Trends and Challenges in Urban Mobility

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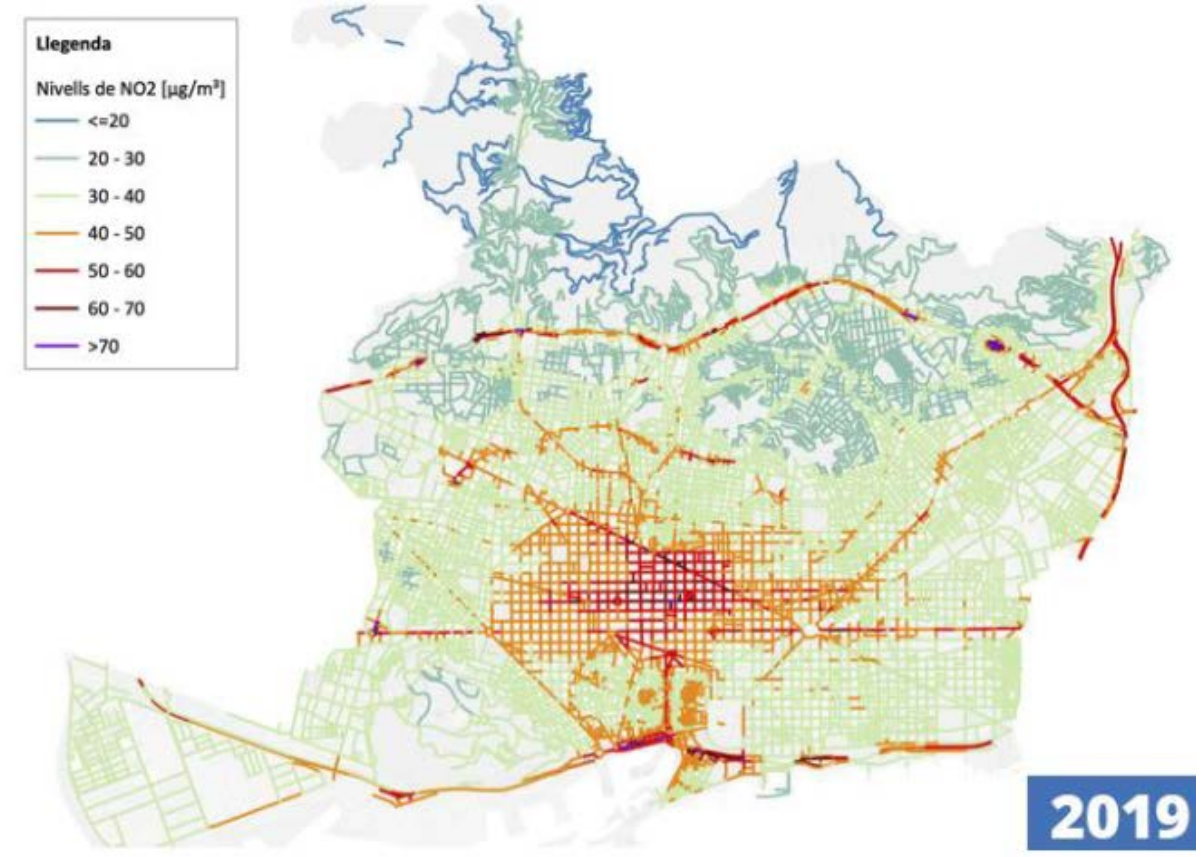
Director of CENIT

