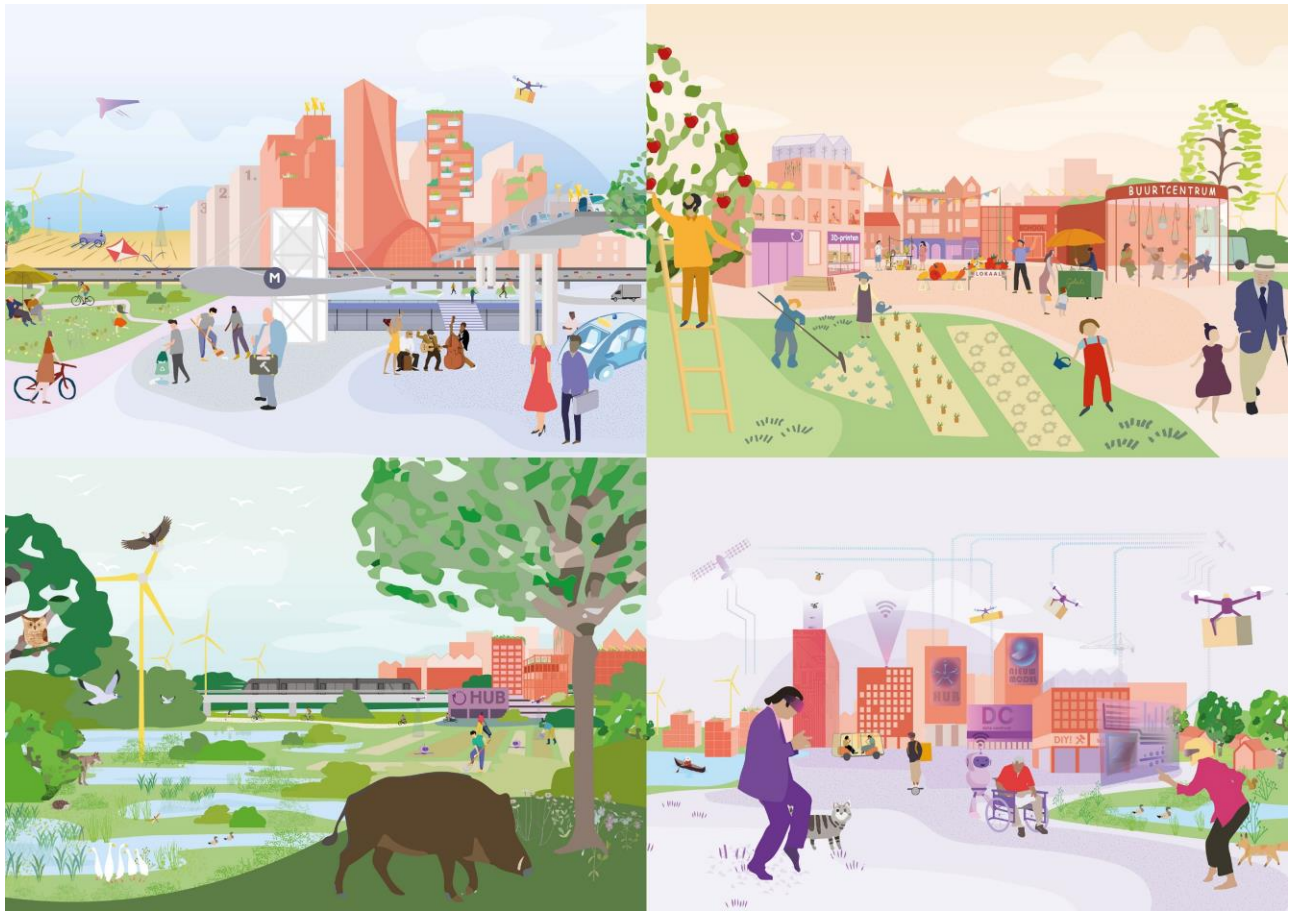
Le sfide del XXI secolo:

il Clima

FONDAZIONE
ROMA SAPIENZA



La transizione verde nella mobilità urbana

Prof. Ing. Pierluigi Coppola
Politecnico di Milano - DMEC

Roma, 9 Giugno 2025

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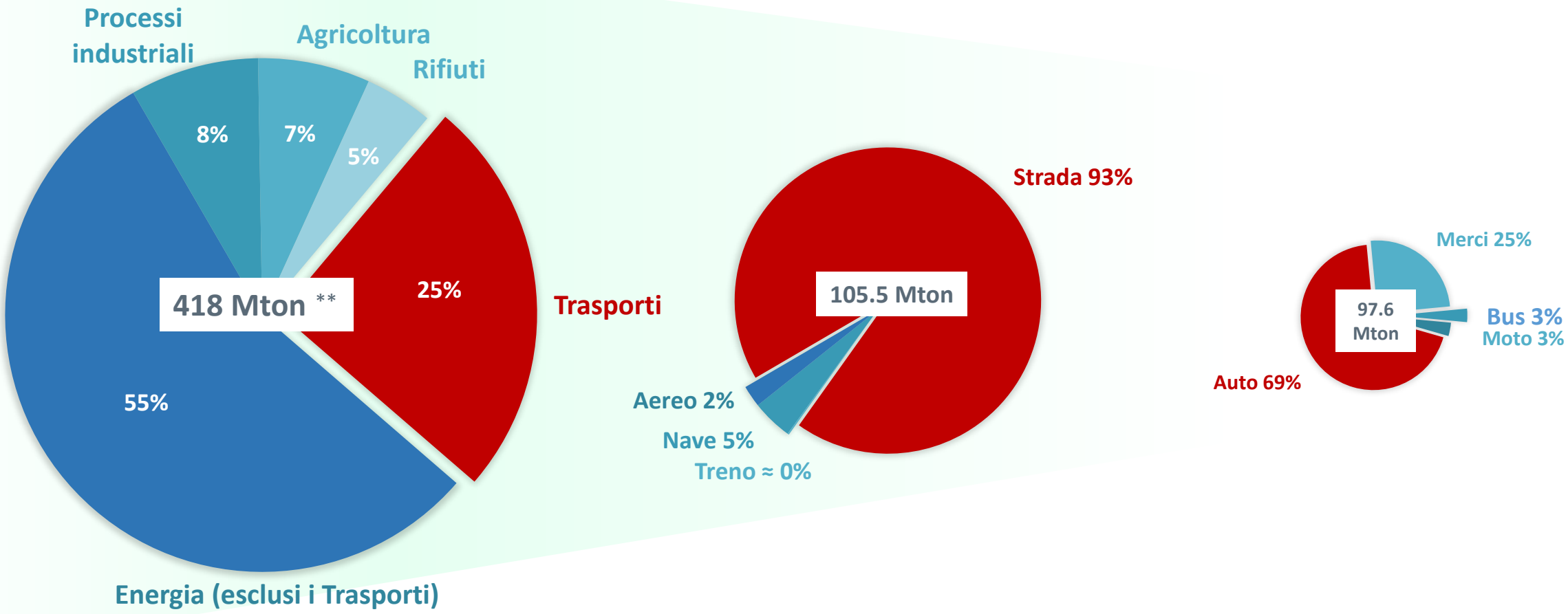
Green House Gas (GHG) Emissions in Italy: transport shares



*Elaborazioni su dati ***ISPRA (2021) – Italian Greenhouse Gas National Inventory Report***

** escluse le emissioni Land use, land-use change and forestry (LULUCF) (-41.6 Mton)

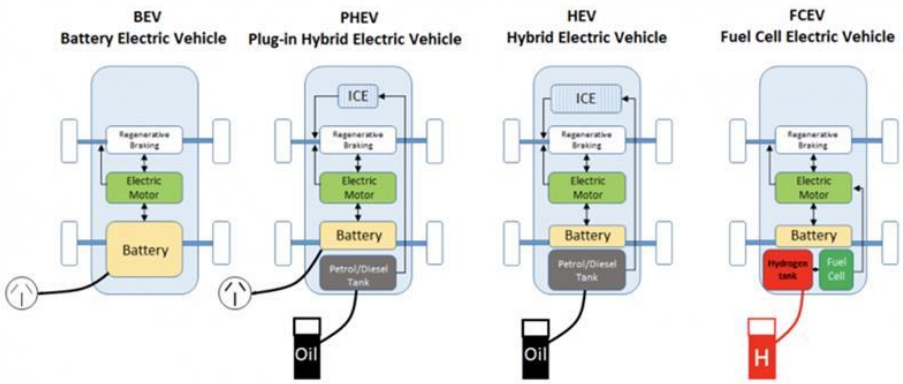
On-going changes in urban mobility

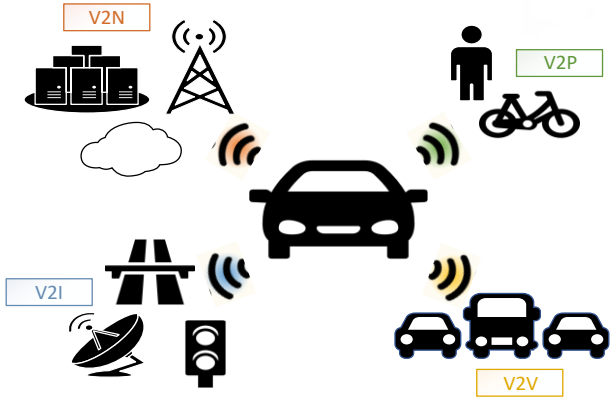
Vehicles
- new engines and fuels
- autonomous and connected driving

