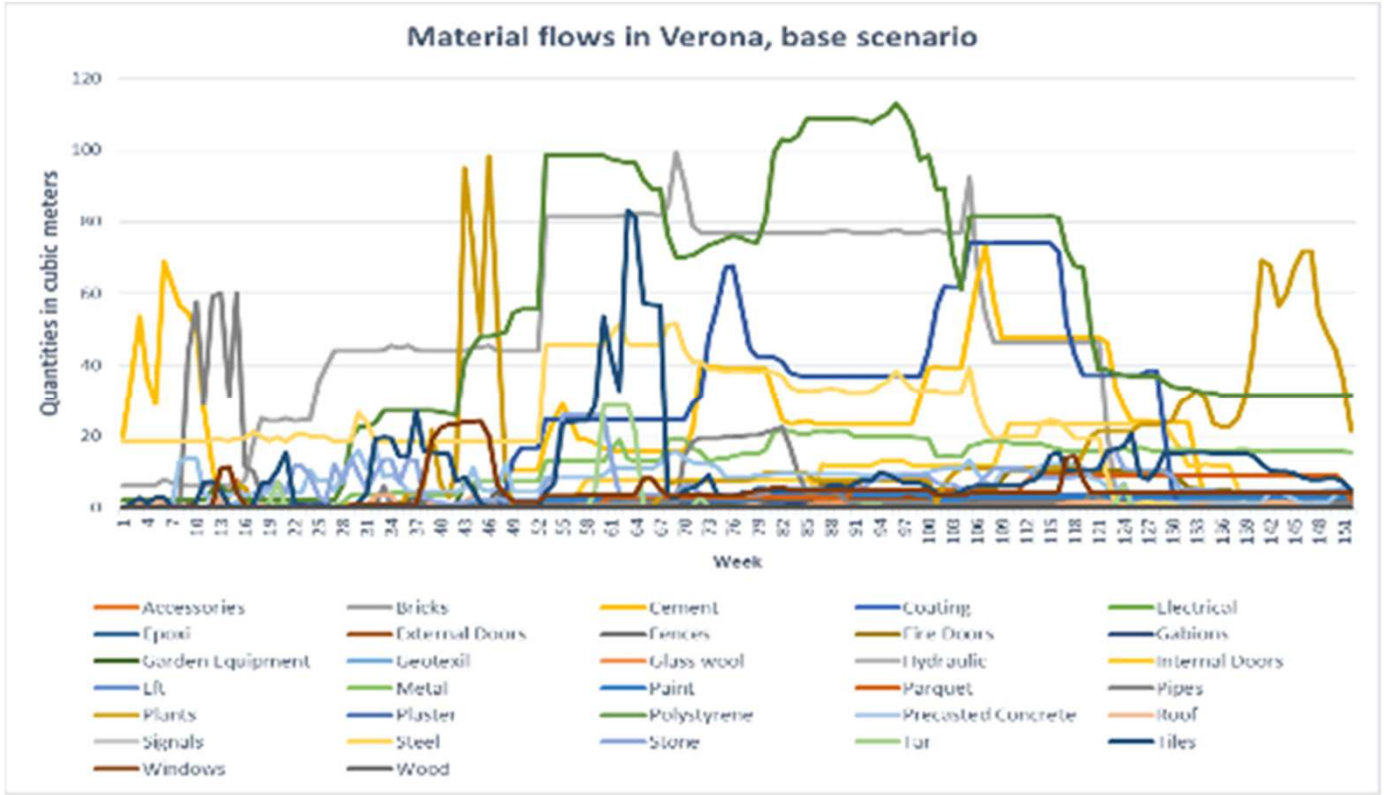
Material flows: Verona



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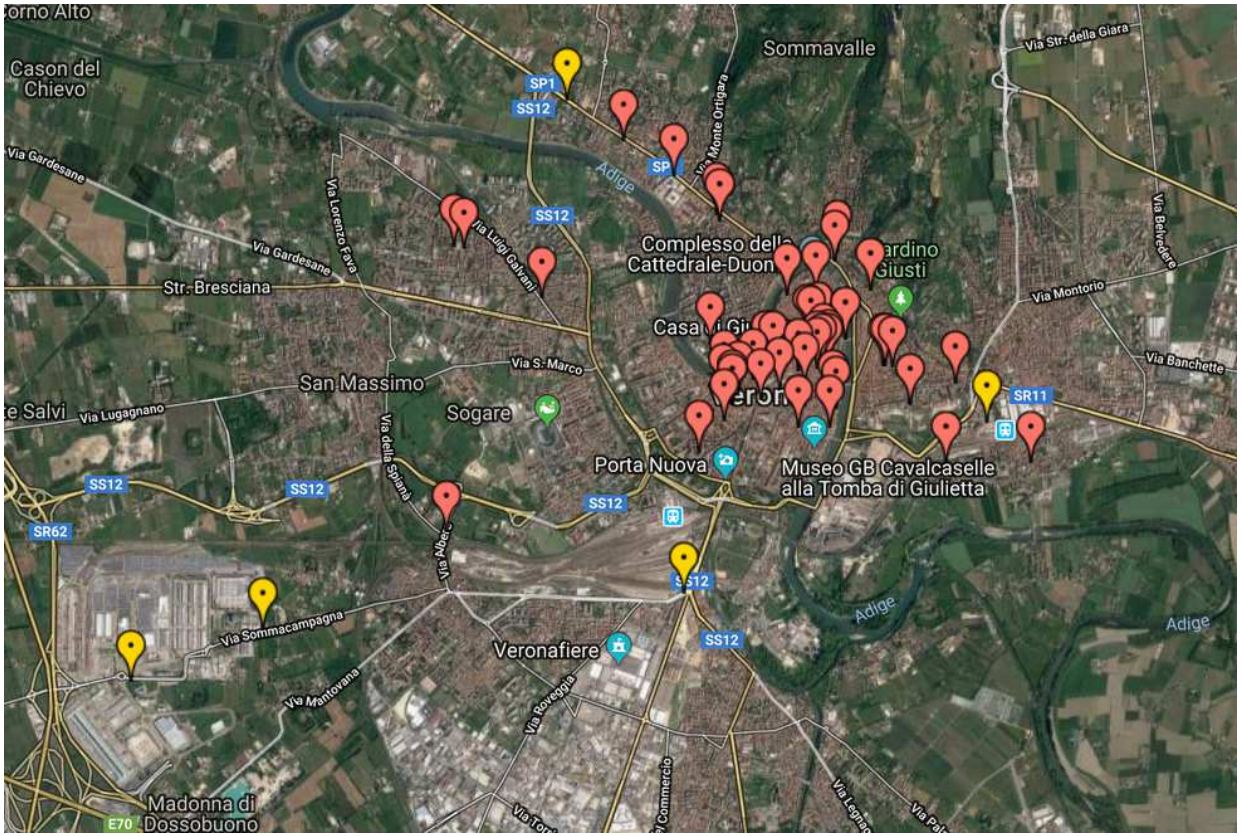
Construction sites - Verona



- 3 years
- 48 sites
- 220 M€
- No site < 500K €

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Suppliers - Verona

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Selection of CCC location

- Facility selection model
- Input data are not deterministic
- The choice must be robust

→stochastic optimization approach

1. Manage uncertainty with some scenarios and probabilities for each one
2. Goal: minimize the m^3 x km needed to serve the construction sites
3. Robust approach: minimize the expected value of the objective function

