

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

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INTELLIGENT TRANSPORT
SYSTEMS:
Ecology, Safety, Quality, Comfort



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

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POLITECNICO DI TORINO (I)

Kyiv, November, 26th 2024



**Politecnico
di Torino**

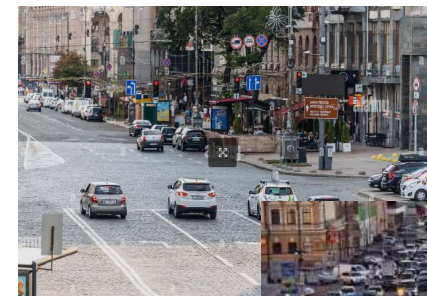
London



Victorian London's © David's



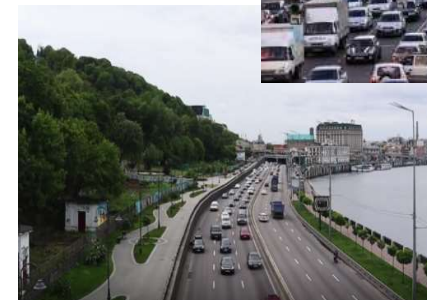
Kyiv



Paris



Kyiv



Milan



Turin



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

Nowadays frequently **REGULATED, CONTROLLED**

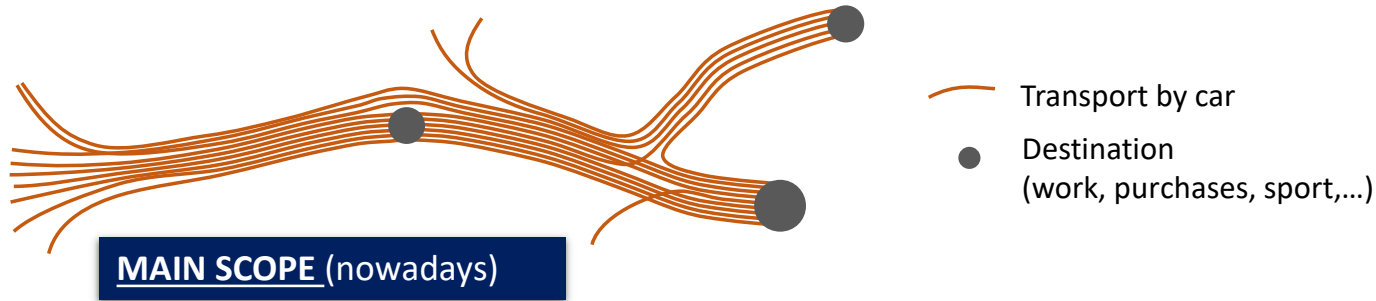


SUSTAINABILITY for the TRANSPORT SYSTEMS DOMAIN

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.

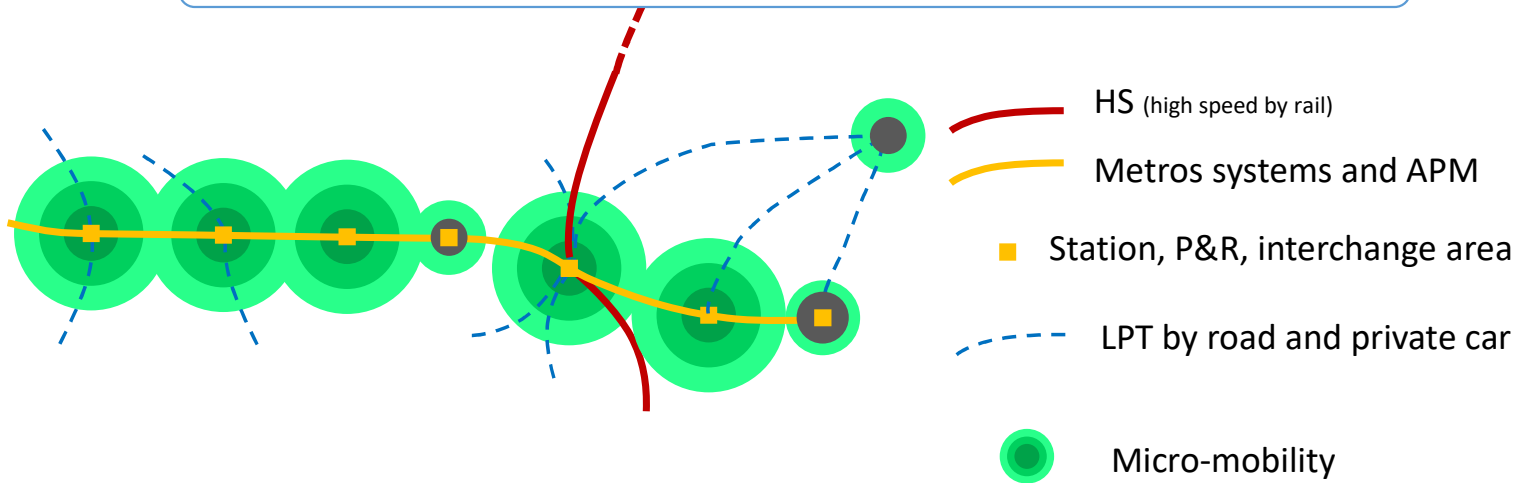
Mobility in **the past** - and still today – for **medium and long distances**: dominated by the **car**