Infrastructure
- Smart roads
- Multimodal/multiservice hubs

- **Management**
  Big Data
- AI application & Digital Twin

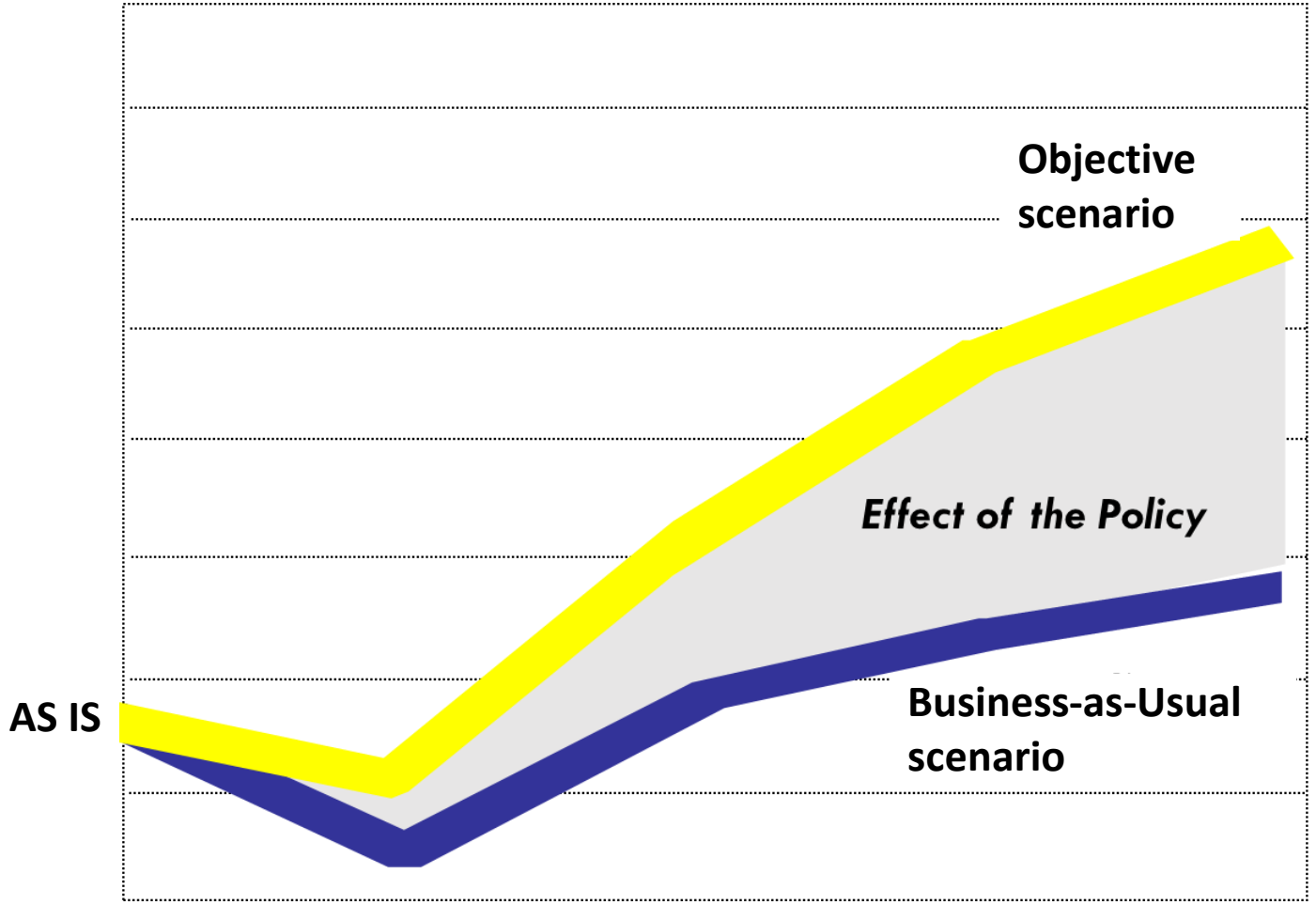
Services (passengers and freights)
- MaaS
- Crowd shipping





The role of transportation planning

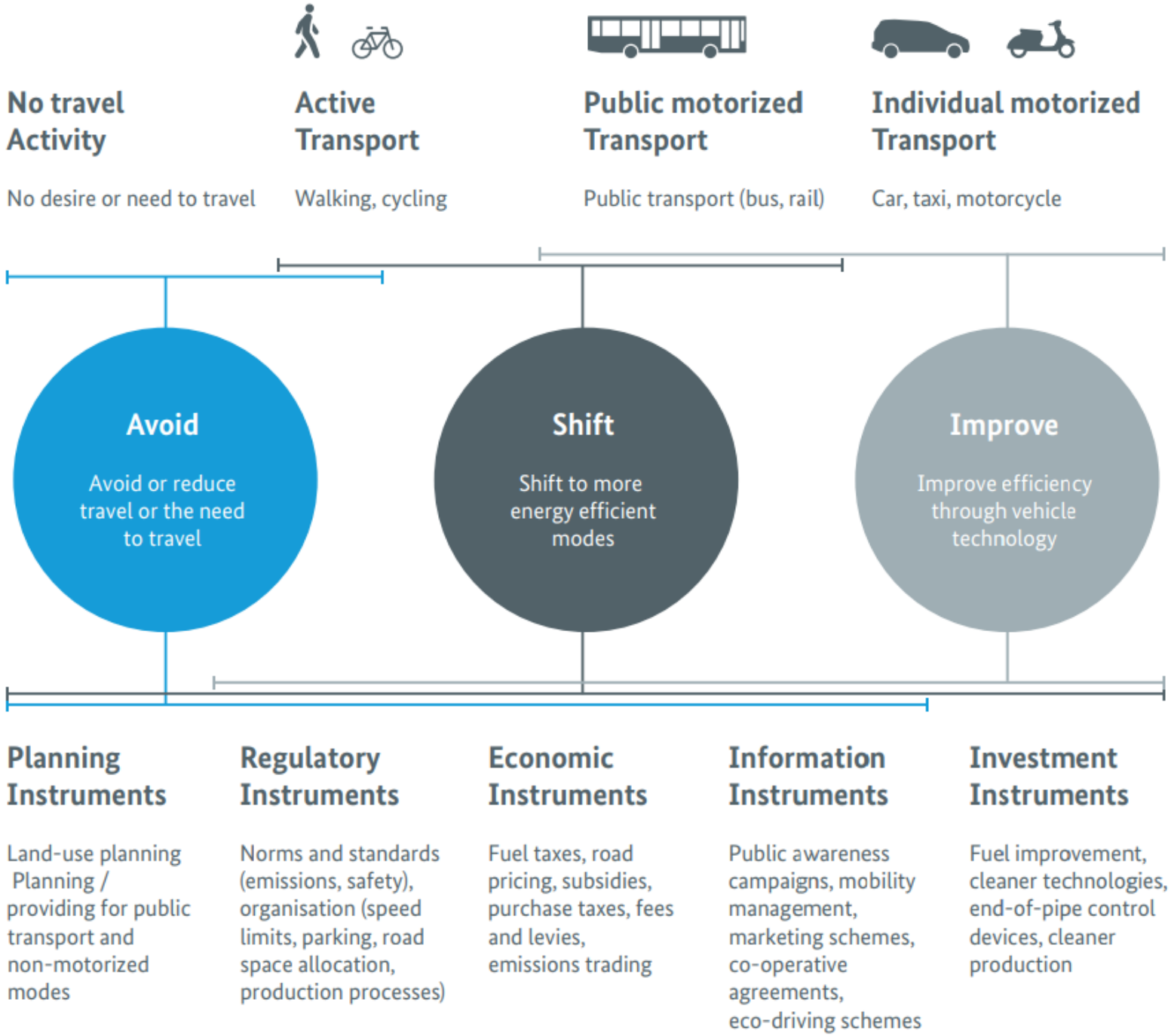
- **Understanding current criticalities** (AS IS) **and trends** (business-as-Usual scenario)
- **supporting decision-makers** about policies and investments to drive the change towards **desirable future scenarios** (objective scenario) and avoid undesirable futures



Policies & Actions

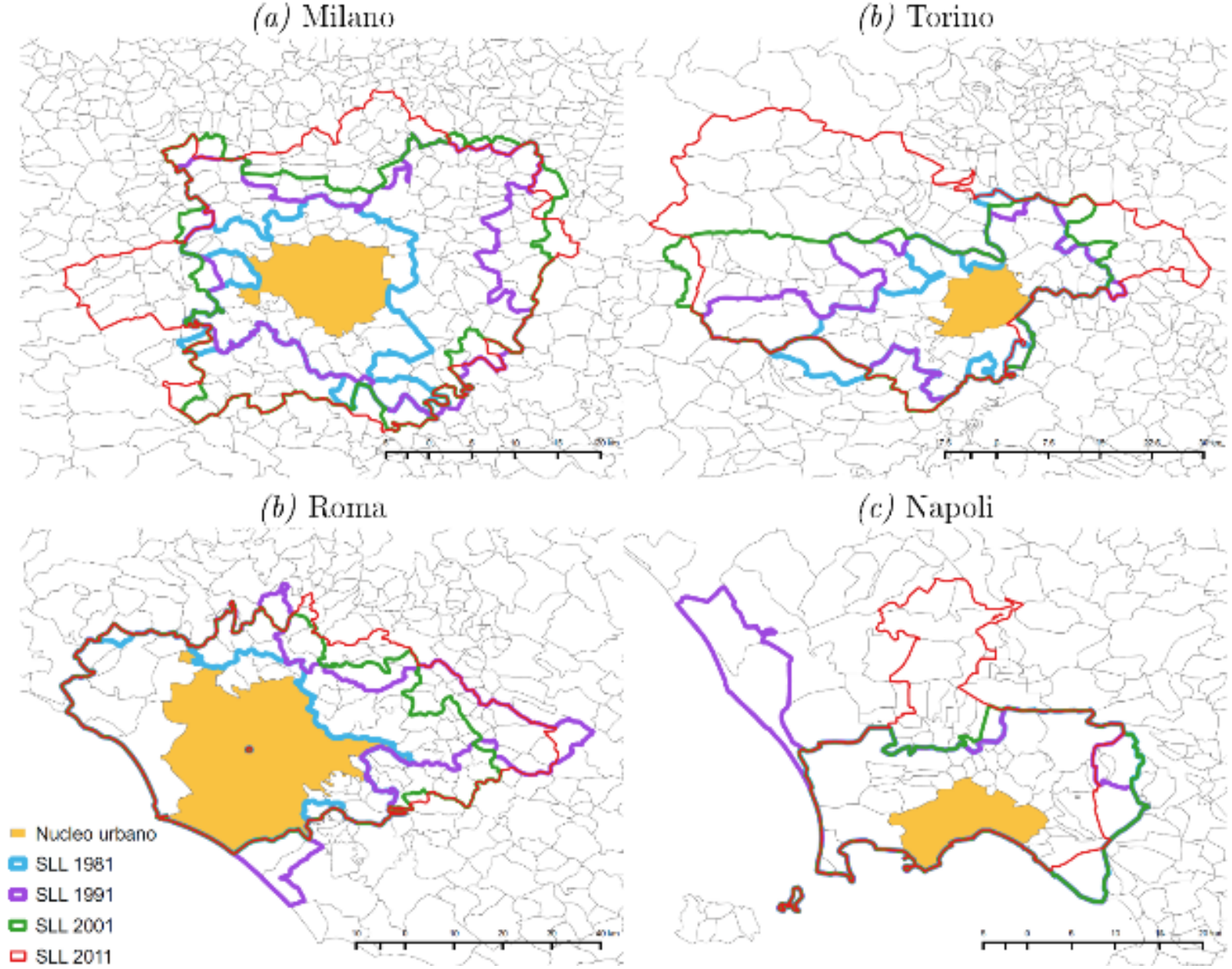
	Supply	Demand	Integrated Land-Use/Transport
«Hardware»	new infrastructure, vehicles, …	-	Transit Oriented Development
«Software»	Intelligent Transport Systems (ITS)	MaaS	-
«Orgware»	Traffic regulation	Travel Demand Management	urban activities times desynchronization

A S I


No travel Activity
No desire or need to travel
Active Transport
Walking, cycling
Public motorized Transport
Public transport (bus, rail)
Individual motorized Transport
Car, taxi, motorcycle
Avoid
Avoid or reduce travel or the need to travel
Shift
Shift to more energy efficient modes
Improve
Improve efficiency through vehicle technology
Planning Instruments
Land-use planning Planning / providing for public transport and non-motorized modes
Regulatory Instruments
Norms and standards (emissions, safety), organisation (speed limits, parking, road space allocation, production processes)
Economic Instruments
Fuel taxes, road pricing, subsidies, purchase taxes, fees and levies, emissions trading
Information Instruments
Public awareness campaigns, mobility management, marketing schemes, co-operative agreements, eco-driving schemes
Investment Instruments
Fuel improvement, cleaner technologies, end-of-pipe control devices, cleaner production