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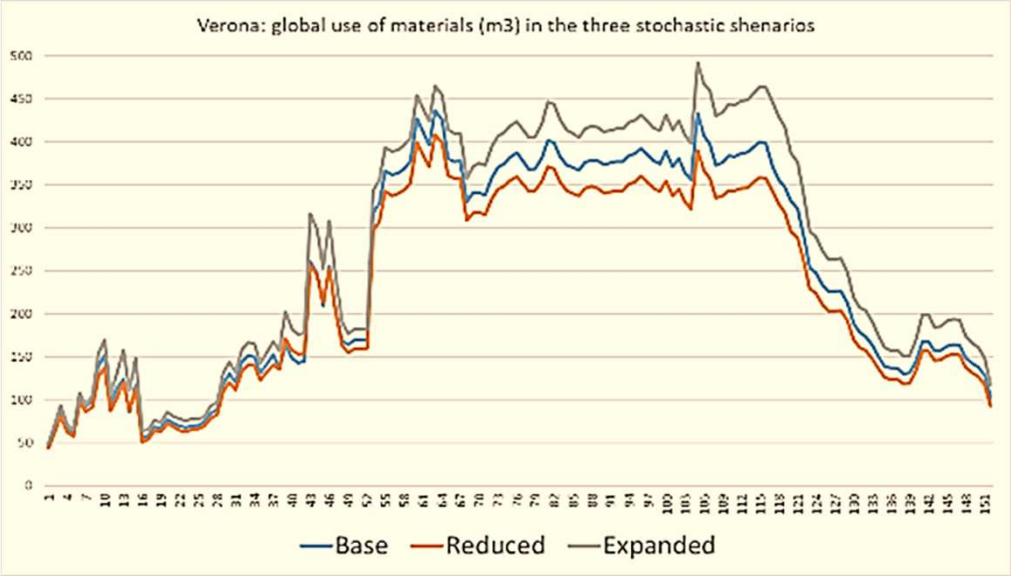
Stochastic model



$$\min \sum_{h\in D} l_h y_h + \sum_{\omega\in\Omega}\sum_{i\in F}\sum_{j\in P}\sum_{h\in D} p_\omega (c_{ih} + c_{hj}) g_{ij}^{h\omega}$$

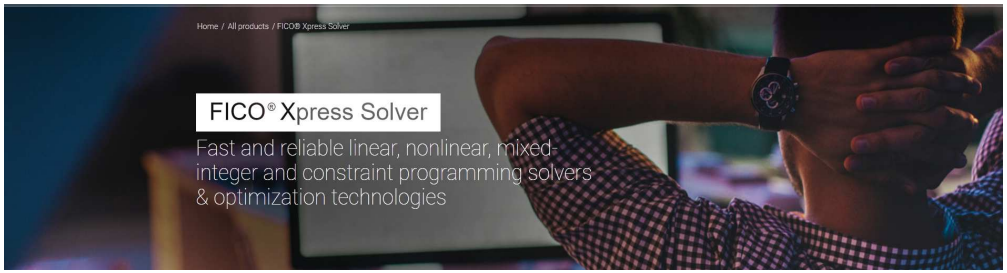
$$\sum_{h\in D} g_{ij}^{h\omega} = \tilde{q}_{ij}^{\omega} \qquad i\in F, j\in P, \omega\in\Omega$$

$$\sum_{i\in F}\sum_{j\in P} g_{ij}^{h\omega} \le C_h y_h \qquad h\in D, \omega\in\Omega$$

$$\sum_{h\in D} y_h \le B$$

$$g_{ij}^{h\omega} \ge 0 \qquad i\in F, j\in P, h\in D, \omega\in\Omega$$

$$y_h \in \{0,1\} \qquad h\in D$$



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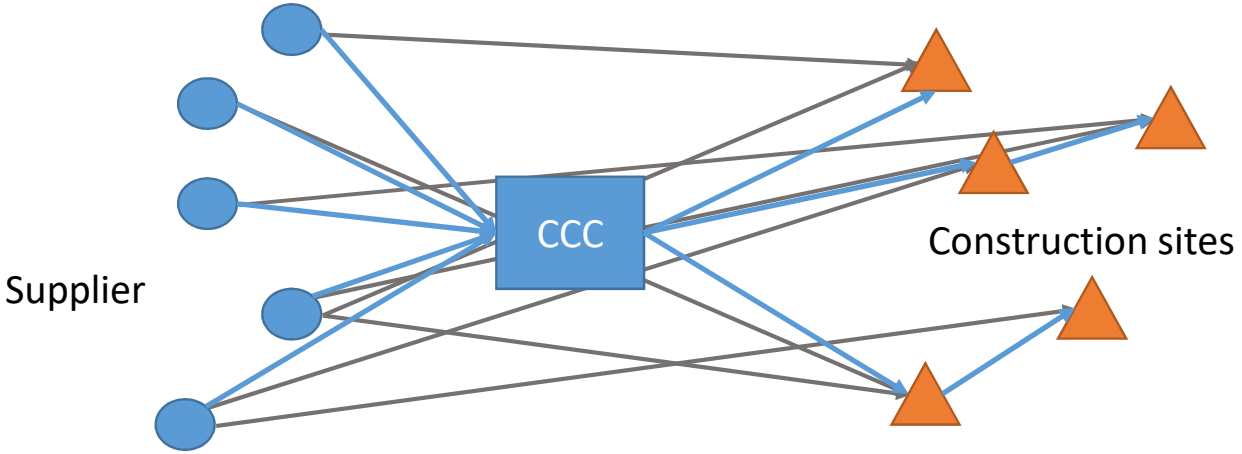
Simulation scenarios



