

The role of sustainable mobility in the future of urban transport: which role for ITS?

*Original*

The role of sustainable mobility in the future of urban transport: which role for ITS? / Dalla Chiara, B.. - ELETTRONICO. - (2024), pp. 1-22. ( INTELLIGENT TRANSPORT SYSTEMS: Ecology, Safety, Quality, Comfort Kiev 26-27.11.2024).

*Availability:*

This version is available at: 11583/2995990 since: 2024-12-28T08:22:02Z

*Publisher:*

National Transport University, Ukraine

*Published*

DOI:

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)



Kyiv-Ukraine  
2<sup>nd</sup> International Scientific  
Conference  
INTELLIGENT TRANSPORT  
SYSTEMS:  
Ecology, Safety, Quality, Comfort



# The role of sustainable mobility in the future of urban transport: which role for ITS?

prof. Bruno DALLA CHIARA  
*full professor in Transport systems, Ph.D., M.Sc. Mech. Eng.*

POLITECNICO DI TORINO (I)

Kyiv, November, 26<sup>th</sup> 2024



**Politecnico  
di Torino**

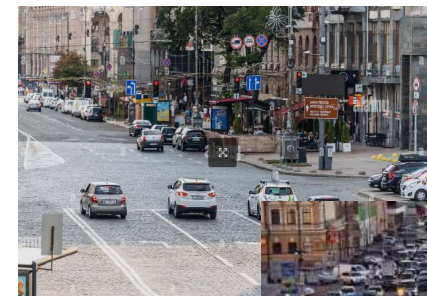
London



Victorian London's © David's



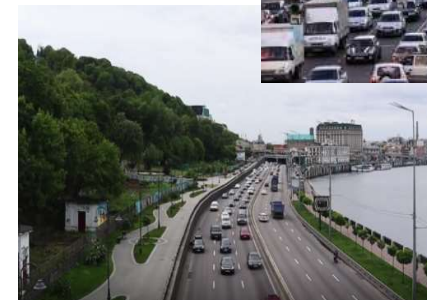
Kyiv



Paris



Kyiv



Milan



Turin



A REACHED **AIM** OF THE EUROPEAN SOCIETY  
**DIFFUSED MOTORISATION**, at personal level

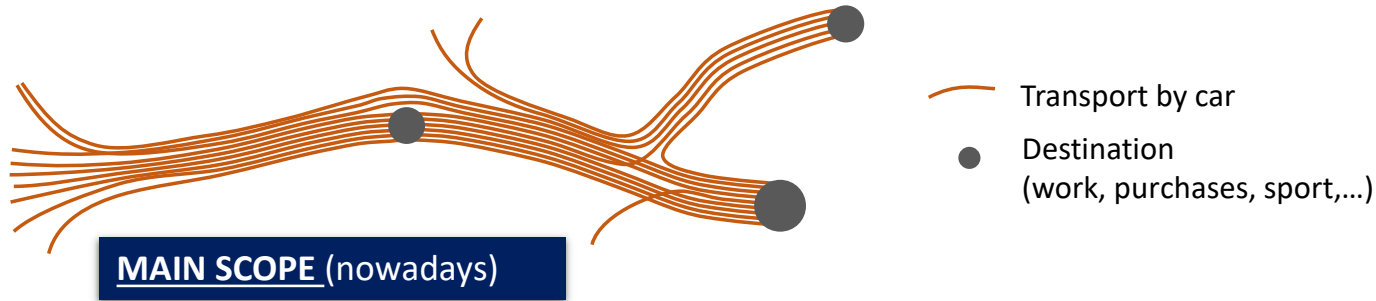
Nowadays frequently **REGULATED, CONTROLLED**

## **SUSTAINABILITY** for the TRANSPORT SYSTEMS DOMAIN

The development of the **circulating vehicles, infrastructures** and **personal mobility**, which have significantly marked the second half of the last century in Europe, show today **some conditioning** factors.

- A. saturation of the **land** or **space**
- B. limitedness of the **energy** resource
- C. respect of the **environment**
- D. **maintenance** of all the existing infrastructures
- E. **safety** increase in transport systems, a will
- F. **relationships** among people and families.