AVOID

Avoiding urban sprawl e *auto-oriented* life-styles

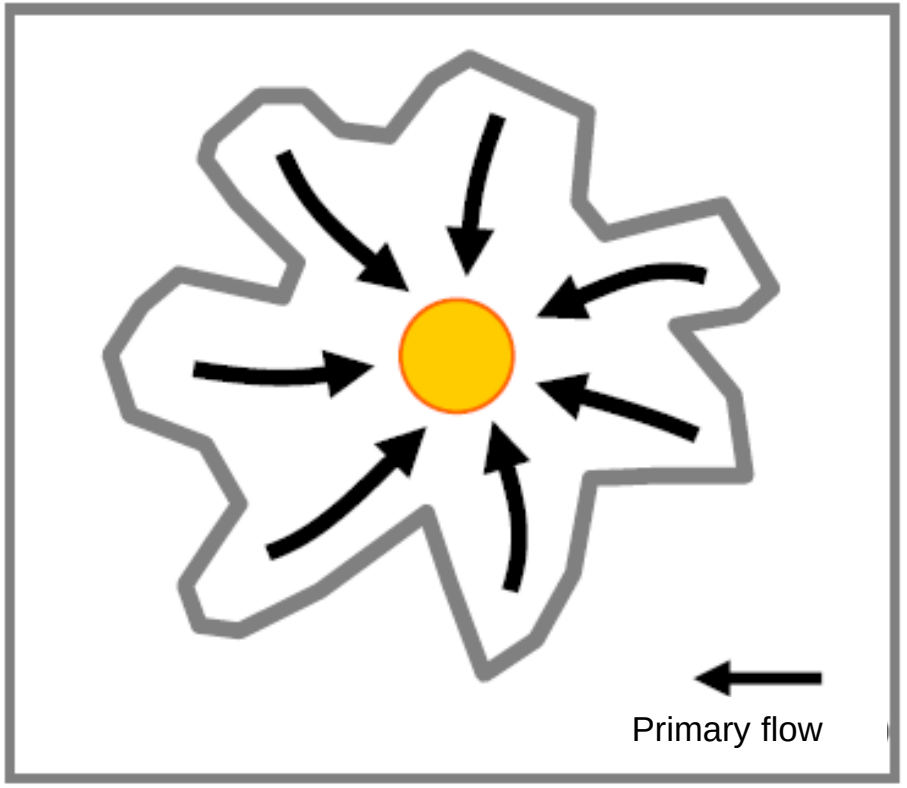


Fonte: Lamorgese e Petrella (2018), Banca d'Italia

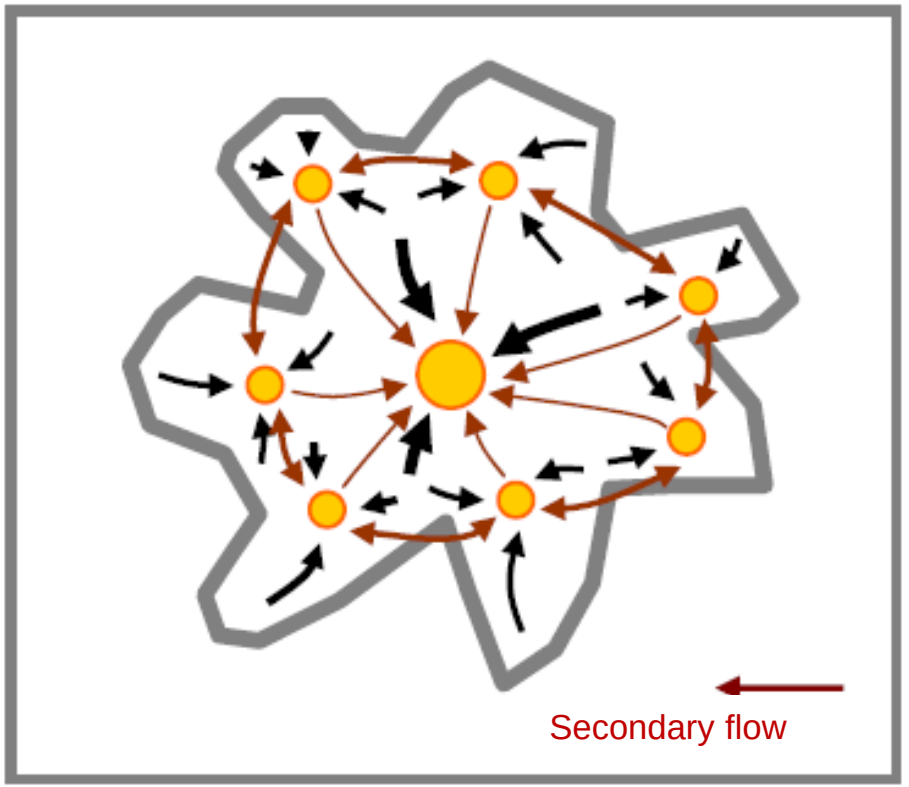
Planning Instruments

promoting integrated Land-use and transport policies

Monocentric highly congested urban structure



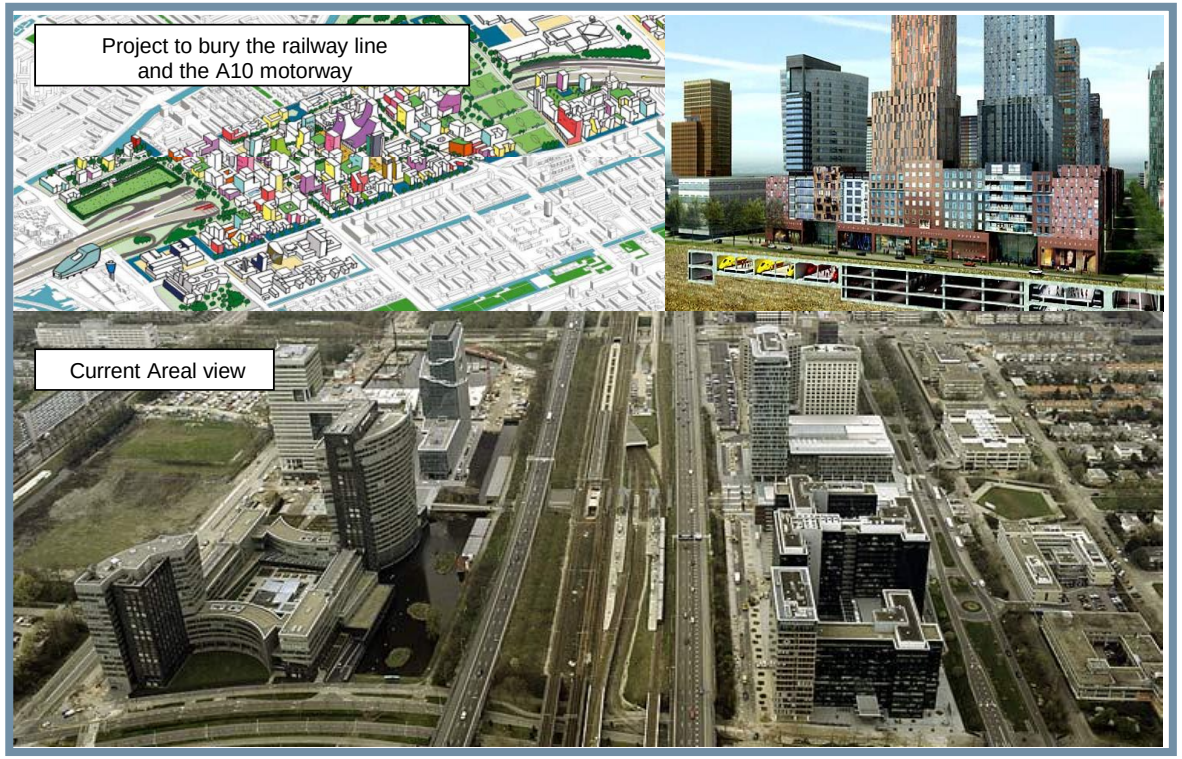
Polycentric urban structure based on Mass Rapid Transit

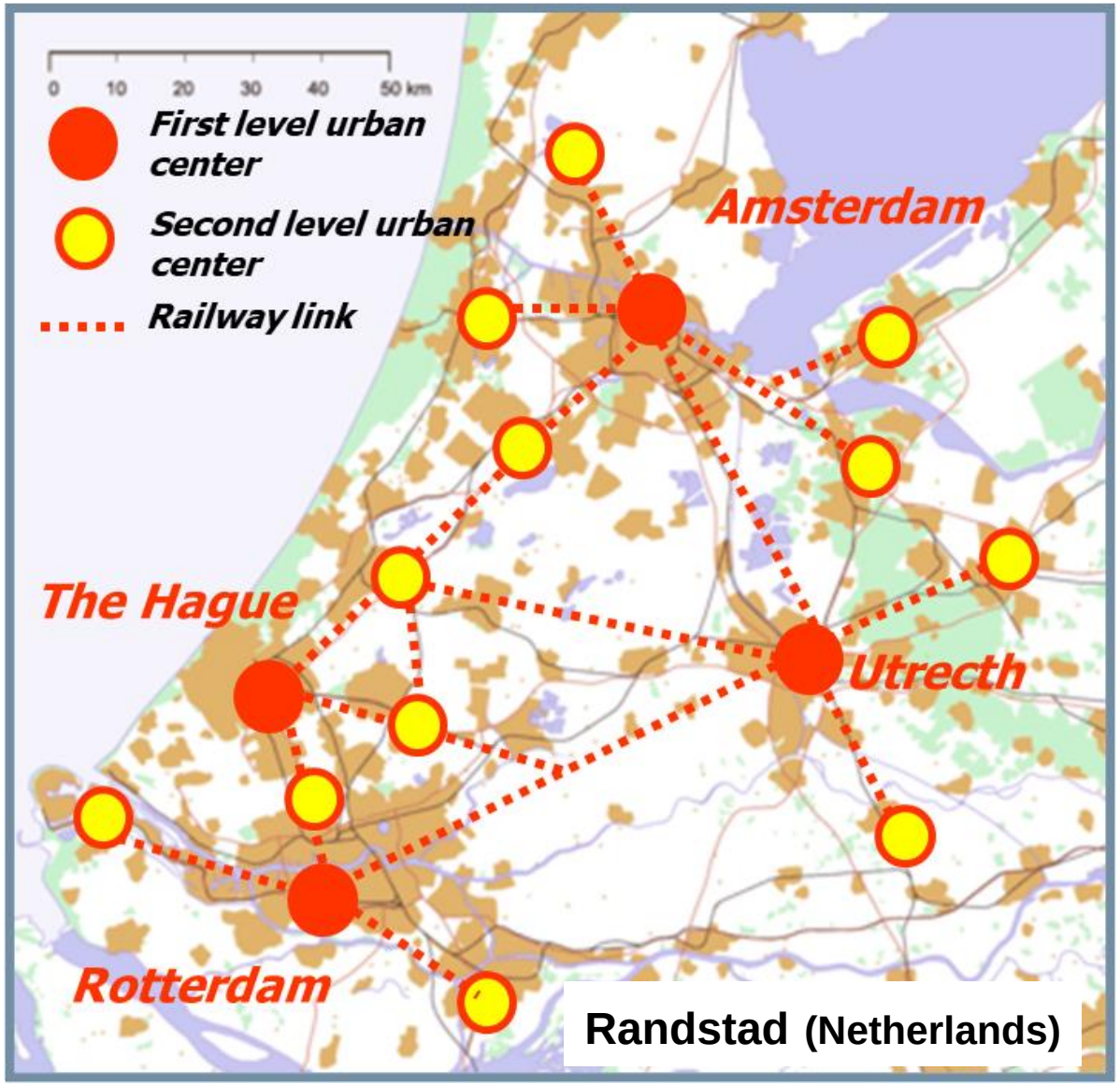


Transit-Oriented Development (TOD)