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/ 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 ~ 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 m² 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: CO₂,
Natural gas/Methane
(CH₄), Nitrius oxide (N₂O)



CO₂

-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,
CO₂ and
CO₂/km ↓

S : less covered km (with ICE)

T : less use in time

η : 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.

Drivers'/
driving
behaviour,
«driving cycle»

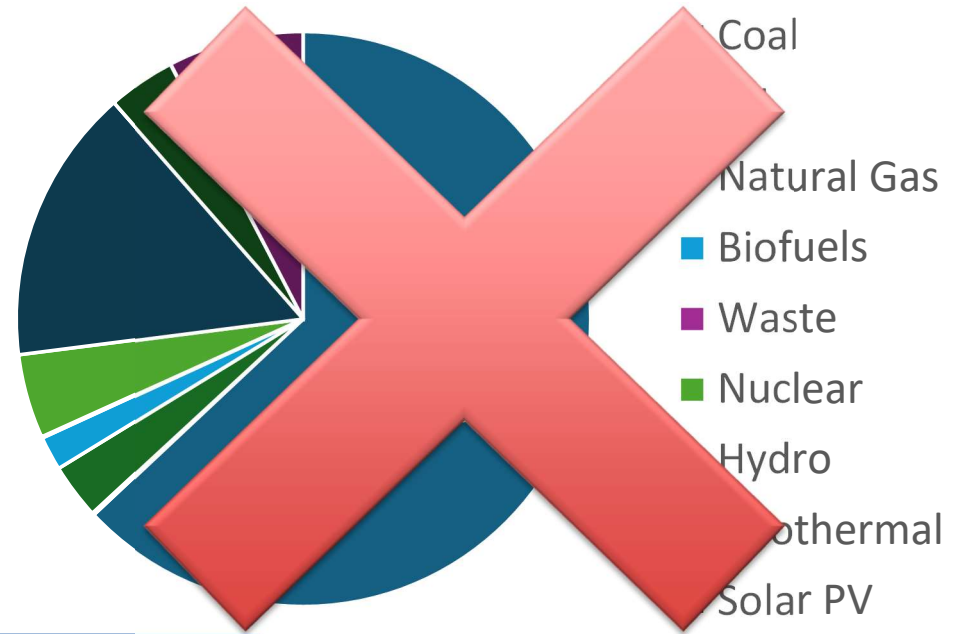
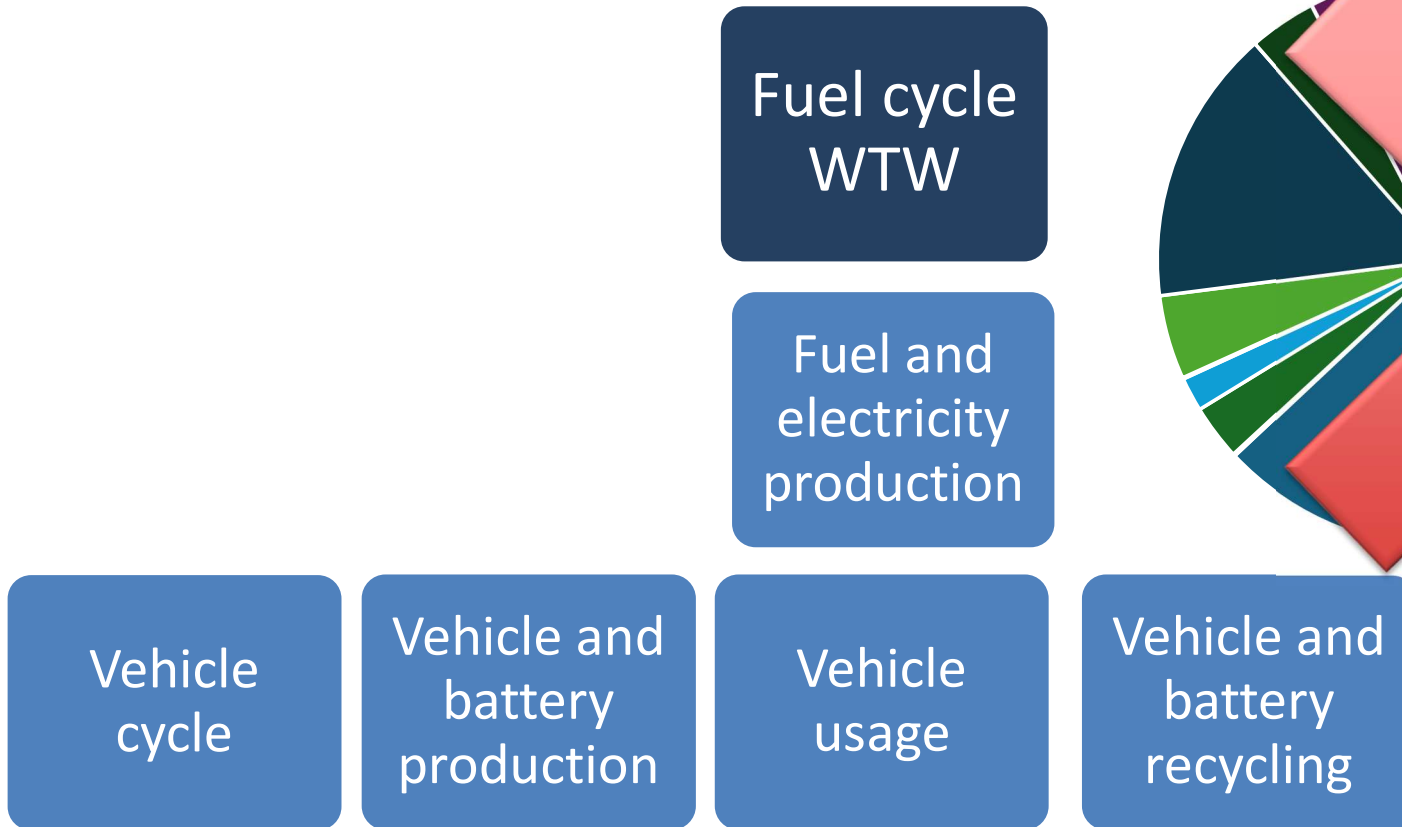
WLTP (Worldwide harmonized Light Vehicles Test Procedure)
(by 2017), ex NEDC (New European Driving Cycle) -> RDE

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

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

Reference	Emission source	PM ₁₀ (mg/vkm)	PM _{2.5} (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
Average	Tyres	6.1	2.9
	Brakes	9.3	2.2
	Road	7.5	3.1
	Resuspension	40	12

EU air quality standards: Directive 50/2008

Pollutant	Concentration	Averaging period	Legal nature	Permitted exceedences each year