Barcelona, March 31 of 2023

Introduction

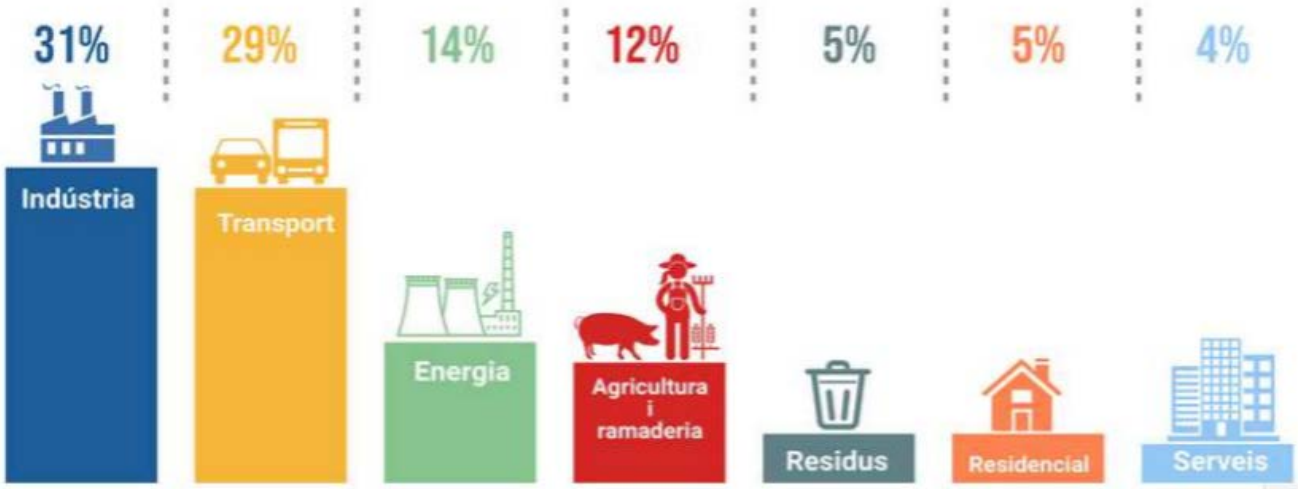
Contamination levels above those recommended by the WHO

Annual average of NO2 (in µg/m3)



Avaluación de la calidad del aire de la ciudad de Barcelona 2020 (Ayuntamiento de Barcelona)

Emissions



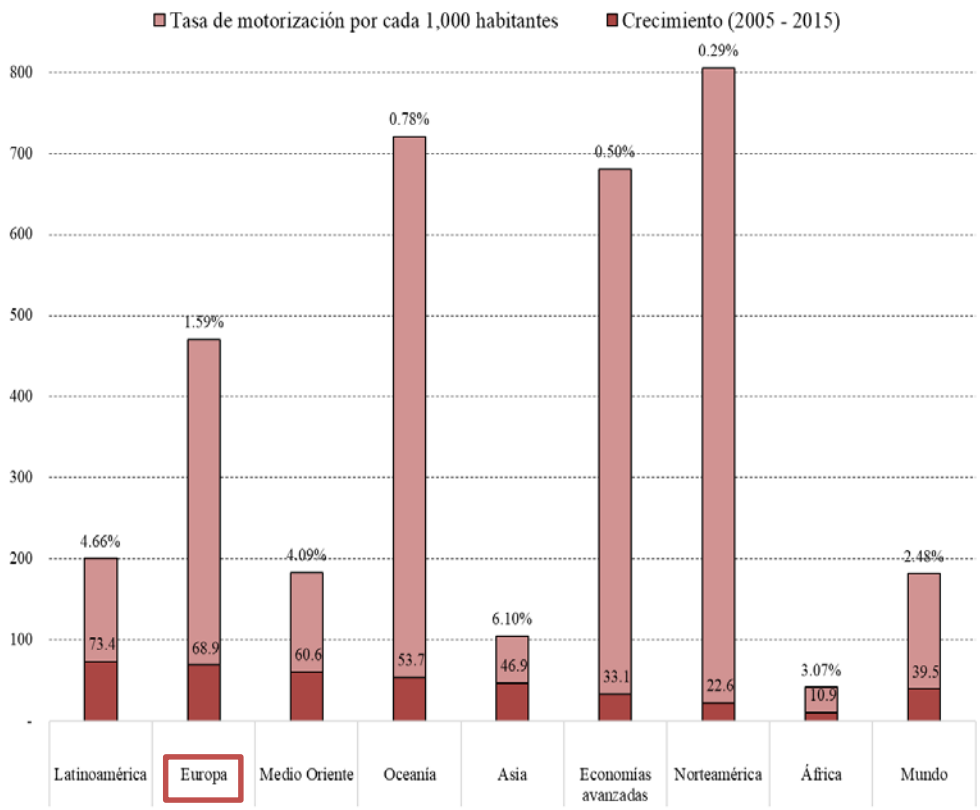
Els sectors que contribueixen a les emissions de GEH. Dades 2018.