Zuidas project, Amsterdam

densification, high functional mix and accessibility to the regional rail network






SHIFT
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NEXT MOBILITY EXHIBITION
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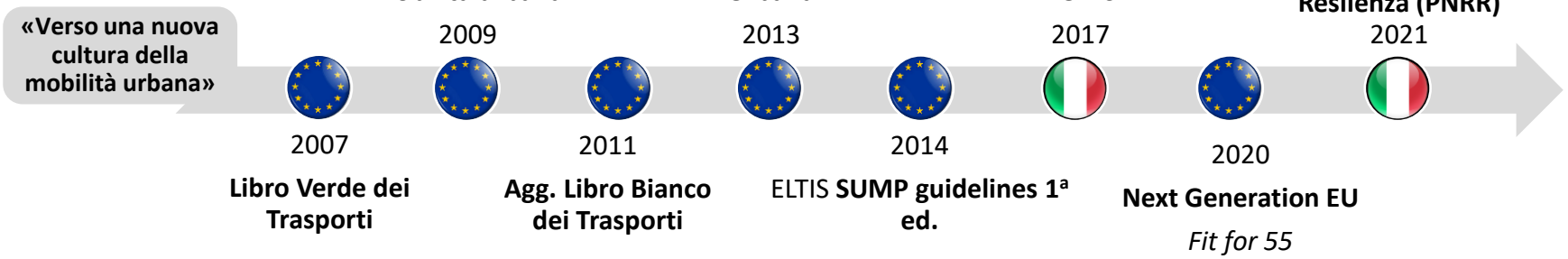
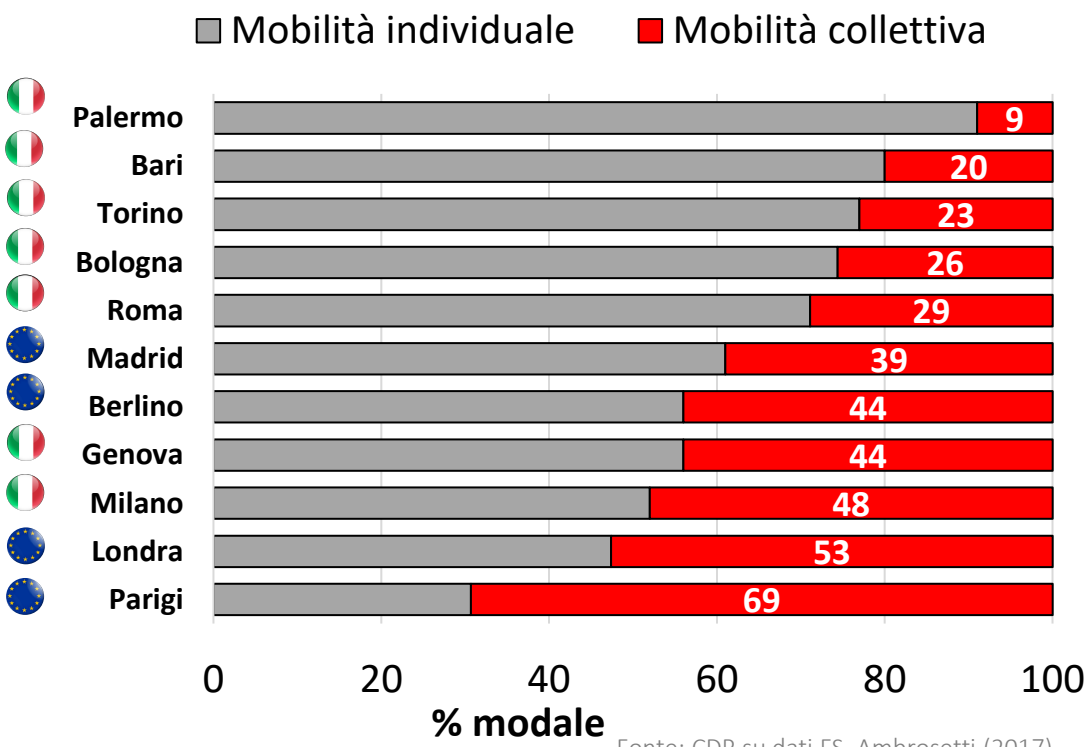
Modal shift towards Public Transit

Increasing the modal share of public transit is not a new strategy in Europe:

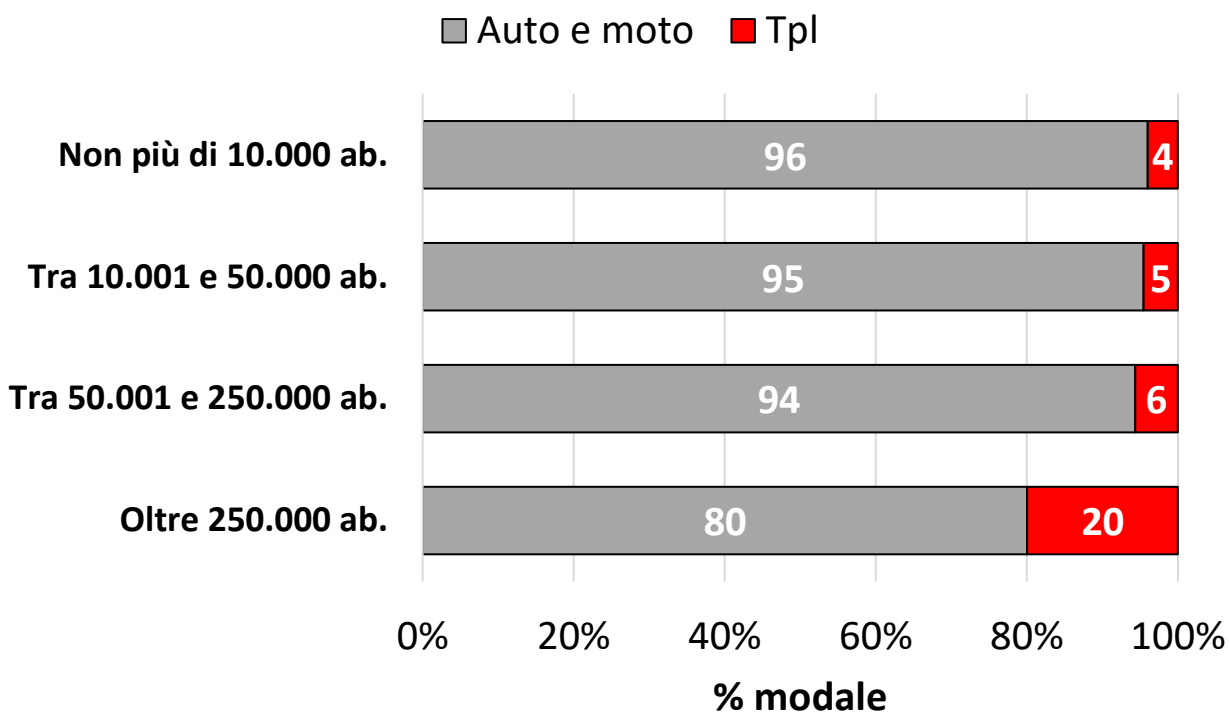
- **1st cycle)** From the early 90s until the first White Paper of the European Commission (2001), modal diversion was considered a functional strategy for **decongestionizing transport systems** (for greater efficiency of the system and safety of road networks)
- **2nd cycle)** Starting from the Green Paper (2007), modal diversion has been gradually considered increasingly functional for the environmental sustainability of transport, and supported by **policies for decarbonization** until the recent European Green Deal (Fit for 55)



Modal shift of Public Transit in Italian cities



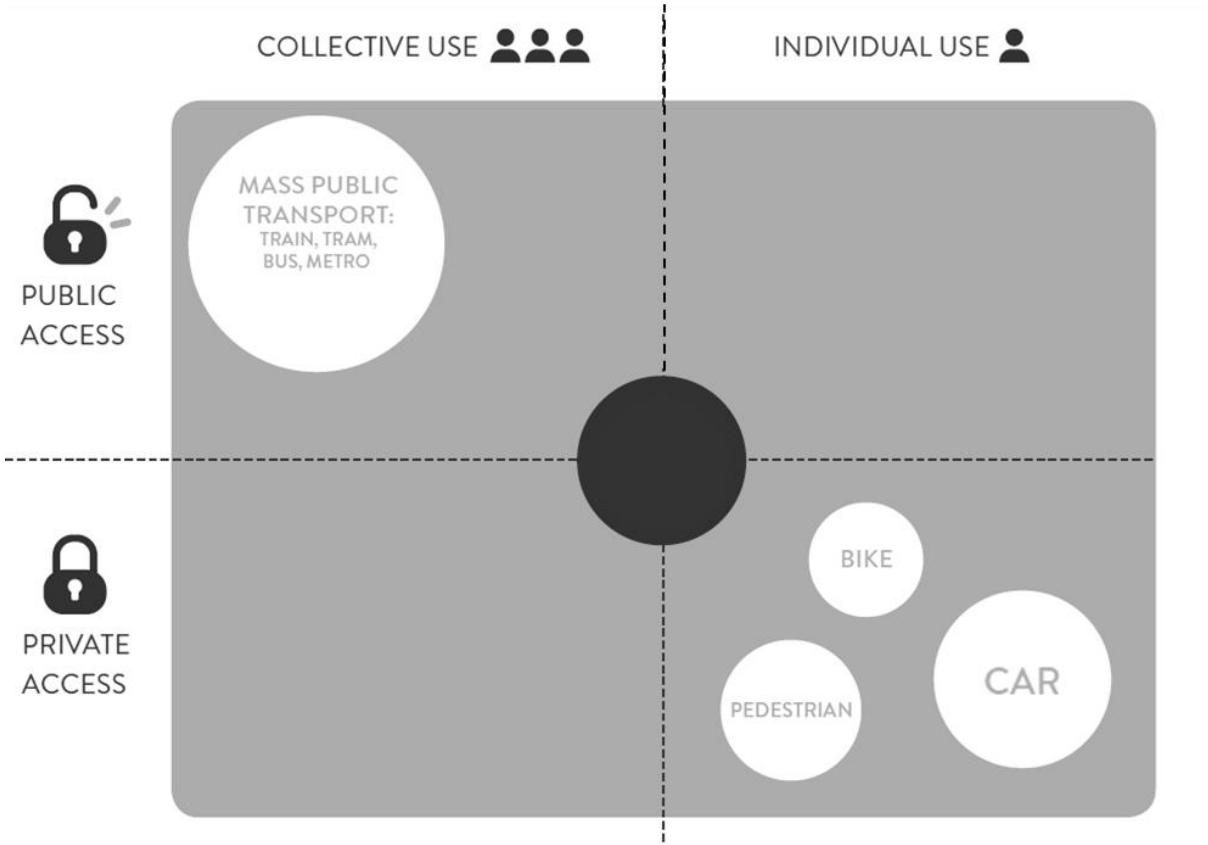
Fonte: CDP su dati FS, Ambrosetti (2017)