Fine particles (PM _{2.5})	25 µg/m ³	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 _{2.5})	20 µg/m ³	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Sulphur dioxide (SO ₂)	350 µg/m ³	1 hour	Limit value to be met as of 1.1.2005	24
Sulphur dioxide (SO ₂)	125 µg/m ³	24 hours	Limit value to be met as of 1.1.2005	3
Nitrogen dioxide (NO ₂)	40 µg/m ³	1 year	Limit value to be met as of 1.1.2005	40
Nitrogen dioxide (NO ₂)	20 µg/m ³	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Particulate matter (PM ₁₀)	50 µg/m ³	1 year	Limit value to be met as of 1.1.2005	35
Particulate matter (PM ₁₀)	35 µg/m ³	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Lead (Pb)	0.5 µg/m ³	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 ³ limit value applied from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m ³	Maximum daily 8 hour mean	Limit value to be met as of 1.1.2005	n/a
Benzene	5 µg/m ³	1 year	Limit value to be met as of 1.1.2010 **	n/a
Ozone	120 µg/m ³	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 ³	1 year	Target value to be met as of 31.12.2012	n/a
Cadmium (Cd)	5 ng/m ³	1 year	Target value to be met as of 31.12.2012	n/a
Nickel (Ni)	20 ng/m ³	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_{2.5}) will be reduced by more than half.