Some data:

2015 75% of the population lived in cities (UN, 2012)

23% of emissions come from transport (IEA, 2015, and ITF, 2015)

Diagnosis of international mobility



Motorization rate per 1,000 inhabitants and its growth (2005-2015)

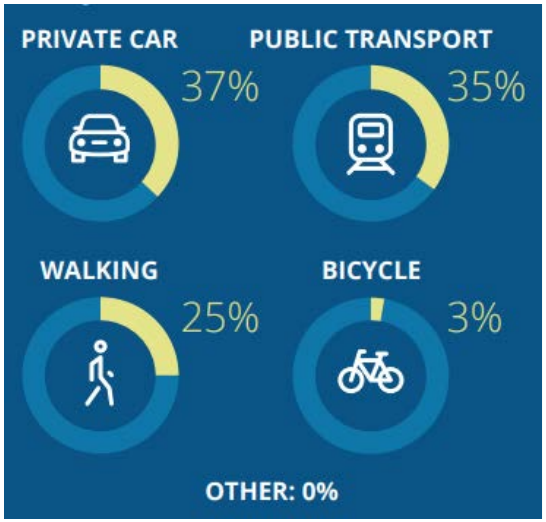
Source: IDB, 2020 .

The **number of vehicles** in Europe (471 vehicles per 1,000 inhabitants) is **below** the values reported by the **advanced economies and the United States** (690 and 805 vehicles per 1,000 inhabitants, respectively).

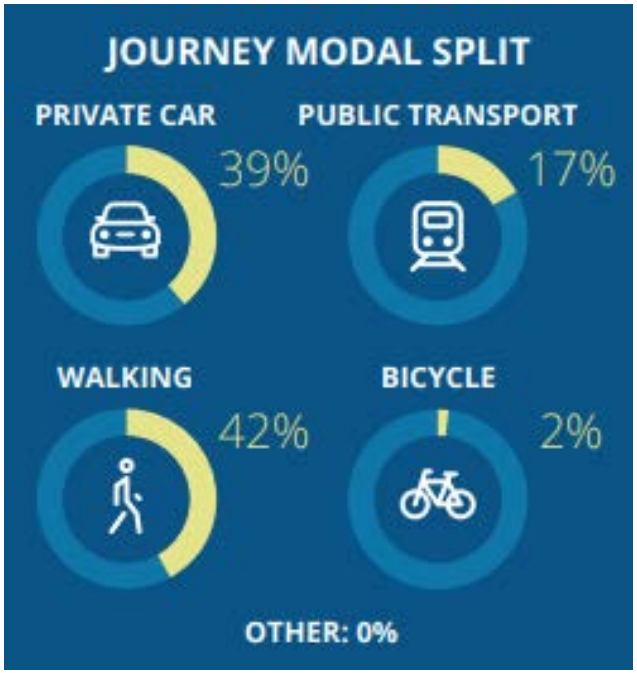
Likewise, its **average annual growth rate** in the last 10 years in the has been **lower** than that evidenced in **the world** (1.59% versus 2.48%, respectively).