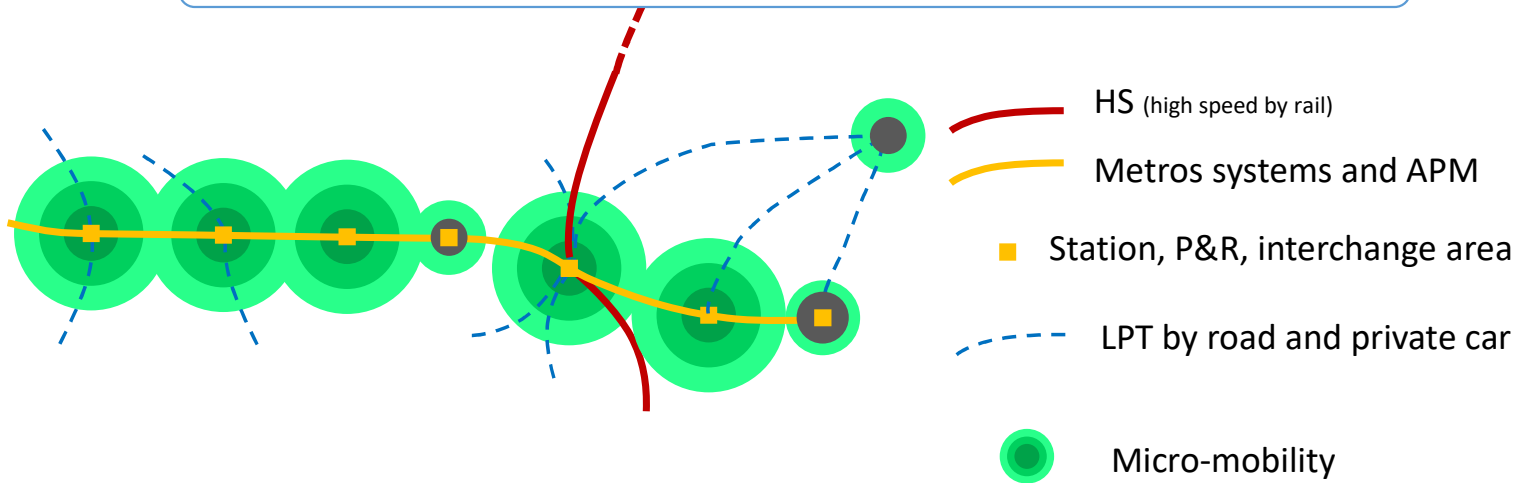
# Mobility in **the past** - and still today – for **medium and long distances**: dominated by the **car**



O/D matrix	Work	Leisure	Sport
Home			
Holiday			
Shopping			

Approach

co-modal, hierarchical networks, decarbonised, 'user pays'



Integration into a Maas provided an ITS exists



# Used Space

Private car generates a footprint of  $\sim 5 \text{ m}^2/\text{person}$  (twice as much, per vehicle)

Public transport  $\sim 4\text{-}5$  passengers/ $\text{m}^2$  ( $0.2\text{-}0.25 \text{ m}^2/\text{person}$ , when well used).

People movers (cable-driven) for urban applications are preferred because of their hourly capacity (below 8,000-9,000 pp/h per dir.);  
above  $\sim 9000$  pp/h per dir. automated metros excel (*availability* close to 100%); they only give way to private cars and bicycles in terms of *flexibility*

*Ropeways: 1.2 m for the  $\varnothing$  ground footprint; 10x10 m<sup>2</sup> for the 3S*

Bicycle :  $\sim 0.2 \text{ m}^2/\text{person}$



## Energy employed

- Utility car with electric traction:  $\sim 0.11 \div 0.20 / 0.25 \dots$  kWh/v·km
- Railways :  $\sim 0.04 \div 0.09$  kWh/pass·km,  $0.03 \div 0.1$  kWh/t·km [source : art. Ing.Ferroviaria]
- Cable-driven and innovative APM:  $0.027$  kWh/pass·km on rigid guideway,  $0.04-0.065$  as a  $f(C)$ ,  
even  $0.08$  kWh/pass·km;  $0.02$  for the traction itself.