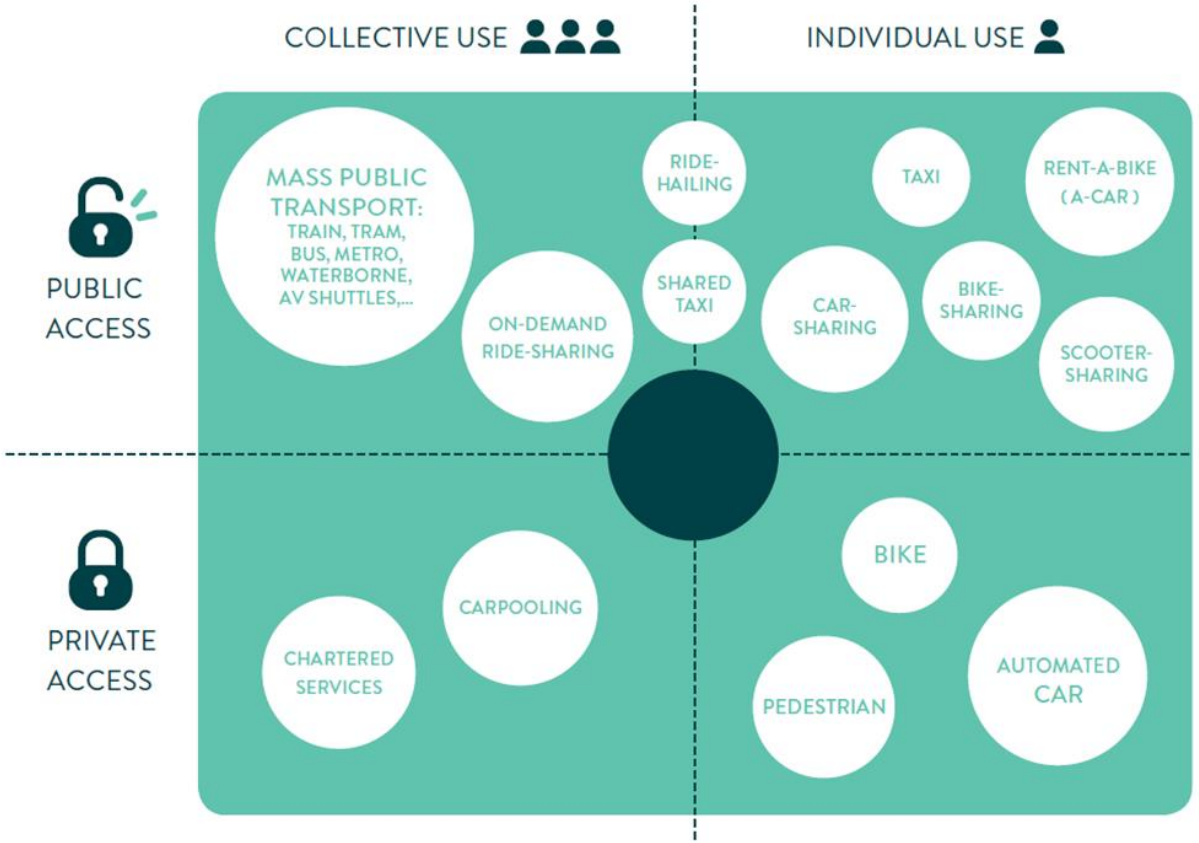
Fonte: Isfort, 18° Rapporto sulla mobilità degli italiani

Mobility services in urban areas

Past …



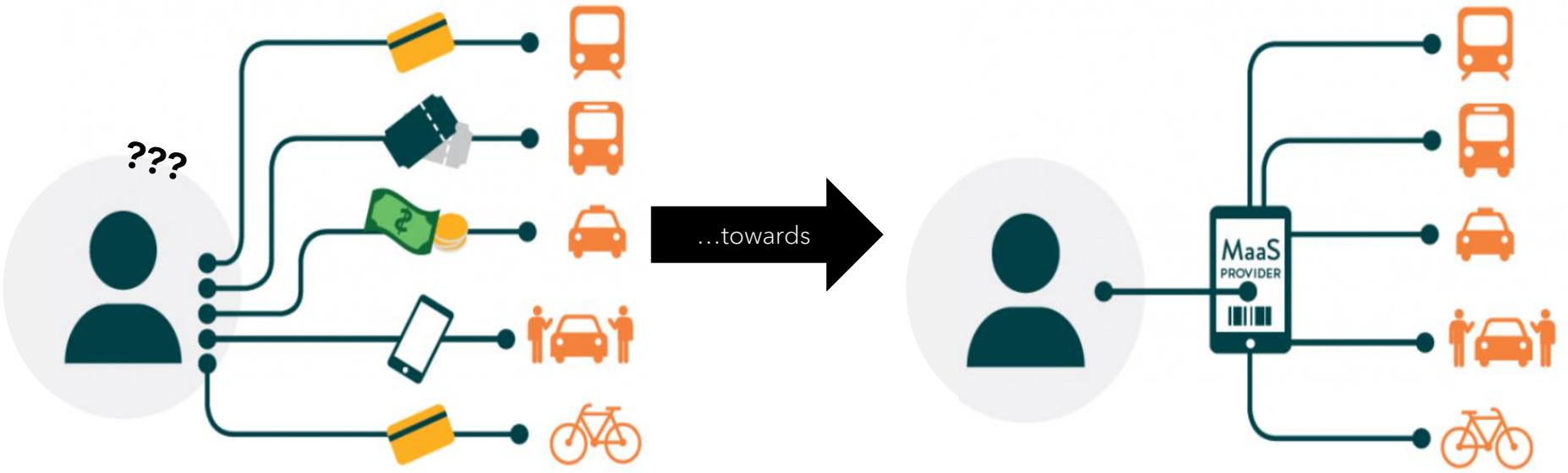
…Present!



Fonte: UITP, 2019, Mobility as a Service - Report

Mobility as a Service (MaaS)

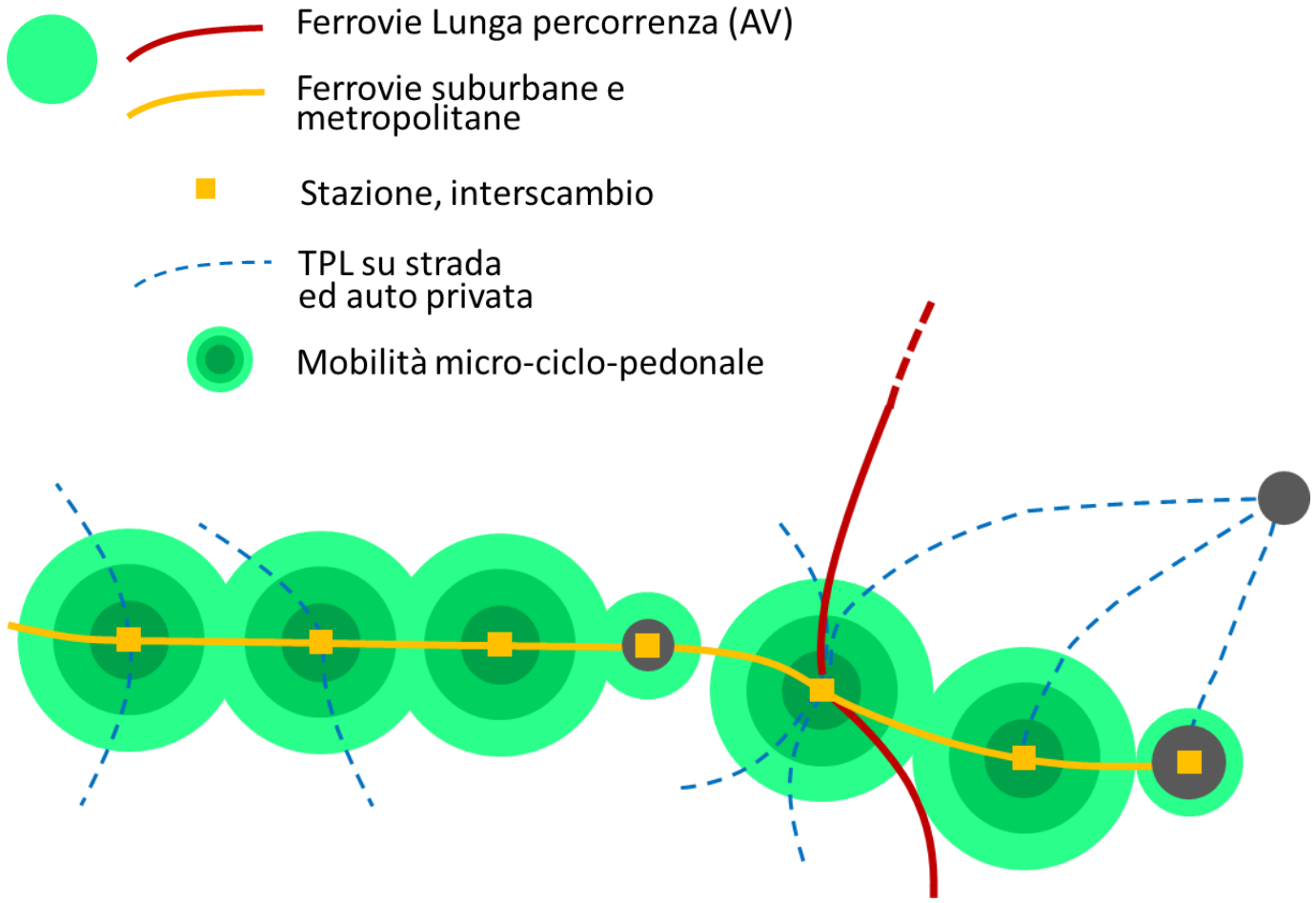
multimodal and multiservice, door-to-door optimized travel solutions



UITP, 2019, Mobility as a Service – Report

Investiment in infrastructure and technology

for an integrated public transportation systems



- **Integrated service networks** to make Public transport competitive even on low-demand OD connections or in the absence of rail connections
- **Integration between modes** (including cars through interchange parking lots) and hierarchization between services
- **Stations as multi-modal and** multi-service hubs, triggering territorial transformations according to TOD principles