Some examples

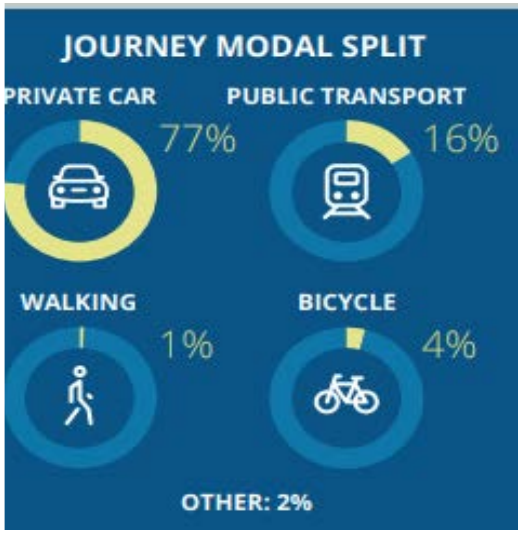
Londres



Barcelona



Washington DC



Main trends and Challenges in Urban Mobility

Stanford Magazine

Demography

Population growth
population aging
Greater concentration of the population in cities

Energy

other energy sources _

Society

New preferences for public space
Less willingness to buy your own vehicle
Mobility as a “ commodity ”
“ Pay per use”

Economy

globalization
Protagonism of the cities
sharing economy

Technology

ITS
Autonomous Vehicle
apps
Mobility as a service

Future world trends

Technology, pandemics, climate change and demography

Technological development

-Increase in Artificial Intelligence, autonomous vehicles, drones.

- Expansion of smartphones and mobility platforms.

-Fintech (financial technology) for mobility, convenience and transparency.

-Mobility as a Service (MaaS)

-Connectivity, Internet of Things (IoT), data platforms.

- ITS and new APPs

Climate change

-Governance, international initiatives for CC.

-Prioritize green and smart mobility solutions.

-Expansion of vehicles with alternative, electric and hydrogen energies.

-Concern of users in the emissions of modes of transport.

- Increase in neutral cities.

-Increase in green financing.

-Increase in the price of fuel

demographic changes

-Change in demographic patterns and behavior of people.

-Change planning and land use.

-Increased urbanization generating demand for efficient and safe means of transportation and growth of the automotive fleet.

-Longevity of the population that requires easy access to inclusive transportation.

-Income inequality (GINI) that generates unequal access to mobility.

-Changes in political priorities.

COVID-19 and future pandemics

-Teleworking and avoiding peak hours.

-Demand for clean public transport.

-Acceleration in *e- commerce* and food delivery.

-Reduction of trade, tourism and business trips.

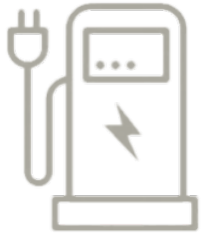
-Lack of access to education.

-Problems in supply chains.

Source: World Bank, 2022

Future trends in mobility

Energy



- Conventional: gasoline and diesel
- Gas: CNG, LNG and LPG

- Traditional Hybrid (HEV)
- Electric Plug-in Hybrid (PHEV)