# Emissions at global level

GHG emissions: CO<sub>2</sub>,  
Natural gas/Methane  
(CH<sub>4</sub>), Nitrius oxide (N<sub>2</sub>O)



CO<sub>2</sub>

-40% of the 1990 levels  
by 2030 (2019)  
- 55% (2021)



Modal shift (different transport modes,  
plus networks)

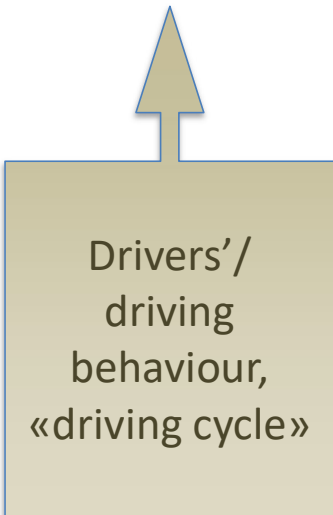
Vehicles and fuel /energy carriers plus  
powertrains and ITS/MaaS  
(technologies)

Transport operation (optimization)

Transport planning

## Emissions at global level

Consumption,  
CO<sub>2</sub> and  
CO<sub>2</sub>/km ↓



$S$  : less covered km (with ICE)

$T$  : less use in time

$\eta$  : ICE/EM more efficient  
Filters for reducing emissions

→ Less resistances  
during the movement/travel

*Or the number of  
passenger/freigh is  
increased (pooling,  
PT,...)*

- Aerodynamics
- *Speed and  
v/t\**
- $r_0$
- Mass/dimens.

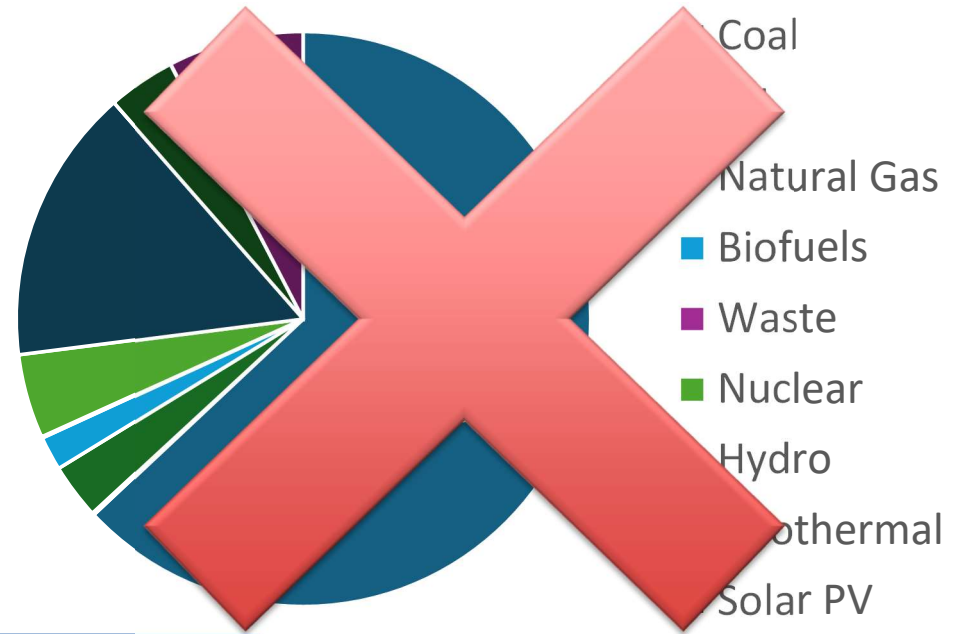
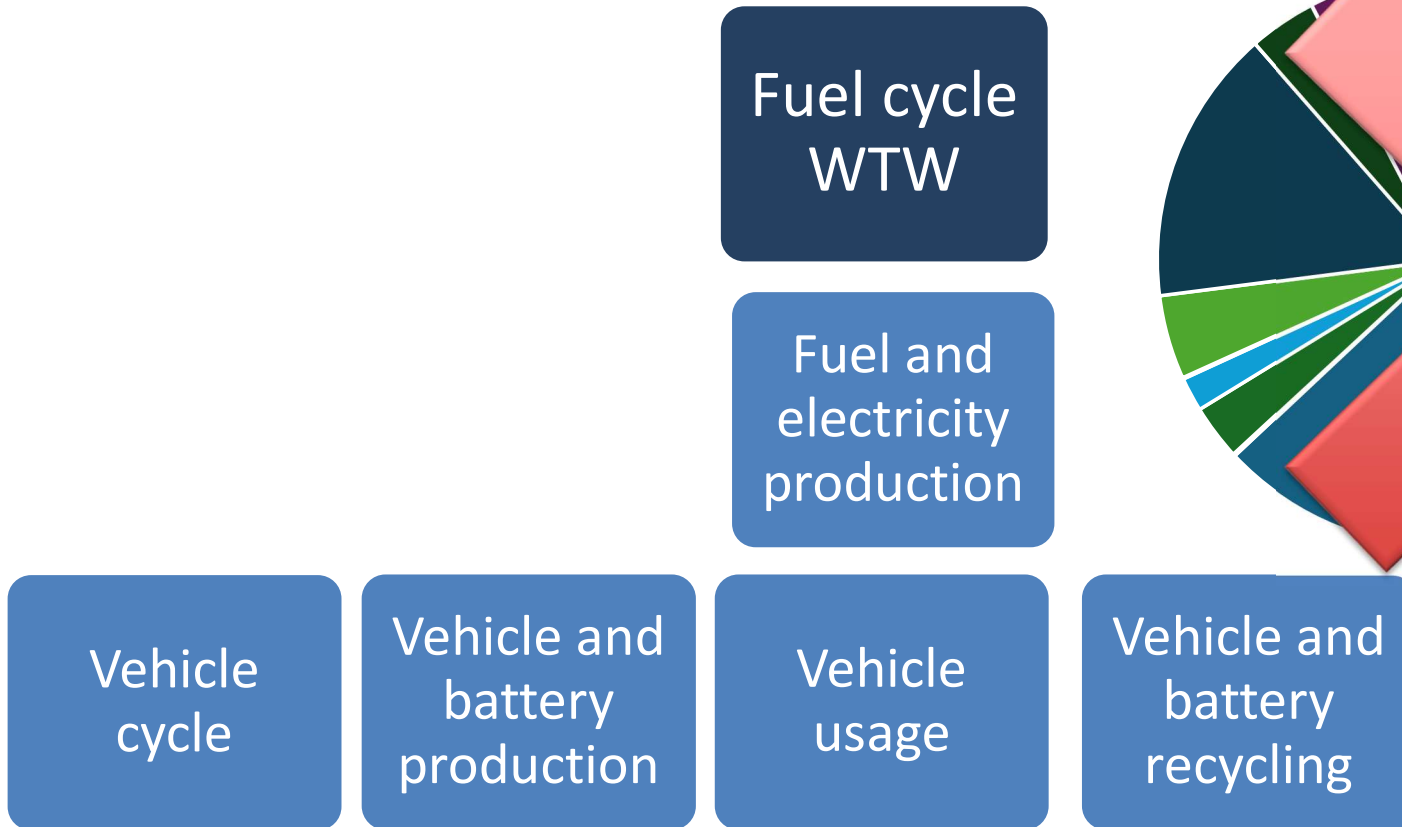
WLTP (Worldwide harmonized Light Vehicles Test Procedure)  
(by 2017), ex NEDC (New European Driving Cycle) -> RDE