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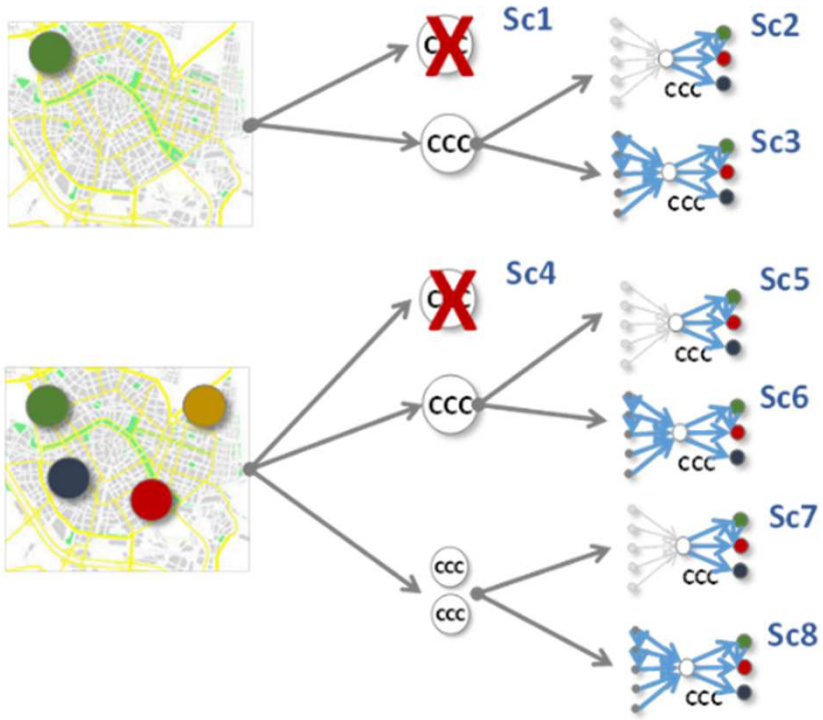

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Simulation hypotesis

- Normal truck load 75%
- Supplier-CCC deliveries: weekly
- CCC-sites deliveries: daily (just-in-time), full load
- Unloading at the sites reduced if truck is scheduled from CCC

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Some results: Verona

SC1 --> SC3			
Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-14%	-30%	-22%
Kilometres / day travelled by vehicles	-12%	-29%	-29%
% Increase load factor	8%	12%	10%
Travel time	-15%	-30%	-30%

SC1 --> SC3			
Polluttant	Inside city	Outside city	Total
CO	-20%	-24%	-24%
PM2.5	-17%	-23%	-23%
PM10	-16%	-22%	-21%
NOx	-21%	-32%	-32%
CO2	-12%	-24%	-24%