- Electric

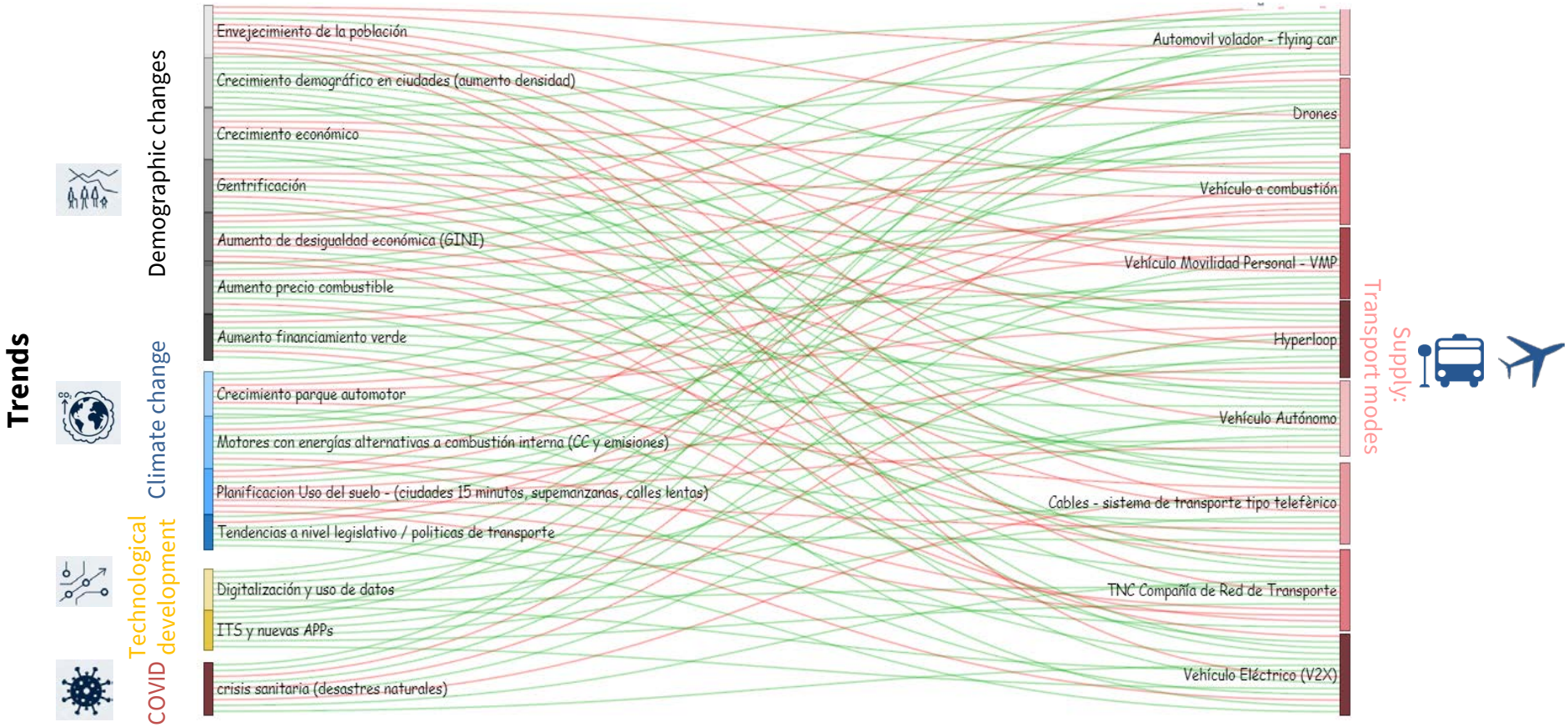
- Hydrogen

Fuente: World Bank, 2022, Strategic Intelligence WEF, 2022

The CHALLENGES of the urban mobility…

Urban freight distribution	Growth of veh-km + e-commerce Importance of last mile delivery solutions
Vehicle	Collaborative driving Autonomous vehicle Communication vehicle-infrastructure DATA
ITS	Faster clock-speed of the technologies Sensors + data “New” mobility services (MaaS)
Energy	New sources of energy (new infrastructure)
Mobility Management	More space for citizens Equity Quality of life New spaces for private collaboration Financing Multimodality Planning