**WTW analysis in the Life cycle (LCA)**

*\*: decisions up to the user*

## Life cycle analysis

## Electricity generation sources, China, 2021, from IEA



# Emissions at local level

V.R.J.H. Timmers, P.A.J. Achten / *Atmospheric Environment* 134 (2016) 10–17

15

**Table 4**  
Emission inventories on average tyre wear, brake wear, road wear and resuspension for passenger cars.

Reference	Emission source	PM <sub>10</sub> (mg/vkm)	PM <sub>2.5</sub> (mg/vkm)
EEA (Ntziachristos and Boulter, 2013)	Tyres	6.4	4.5
	Brakes	7.4	2.9
	Road	7.5	4.1
US EPA (2014)	Tyres	6.1	0.9
	Brakes	18.5	2.3
Dutch PRTR (Klein et al., 2014)	Tyres	5	1
	Brakes	4.3	0.6
Dutch PRTR (Denier van der Gon et al., 2008)	Road	7	1.1
UK NAEI (Brown and Pang, 2014)	Tyres	7	5
	Brakes	7	3
	Road	8	4
	Resuspension	40	12
<b>Average</b>	<b>Tyres</b>	<b>6.1</b>	<b>2.9</b>
	<b>Brakes</b>	<b>9.3</b>	<b>2.2</b>
	<b>Road</b>	<b>7.5</b>	<b>3.1</b>
	<b>Resuspension</b>	<b>40</b>	<b>12</b>