Regulatory instruments

for parking, speed, freight deliveries, …

Access and speed control

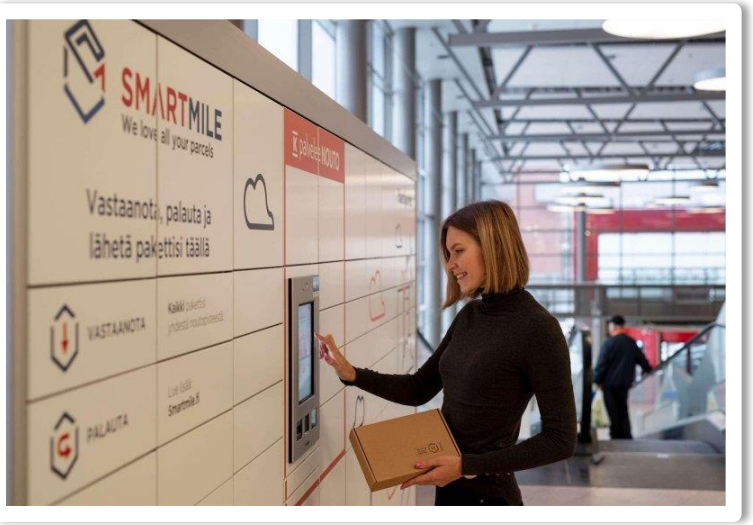
- LTZ
- Zone 30

Pricing

- Parking fares
- Road and area tolls

Timing

- Last mile freight deliveries




IMPROVE
LIVEVIEW
Model
Climate
OUTDOOR
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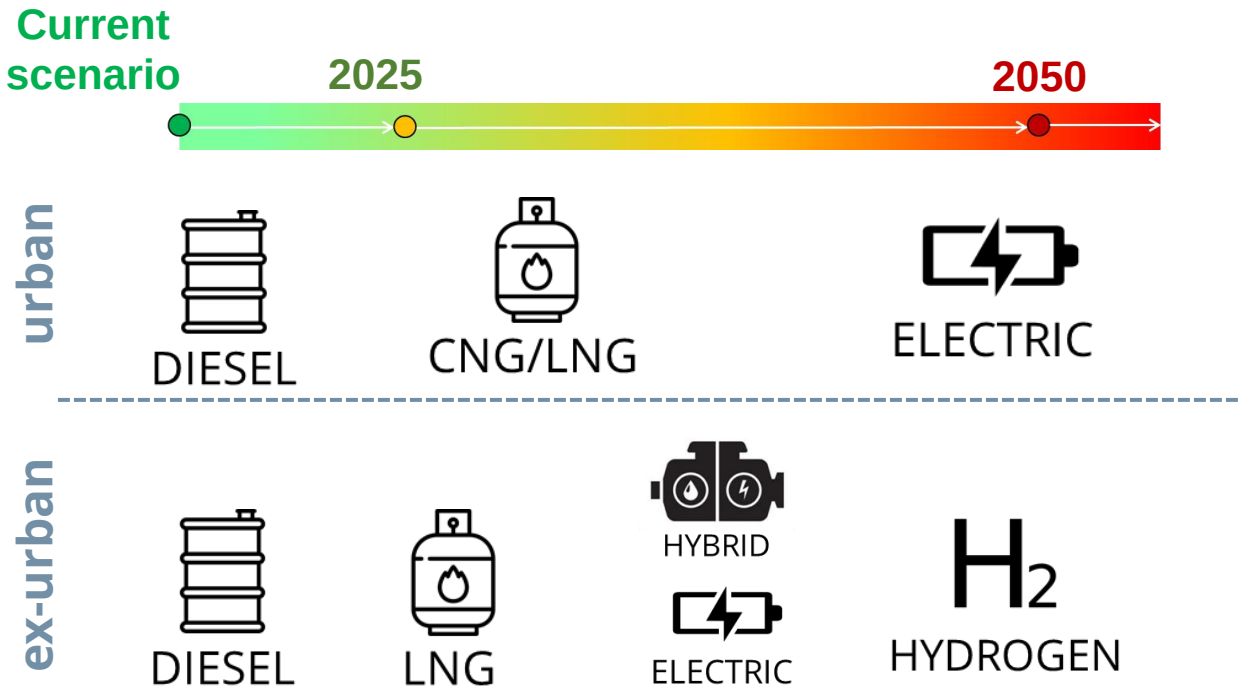
Decarbonising vehicles

Identifying the most suitable **technologies, incentives and timing** for the transition towards **zero emission vehicles**

Lyfe-Cycle Assessment: to assess lifetime environmental impacts ("*from craddle to grave*") of a vehicle taking into consideration all the phases of vehicles and energy production and use; from raw material through manufacture, distribution and usage to recycling/disposal.

Example: decarbonising bus fleets

? **Problem**: identifying the most suitable technologies for the transition towards zero emission vehicles in the urban and ex-urban context, based on **economic budget and environmental impacts (on climate change and air quality)**

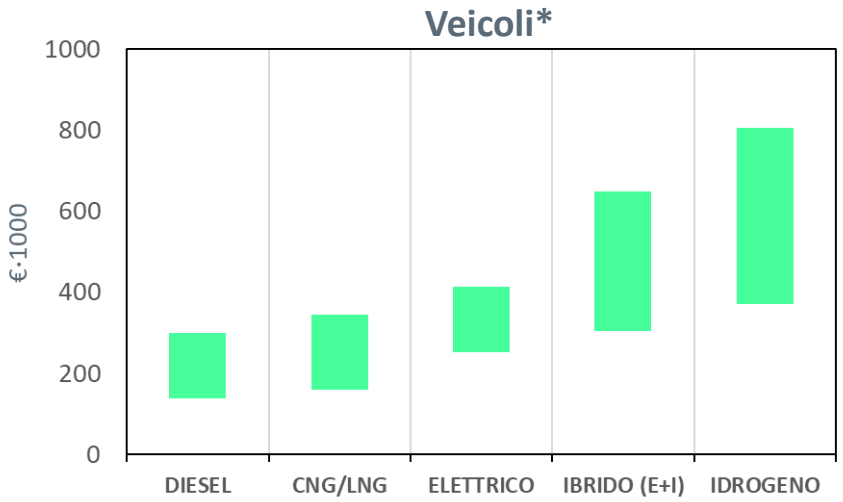


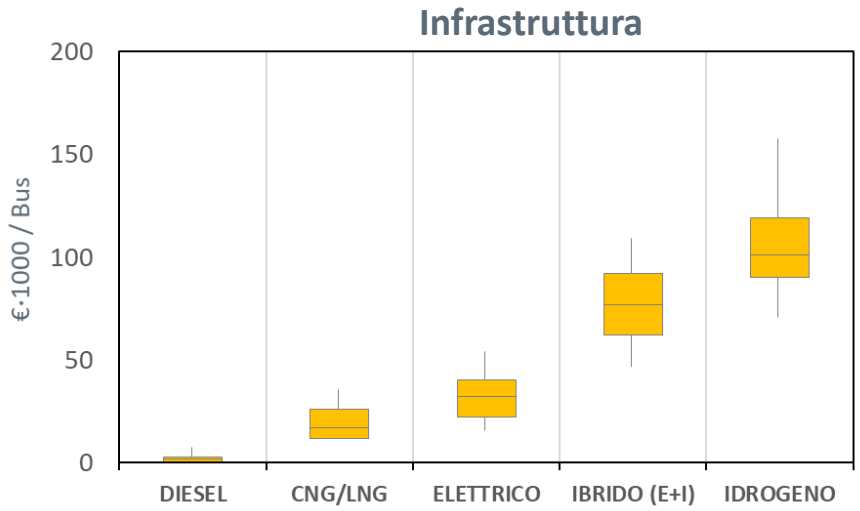
Multi-criteria LCA assessment

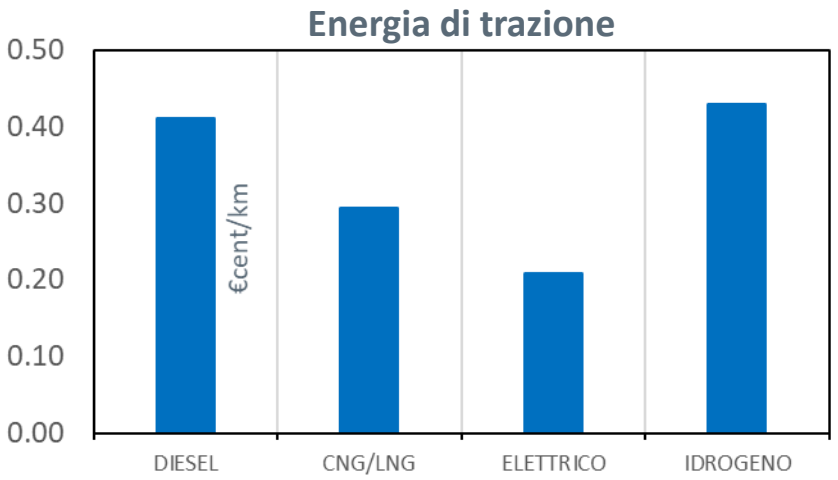
- **Costs** (vehicles, fuel and recharging infrastructure)
- **Climate change** (CO2 equivalent emissions)
- **Air quality** (pollutants emissions: Nox, PM2.5,…)