List of trends in transport modes

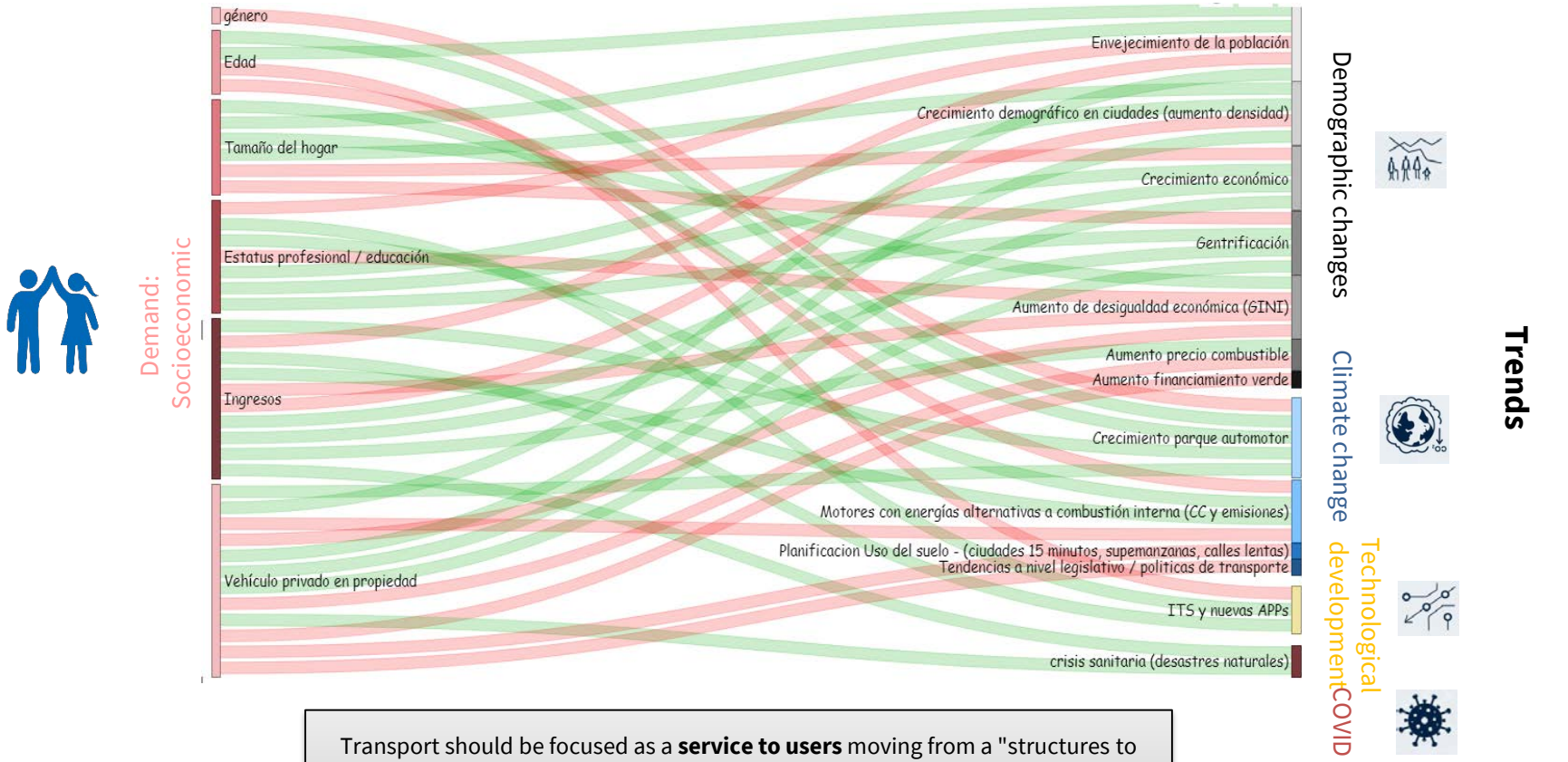


In general, future global trends such as technological development have a direct impact on supply planning and should be considered one of the pillars of the sector.
Technological transformation must be promoted and the benefits of new technologies (such **as autonomous, electric and hydrogen vehicles**) leveraged to achieve efficient, inclusive and sustainable transport.