## EU air quality standards: Directive 50/2008

Pollutant	Concentration	Averaging period	Legal nature	Permitted exceedences each year
Fine particles (PM <sub>2.5</sub> )	25 µg/m <sup>3</sup>	1 year	Target value to be met as of 1.1.2010 Limit value to be met as of 1.1.2015	n/a
Fine particles (PM <sub>2.5</sub> )	20 µg/m <sup>3</sup>	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Sulphur dioxide (SO <sub>2</sub> )	350 µg/m <sup>3</sup>	1 hour	Limit value to be met as of 1.1.2005	24
Sulphur dioxide (SO <sub>2</sub> )	125 µg/m <sup>3</sup>	24 hours	Limit value to be met as of 1.1.2005	3
Nitrogen dioxide (NO <sub>2</sub> )	40 µg/m <sup>3</sup>	1 year	Limit value to be met as of 1.1.2005	6
Nitrogen dioxide (NO <sub>2</sub> )	20 µg/m <sup>3</sup>	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Particulate matter (PM <sub>10</sub> )	50 µg/m <sup>3</sup>	1 year	Limit value to be met as of 1.1.2005	35
Particulate matter (PM <sub>10</sub> )	35 µg/m <sup>3</sup>	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Lead (Pb)	0.5 µg/m <sup>3</sup>	1 year	Limit value to be met as of 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m <sup>3</sup> limit value applied from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m <sup>3</sup>	Maximum daily 8 hour mean	Limit value to be met as of 1.1.2005	n/a
Benzene	5 µg/m <sup>3</sup>	1 year	Limit value to be met as of 1.1.2010 **	n/a
Ozone	120 µg/m <sup>3</sup>	Maximum daily 8 hour mean	Target value to be met as of 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m <sup>3</sup>	1 year	Target value to be met as of 31.12.2012	n/a
Cadmium (Cd)	5 ng/m <sup>3</sup>	1 year	Target value to be met as of 31.12.2012	n/a
Nickel (Ni)	20 ng/m <sup>3</sup>	1 year	Target value to be met as of 31.12.2012	n/a

THE EUROPEAN PARLIAMENT THE COUNCIL Brussels, 2 October 2024 (OR. en) 2022/0347(COD) PE-CONS 88/24, DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on ambient air quality and cleaner air for Europe

The Commission has proposed (2023) to revise the guidelines on ambient air quality. The revision aligns the air quality standards more closely with the recommendations of the **World Health Organisation** (see the latest WHO air quality guidelines, published on 22 September 2021). For example, the annual limit value for fine particulate matter (PM<sub>2.5</sub>) will be reduced by more than half.