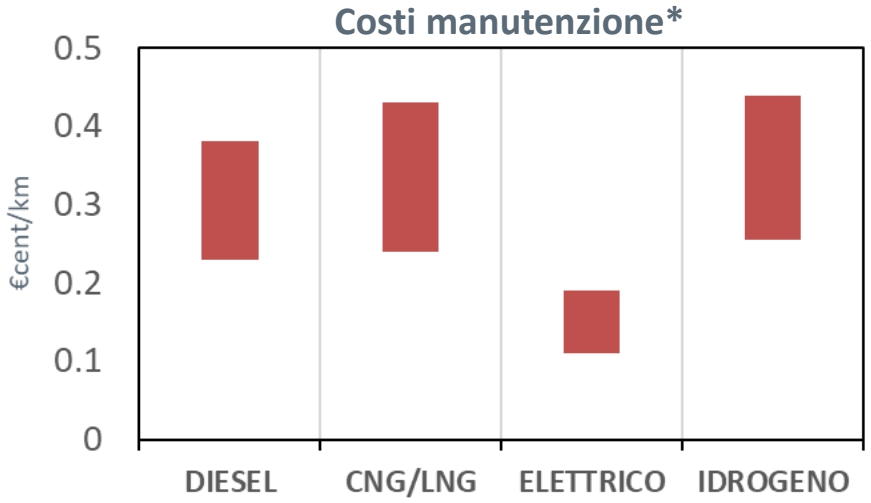
Unitary Investiment and operating Costs

by vehicle technology



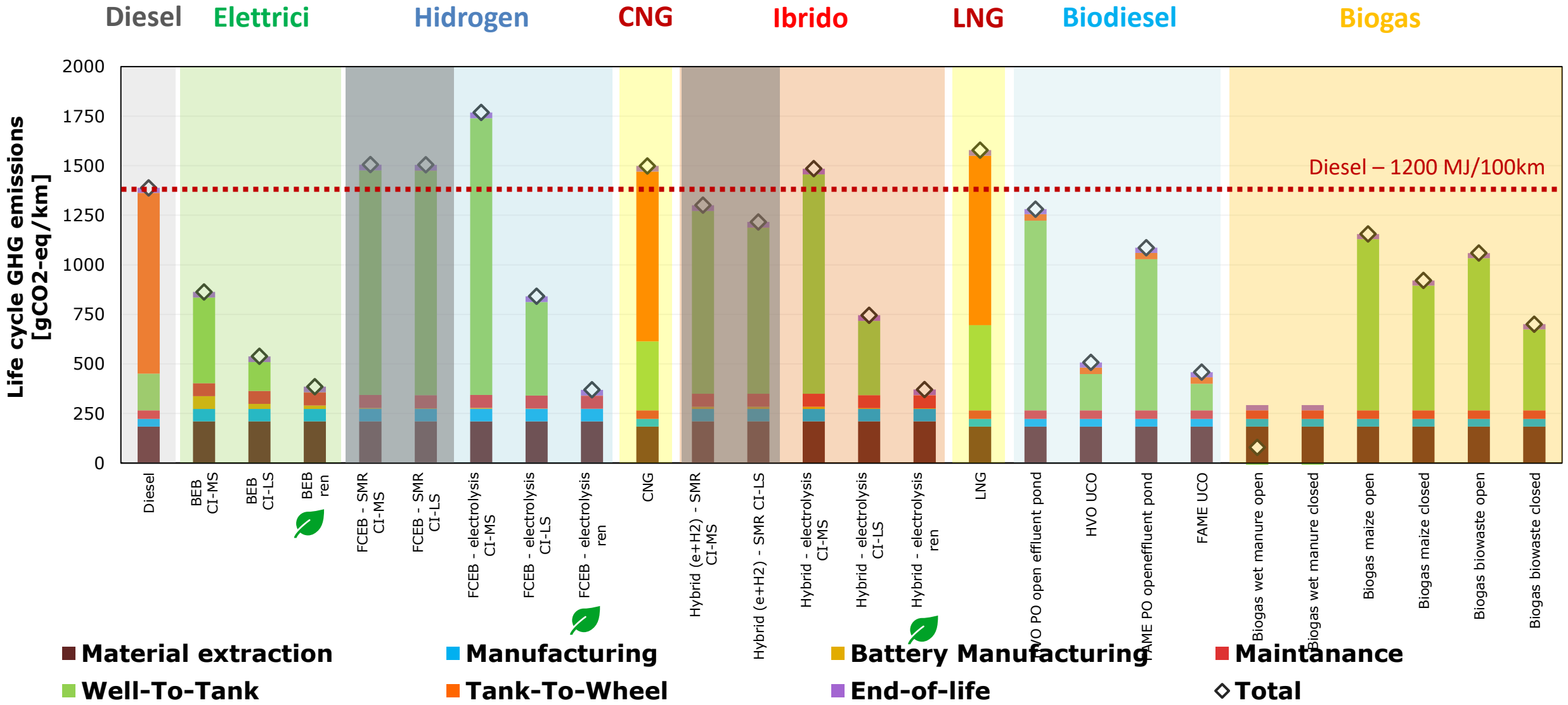






* Costs depending on the vehicle length; the analysis considers buses ranging from 6 m to 18 m

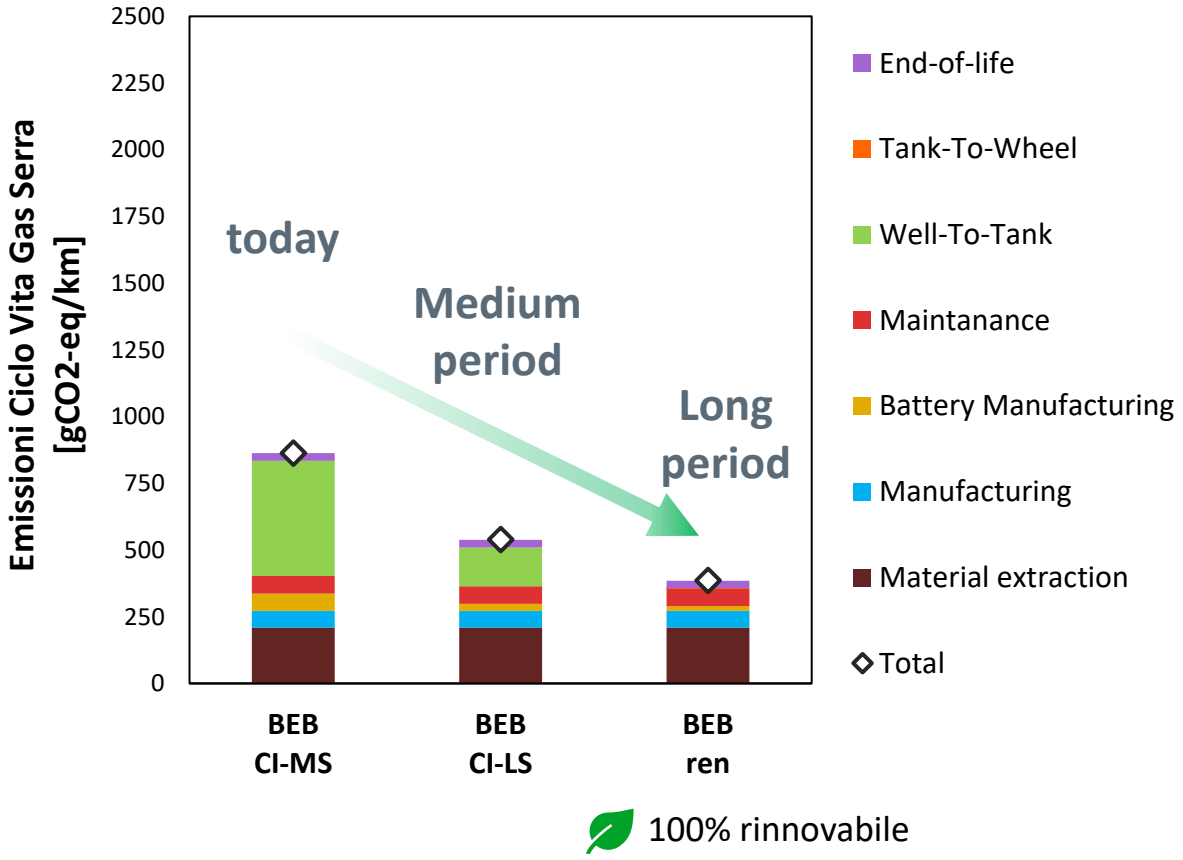
(LCA) unitary CO_2 equivalent emissions



Coppola P, Bocciolone M, Colombo E, De Fabiis F, Sanvito F (2023) *Multi-Criteria Life-Cycle Assessment of bus fleet renewal: A methodology with a case study from Italy* **Case Studies on Trasport Policy**, Vol 13, 101044, https://doi.org/10.1016/j.cstp.2023.101044

(LCA) unitary CO_2 eq. emissions

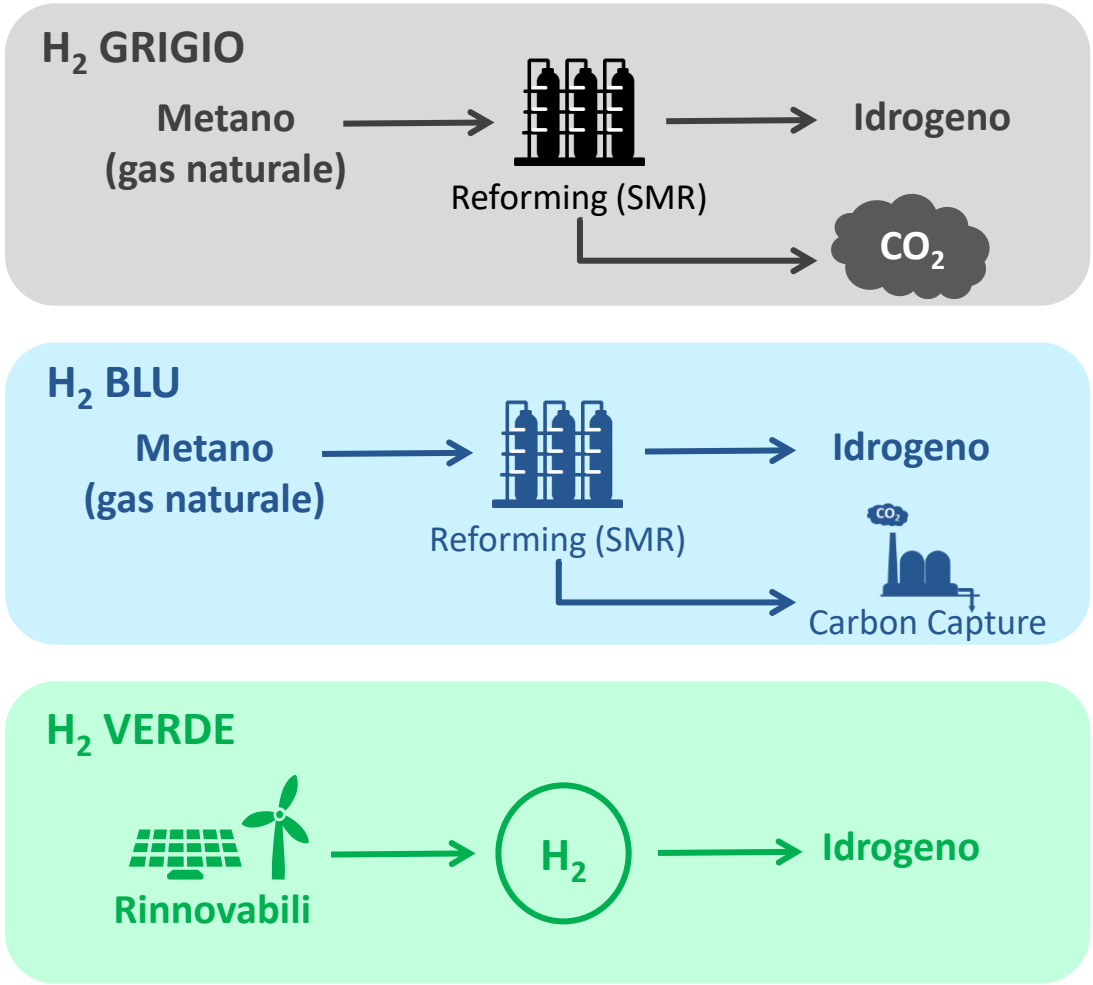
Electric bus



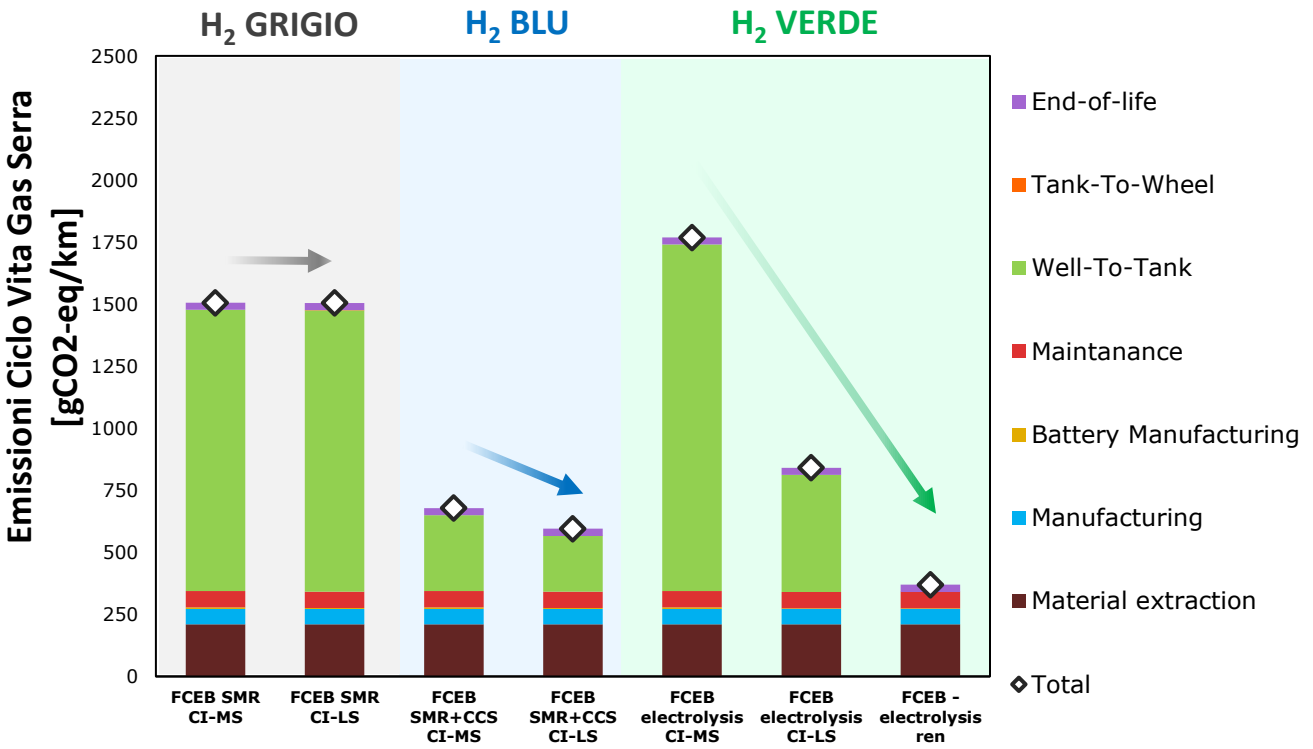
Carbon Intensity of Electric Energy production