Positive relationship
Negative relationship

Source: own elaboration

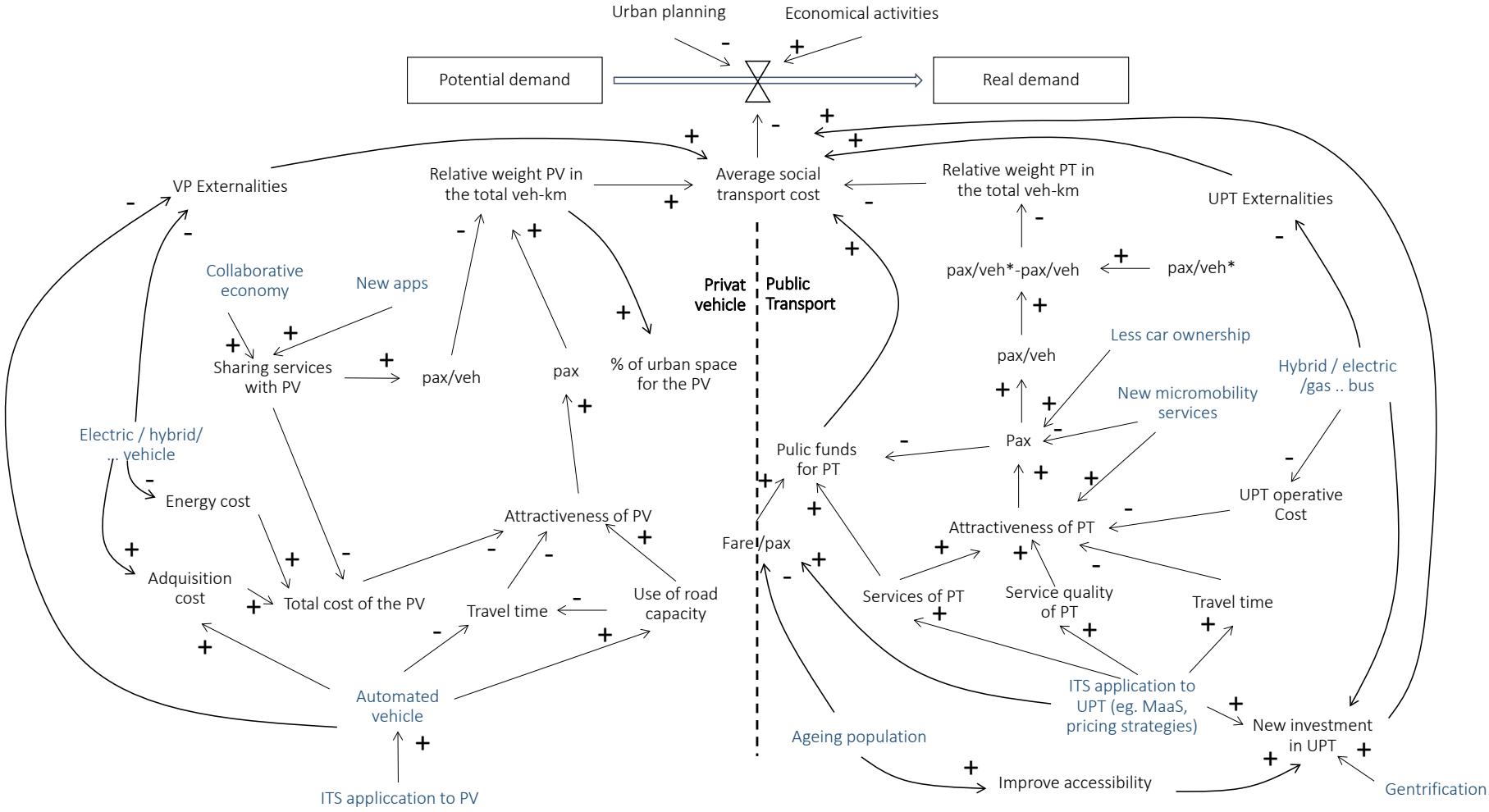
Impact of demand on transport trends



Transport should be focused as a **service to users** moving from a "structures to services" approach. Access gaps must be closed, and work must be done to improve the **quality and affordability** of services. Transport providers must increase the efficiency of systems, offering better quality, safe and more affordable services to users by customizing their needs and characteristics such as **gender, income and age.**