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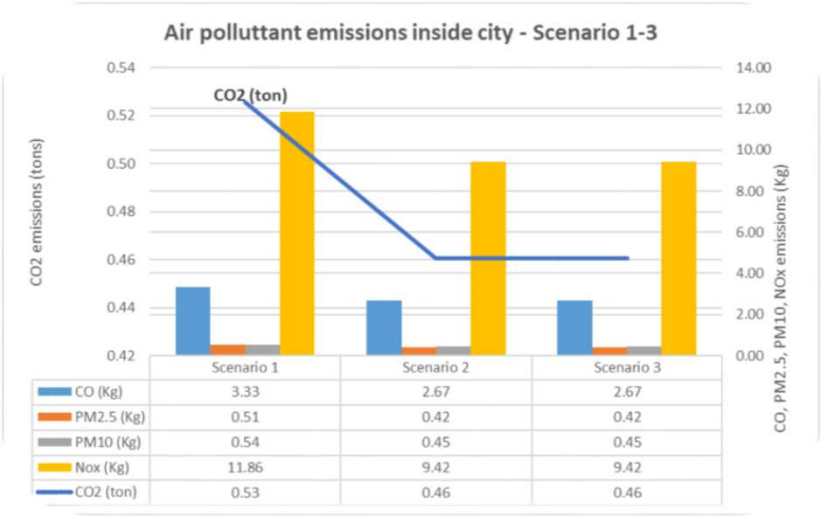
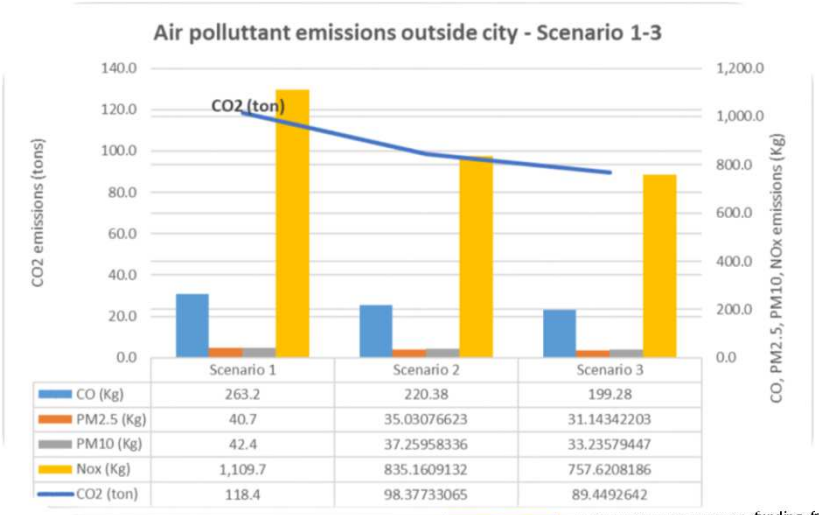
Some results: Verona



	Scenario 1	Scenario 2	Scenario 3
CO (Kg)	3.33	2.67	2.67
PM2.5 (Kg)	0.51	0.42	0.42
PM10 (Kg)	0.54	0.45	0.45
Nox (Kg)	11.86	9.42	9.42
CO2 (ton)	0.53	0.46	0.46



	Scenario 1	Scenario 2	Scenario 3
CO (Kg)	263.2	220.38	199.28
PM2.5 (Kg)	40.7	35.03076623	31.14342203
PM10 (Kg)	42.4	37.25958336	33.23579447
Nox (Kg)	1,109.7	835.1609132	757.6208186
CO2 (ton)	118.4	98.37733065	89.4492642

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Some results: Verona

SC4 --> SC6			
Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-85%	-23%	-54%
Kilometres / day travelled by vehicles	-86%	-20%	-23%
% Increase load factor	452%	12%	232%
Travel time	-72%	-19%	-23%

SC4 -->SC6			
Polluttant	Inside city	Outside city	Total
CO	-67%	-17%	-19%
PM2.5	-74%	-16%	-19%
PM10	-75%	0%	-19%
NOx	-51%	-21%	-22%
CO2	-86%	-16%	-19%