Emissions at local level

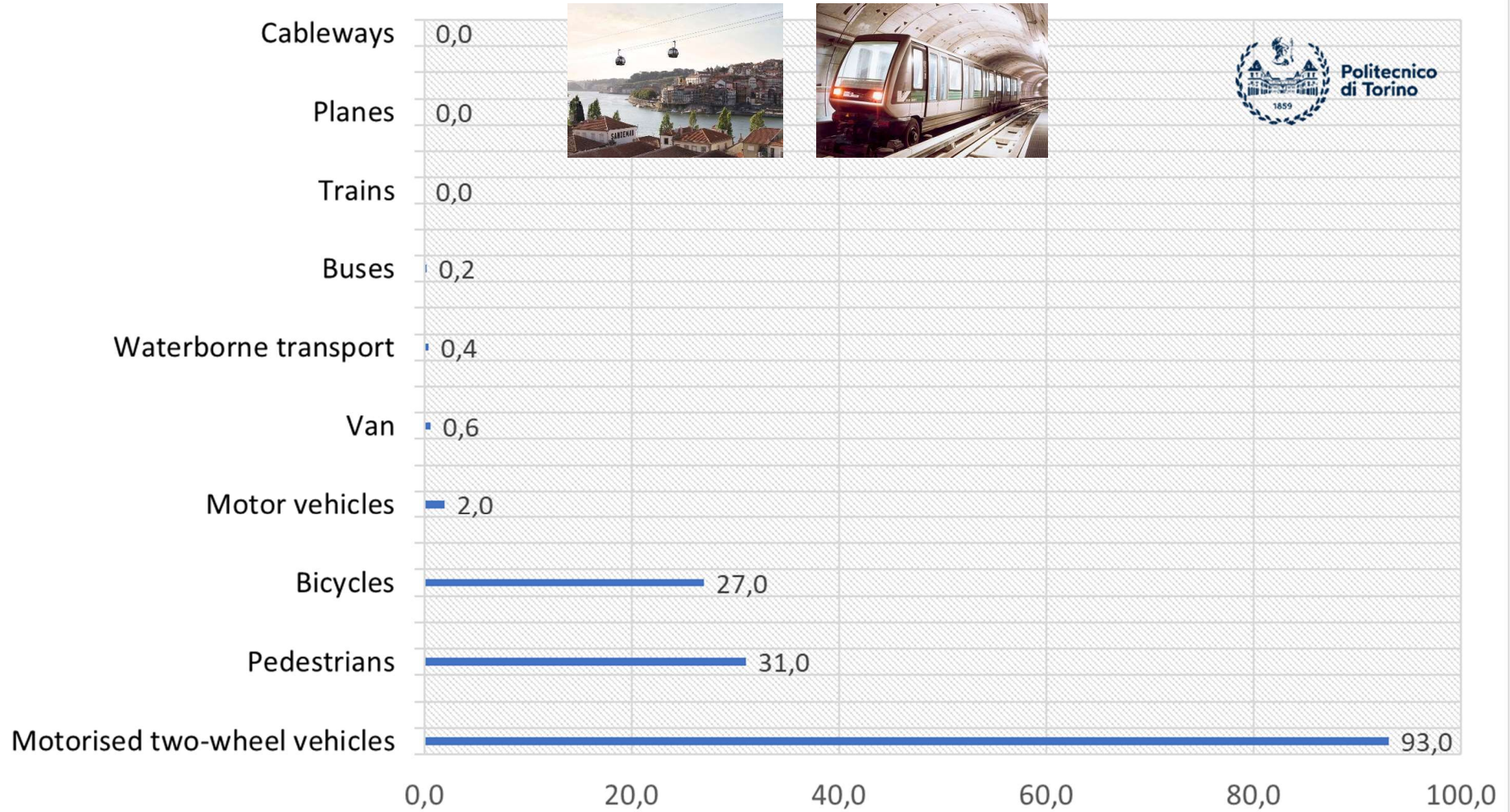
Territory-specific issues

- 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

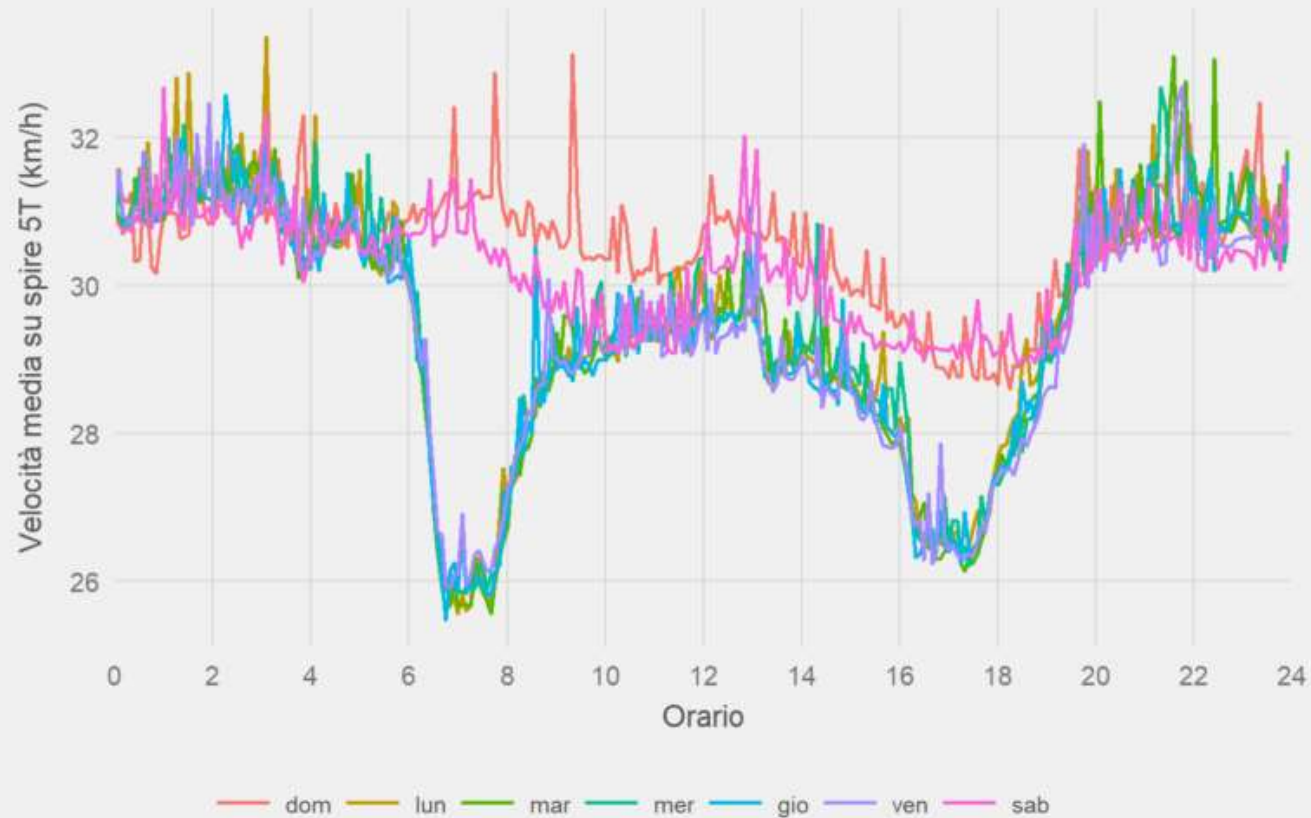
Worldwide, around 1.25 to 1.35 million road accidents occur each year, 49% of which involve pedestrians, cyclists and motorcyclists, according to several World Health Organisation sources (...2022)

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

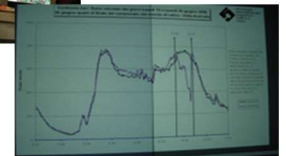
QUALITY,
SAFETY,
SECURITY,
EFFICIENCY

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, bus, train, bicycle, and scooter, all connected to a central smartphone icon held by a hand.

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

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**Politecnico
di Torino**

Some main references



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