# Emissions at local level

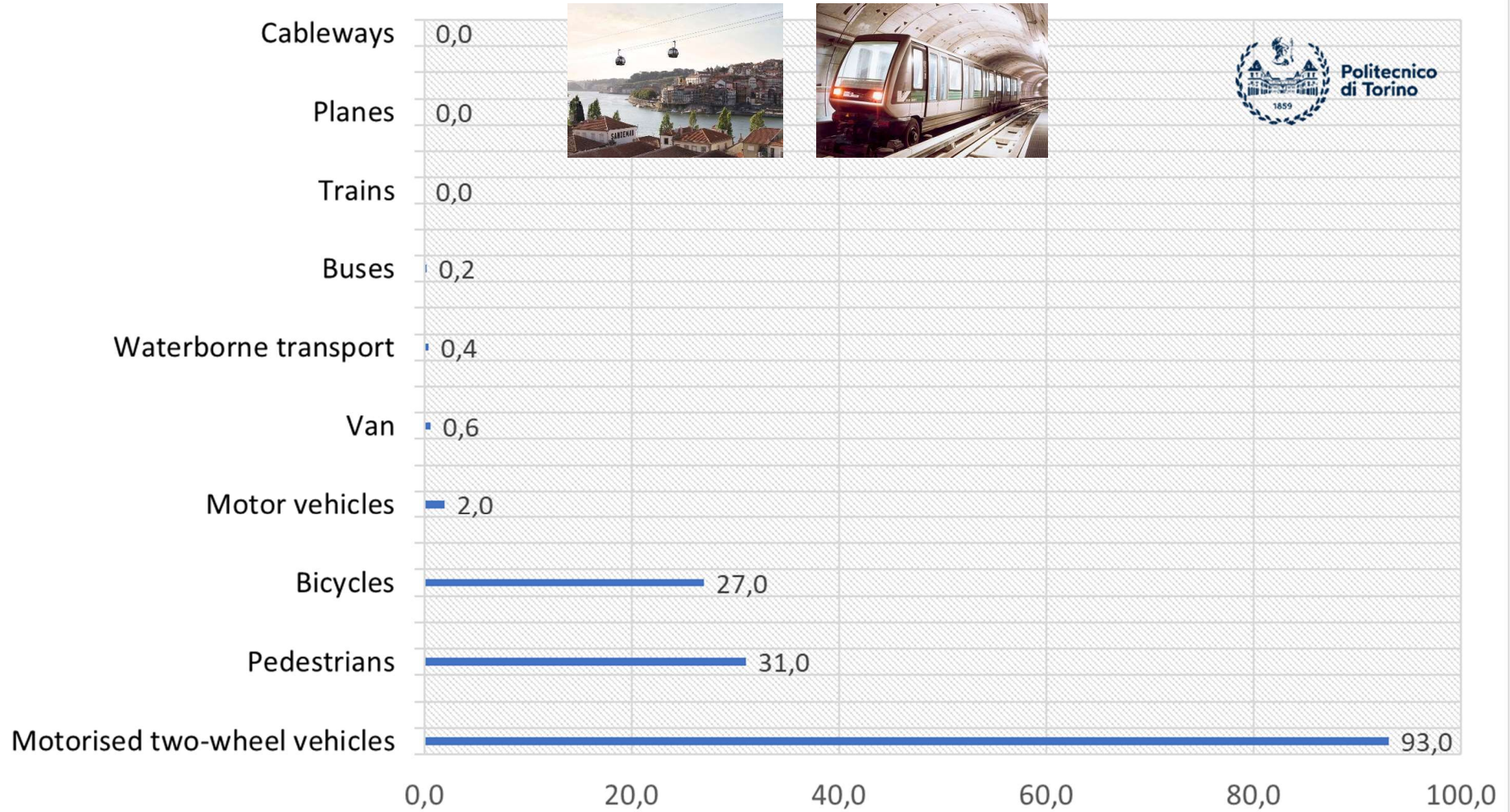
## Territory-specific issues

- Modal share
- Composition of the circulating car fleet (old/recent)
- Level of vehicle use (rational displacement, modal choice, non-displacement)
- Network features besides prevailing ventilation and orography
- **Technological endowment of the territory (ITS)**

# Safety

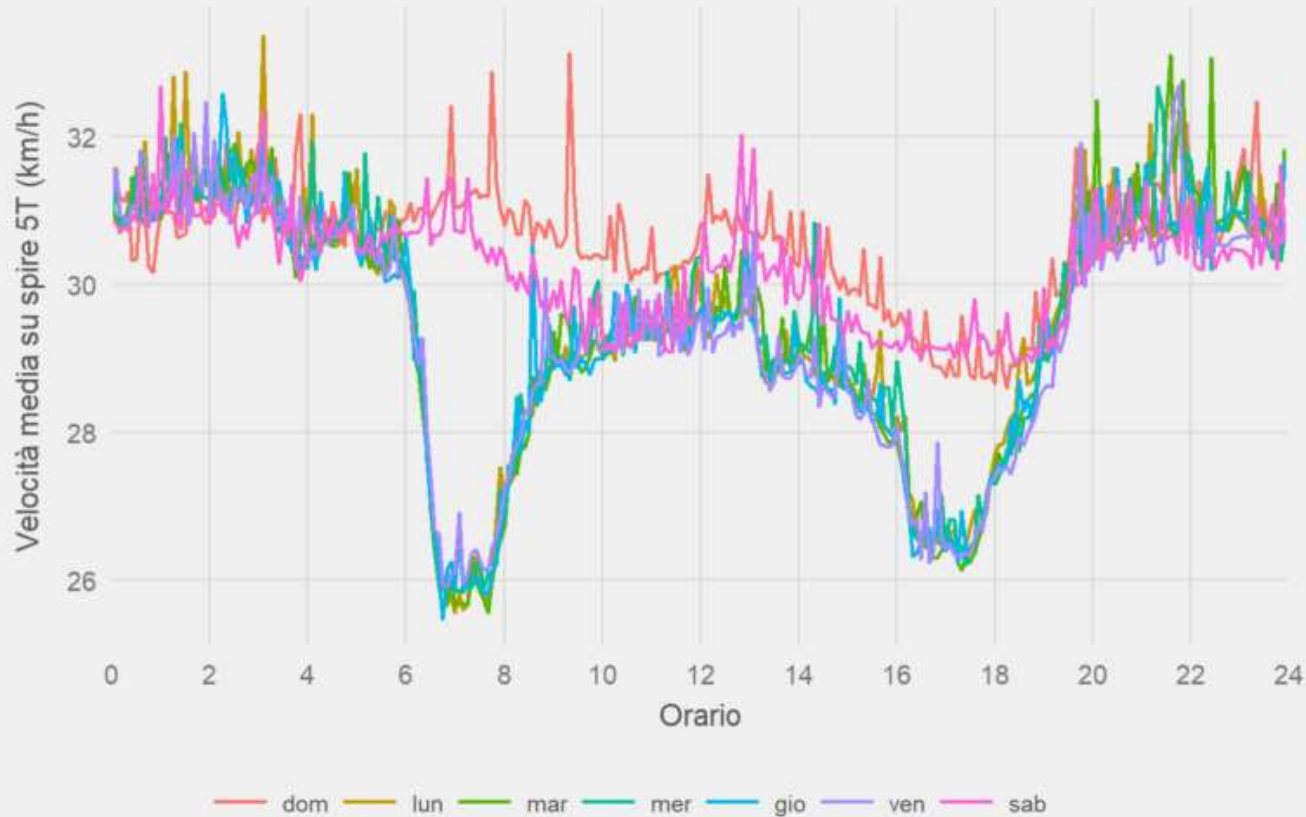
Worldwide, around 1.25 to 1.35 million road accidents occur each year, 49% of which involve pedestrians, cyclists and motorcyclists, according to several World Health Organisation sources (...2022)