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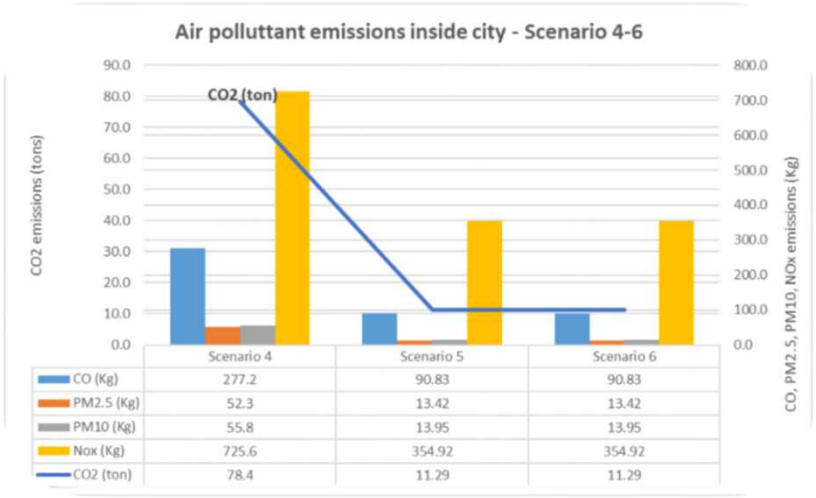
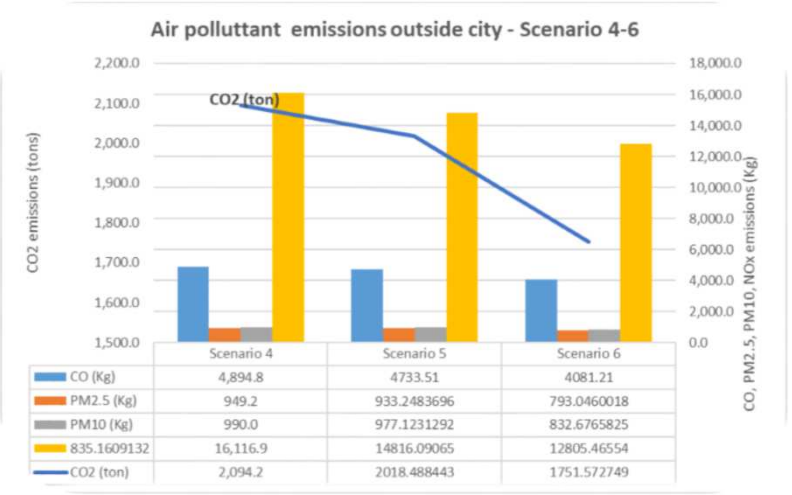
Some results: Verona



	Scenario 4	Scenario 5	Scenario 6
CO (Kg)	277.2	90.83	90.83
PM2.5 (Kg)	52.3	13.42	13.42
PM10 (Kg)	55.8	13.95	13.95
Nox (Kg)	725.6	354.92	354.92
CO2 (ton)	78.4	11.29	11.29



	Scenario 4	Scenario 5	Scenario 6
CO (Kg)	4,894.8	4733.51	4081.21
PM2.5 (Kg)	949.2	933.2483696	793.0460018
PM10 (Kg)	990.0	977.1231292	832.6765825
835.1609132	16,116.9	14816.09065	12805.46554
CO2 (ton)	2,094.2	2018.488443	1751.572749

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Some results: Verona

- Reduction in the number of trips inside the city → **increase safety, decrease congestion, improve on-time delivery**
- Reduction number of km in/out →**decrease air polluttant emissions**
- Increase load factor →**economical saving**

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Some results

- The results in the 4 pilots are **not identical**, mainly because of the city topology, but **savings always exist**

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Different cities

Valencia

SC4 --> SC6			
Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-57%	-40%	-48%
Kilometres / day travelled by vehicles	-44%	-34%	-34%
% Increase load factor	87%	1%	44%
Travel time	-39%	-33%	-34%

Luxemburg

SC4 --> SC6			
Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-54%	-42%	-48%
Kilometres / day travelled by vehicles	-23%	-43%	-42%
% Increase load factor	75%	5%	40%
Travel time	-27%	-42%	-41%

Paris

SC4 --> SC6			
Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-43%	-52%	-38%
Kilometres / day travelled by vehicles	-22%	-32%	-24%
% Increase load factor	48%	-6%	21%
Travel time	-5%	-32%	-22%

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Global savings

Polluttant	Inside city	Outside city	Total
CO	-27%	-26%	-26%
PM2.5	-31%	-24%	-24%
PM10	-32%	-3%	-22%
NOx	-18%	-37%	-34%
CO2	-34%	-27%	-26%

Indicator	Inside city	Outside city	Total
Daily number of freight vehicles	-60%	-35%	-46%
Kilometres / day travelled by vehicles	-51%	-26%	-25%
% Increase load factor	174%	1%	88%
Travel time	-38%	-26%	-25%

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Thank you for your kind attention!

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