- CI-MS : **Carbon Intensity high** (349 gCO2-eq/kWh)
- CI-LS : **Carbon Intensity low** (118 gCO2-eq/kWh)
- REN : **100% renewable**

(LCA) unitary CO_2 eq. emissions

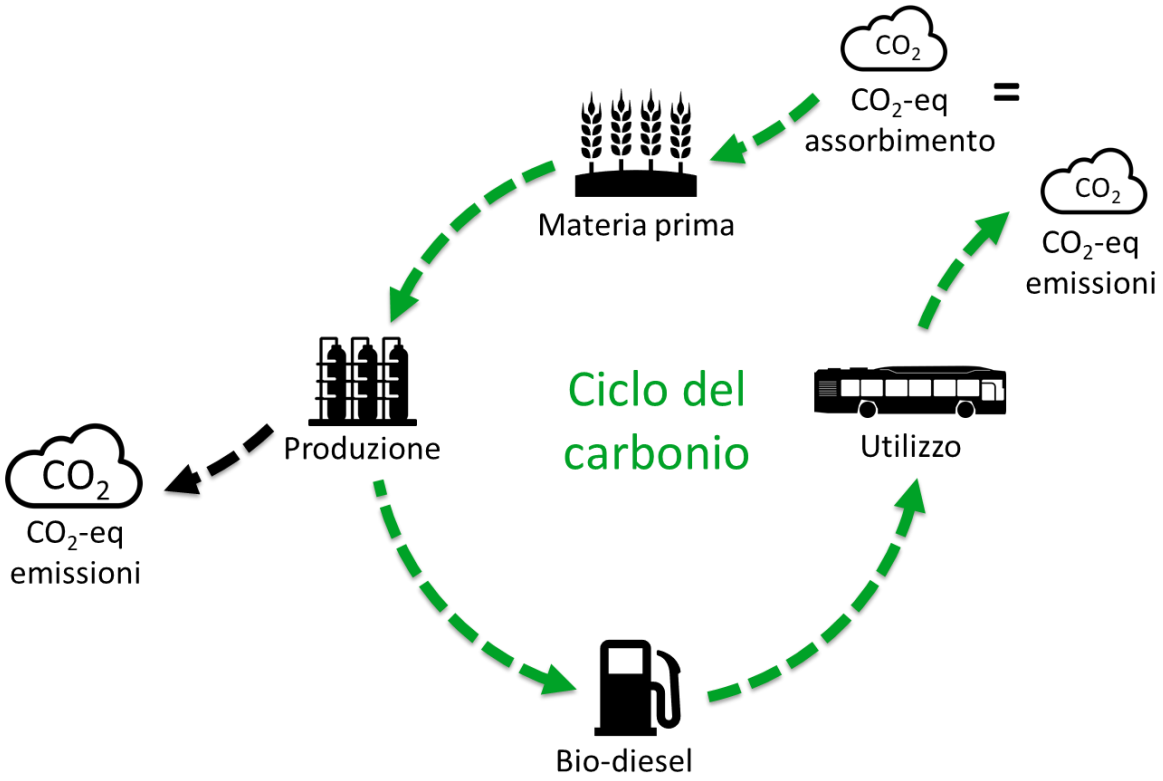


Hydrogen Fuel Cell Bus

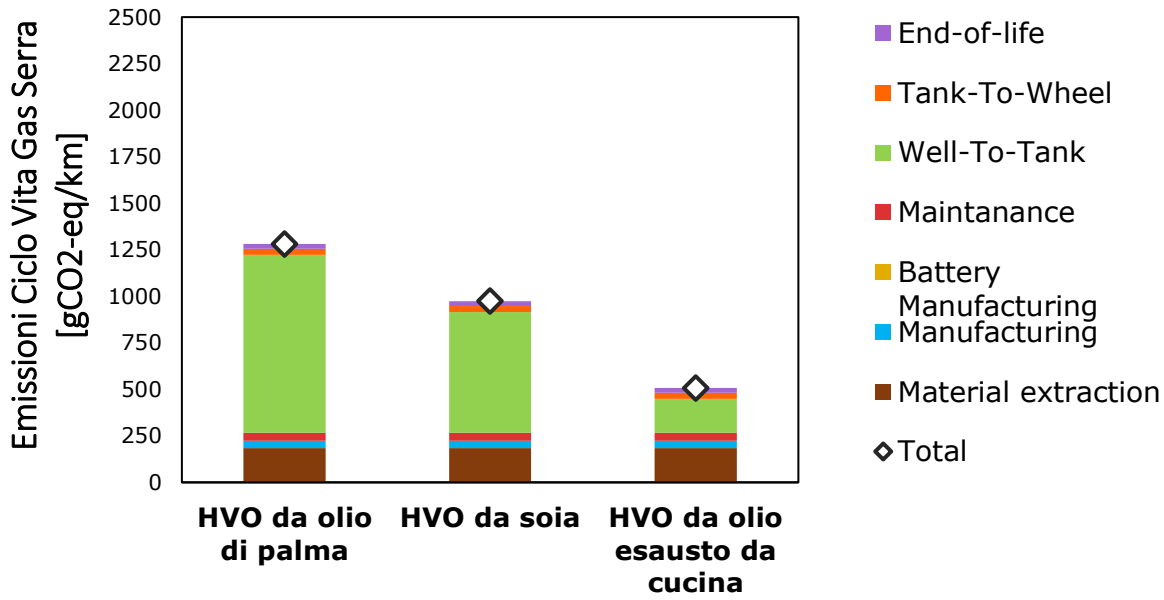


CI-MS : intensità carbonica alta (349 gCO2-eq/kWh)
CI-LS : intensità carbonica bassa (118 gCO2-eq/kWh)
REN : 100% rinnovabile

(LCA) unitary CO_2 eq. emissions



Bio-diesel bus



CONCLUSION

DRIVERS OF CHANGE

Environmental

New sensitivities towards transport externalities (notably climate changes and safety)

"green" vehicles, infrastructure and fuels

technological

Emerging innovation in transportation supply enabling innovative mobility solutions, new services and business models

Big Data & Artificial intelligence

Social

Global trends in urbanization, population aging and (digitalized) society, lifestyles and economy (shared)

New travel behaviors and life-styles

CONCLUSION

investment in infrastructure and technology

To enable integration between transport modes, services and operators (MaaS), as well as to enable new business and governance models of transport systems to promote efficient as well as "intelligent" management

new skills

for managing and designing intelligent green infrastructures and innovative transport services, to make transport systems more efficient and responsive to the new mobility needs of people and goods

user-centric integrated green policies and services

Focus on environment, but offering transport services that allow individuals to make rational and sustainable choices, convenient for themselves and for the community

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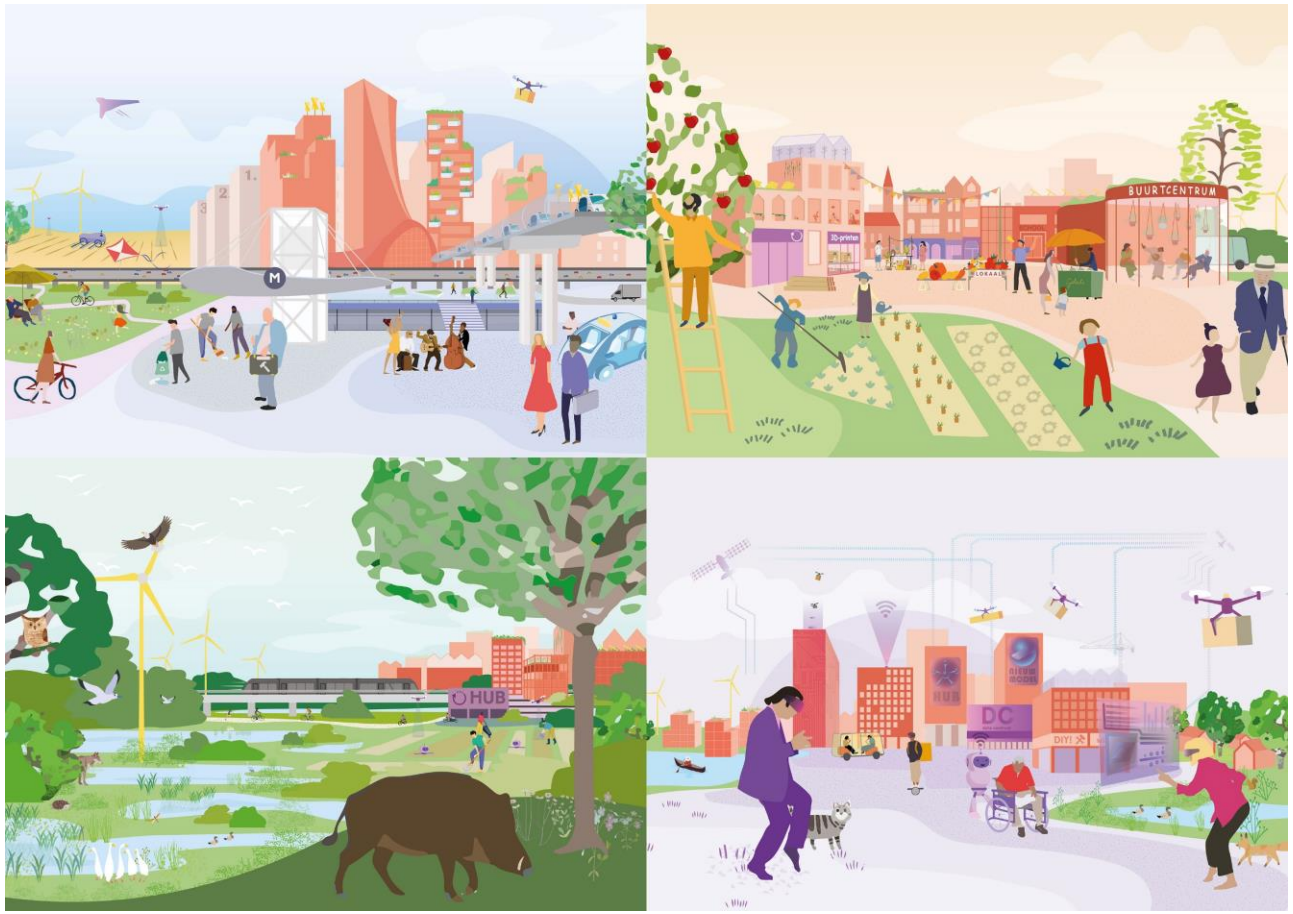

Grazie per l'attenzione!

pierluigi.coppola@polimi.it

Roma, 9 Giugno 2025

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