Passenger fatality rate per billion passengers per km  
(UK average values 2003-2012)



# Availability of transport systems and commercial speed

Average speed in Turin per day of the week (e.g.)



Dati: opendata 5T, elaborazione: raccontadati.it

Some EU cities, today



FUTURE AIMS  
OF SOCIETY

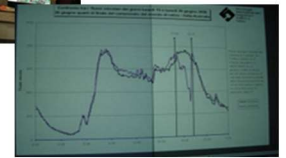
QUALITY,  
SAFETY,  
SECURITY,  
EFFICIENCY

Technological solutions  
for **Urban Sustainable Mobility**

Automated People  
movers and Metros

Intelligent transport  
systems and data

More oil-  
independent vehicles  
and green motor  
vehicles  
*including sharing mobility*



«Sustainable Urban Mobility Plans»

Carbon neutrality (mission impossible), however on the life cycle

# 100 CITTÀ EUROPEE ALLA SFIDA DELLA NEUTRALITÀ CLIMATICA

LA MISSIONE "CLIMATE NEUTRAL AND SMART CITIES" HA INDIVIDUATO 100 CITTÀ EUROPEE CHE DIVENTERANNO CENTRI DI SPERIMENTAZIONE E INNOVAZIONE PER CONTRIBUIRE A RAGGIUNGERE GLI OBIETTIVI DEL GREEN DEAL EUROPEO. SARANNO MESSI IN CAMPO MOLTEPLICI PROGETTI E STRUMENTI DI FINANZIAMENTO PER LA TRANSIZIONE.

NEUTRALITÀ CLIMATICA



## EU MISSIONS

CLIMATE-NEUTRAL & SMART CITIES

100 Climate Neutral Cities by 2030

### EU CITIES



# Mobility as a service, including the private car

Italy: 2023-2026 in test

**MaaS**  
**Mobility as a Service**  
 Indirizzi per l'attuazione del progetto "MaaS for Italy"

The poster features icons for various transport modes: car-sharing, bus, train, bicycle, and car. A hand is shown holding a smartphone, symbolizing digital access to these services.

Presidenza del Consiglio dei Ministri  
 Ministero per la semplificazione e la pubblica amministrazione

**LINEE GUIDA SULLA CONSULTAZIONE PUBBLICA IN ITALIA**

Finanziato dall'Unione europea NextGenerationEU

**DIPARTIMENTO PER LA TRASFORMAZIONE DIGITALE**

Ministero delle Infrastrutture e dei Trasporti

Documento post consultazione

27 luglio 2022

**1 Stato di avanzamento di MaaS for Italy**

ENTI PILOTA	MILESTONE
3 Città pilota PNRR - Milano, Napoli e Roma	Q4 2023
3 Città pilota Fondo complementare - Bari, Firenze e Torino	Q1 2024
2 Living lab - Milano e Torino	Q2 2023
7 territori da selezionare in Q4 2022	Q1 2025

**BUDGET**

€ 57 milioni

- 40 PNRR
- 17 Fondo Comp. PNRR

Sperimentazioni in 13 città/territori  
 Realizzazione layer dati nazionale (DS&SRF)  
 Sostegno finanziario agli operatori di trasporto locale

**Investimento PNRR 1.4.6 "Mobility as a Service for Italy"**  
**Discussion paper "Data Sharing and Service Repository Facilities" (DS&SRF)**

**1. Premesse**

Il Ministro per l'Innovazione Tecnologica e la Transizione Digitale (MITD) e il Ministero delle Infrastrutture e della Mobilità Sostenibili (MIMS) in attuazione dell'investimento 1.4.6 del Piano Nazionale di Ripresa e Resilienza (PNRR) "Mobility as a Service for Italy", finalizzato allo sviluppo dei nuovi servizi alla mobilità, basati sul paradigma "Mobilità come servizio" (MaaS - "Mobility As A Service"), promuovono una consultazione pubblica finalizzata a ricevere un apporto tecnico, informativo e conoscitivo per la realizzazione di una piattaforma nazionale abilitante, capace di realizzare servizi utili agli operatori MaaS e agli operatori di trasporto, per un efficace sviluppo dei progetti pilota previsti dall'investimento 1.4.6 e, in prospettiva, dei servizi MaaS in Italia. Tale piattaforma abilitante è chiamata "Data Sharing and Service Repository Facilities" (DS&SRF).

# Conclusions

- I. Urban sustainability as a whole
- II. Co-modal, flexible, hierarchical mobility and transport
- III. Monitored mobility (ITS)
- IV. Urban geofencing (environmental fingerprint of the vehicle on the life cycle)
- V. MaaS

## Contacts

prof. ing. Bruno DALLA CHIARA ([bruno.dallachiara@polito.it](mailto:bruno.dallachiara@polito.it)),

*full prof. in Transport systems, Mobility Manager of the Politecnico di Torino*

POLITECNICO DI TORINO

Dip. DIATI – Trasporti

Corso Duca degli Abruzzi, 24

10129 Torino - Italia



**Politecnico  
di Torino**

## Some main references



- Gerboni R., Caballini C., Minetti A., Grosso D., Dalla Chiara B. (2021), Recharging scenarios for differently electrified road vehicles: A methodology and its application to the Italian grid (2021), *Transportation Research Interdisciplinary Perspectives*, Volume 11, 2021, 100454, ISSN 2590-1982, <https://doi.org/10.1016/j.trip.2021.100454>
- Dalla Chiara B., Deflorio F., Eid M. (2018), Analysis of real driving data to explore travelling needs in relation to hybrid-electric vehicle solutions, *Transport Policy*, Available online 26 April 2018, ISSN 0967-070X, Volume 80, August 2019, Pages 97-116 <https://doi.org/10.1016/j.tranpol.2018.04.009>
- Dalla Chiara B., Deflorio F., Pellicelli M., Castello L, Eid M. (2019), Perspectives on Electrification for the Automotive Sector: A Critical Review of Average Daily Distances by Light-Duty Vehicles, Required Range, and Economic Outcomes, *Sustainability*, 2019, Volume: 11, Number: 5784; <https://www.mdpi.com/2071-1050/11/20/5784>
- Marabete M., Dalla Chiara B., Maino C., Spessa E., Electrified road transport through plug-in hybrid powertrains: Compliance by simulation of CO2 specific emission targets with real driving cycles, *Transportation Research Interdisciplinary Perspectives*, Volume 15,2022, 100651, ISSN 2590-1982, <https://doi.org/10.1016/j.trip.2022.100651>.
- Caballini C., Olivari E., Gasparini C., Dalla Chiara B., 2023. "The Spread of MaaS Initiatives in Europe: The Leading Role of Public Governance Emerging from an Italian Regional Application" *Sustainability* 15, no. 18: 13413. <https://doi.org/10.3390/su151813413>
- Caballini C. , Agostino M., Dalla Chiara B, "Physical mobility and virtual communication in Italy: trends, analytical relationships and policies for the post COVID-19", *Transport Policy*, 2021, ISSN 0967-070X, <https://doi.org/10.1016/j.tranpol.2021.06.007>. (<https://www.sciencedirect.com/science/article/pii/S0967070X21001888>)