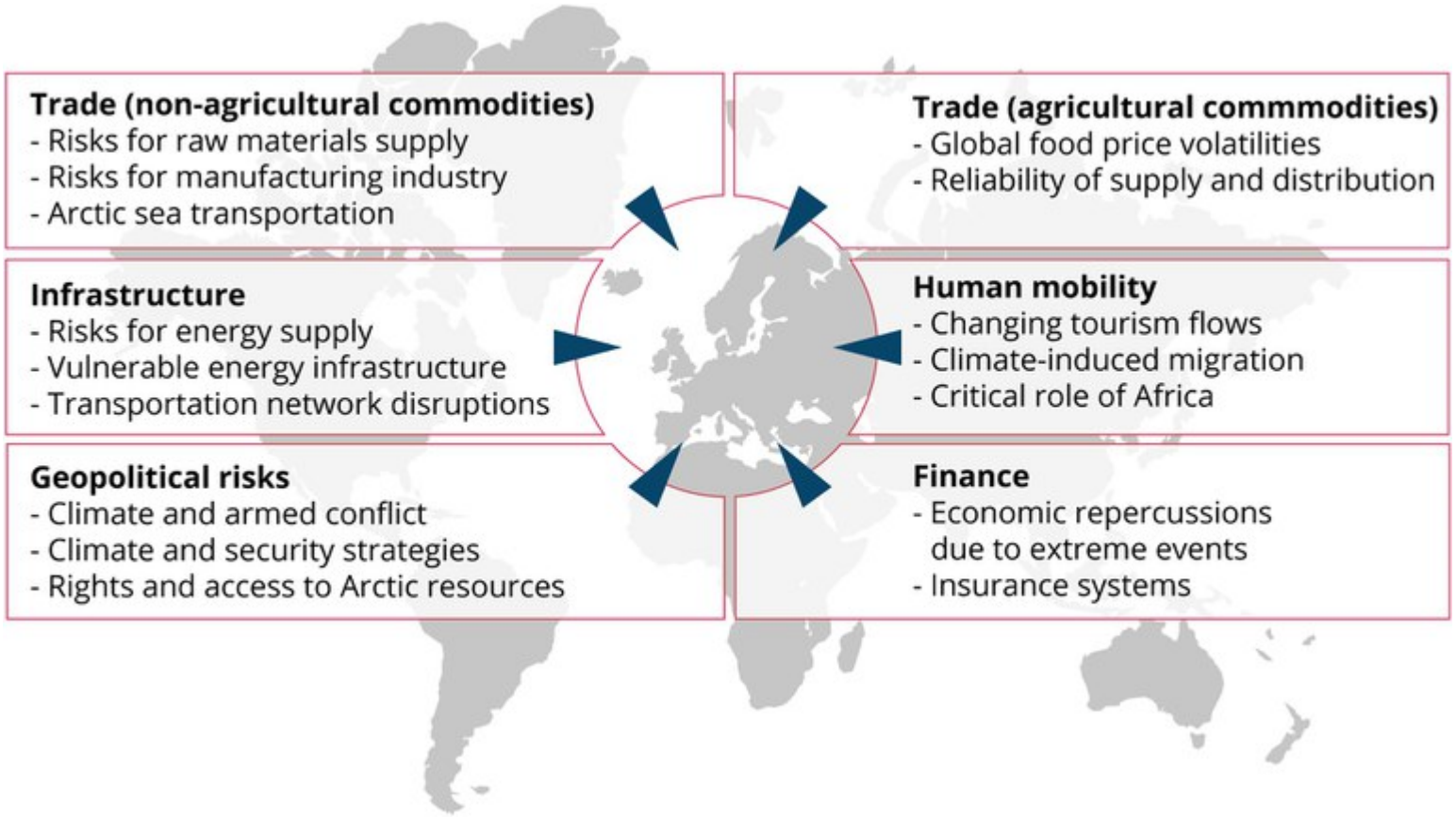
Source: own elaboration

Impact of transport trends on modal split



Source: own elaboration

Climate Change Impacts

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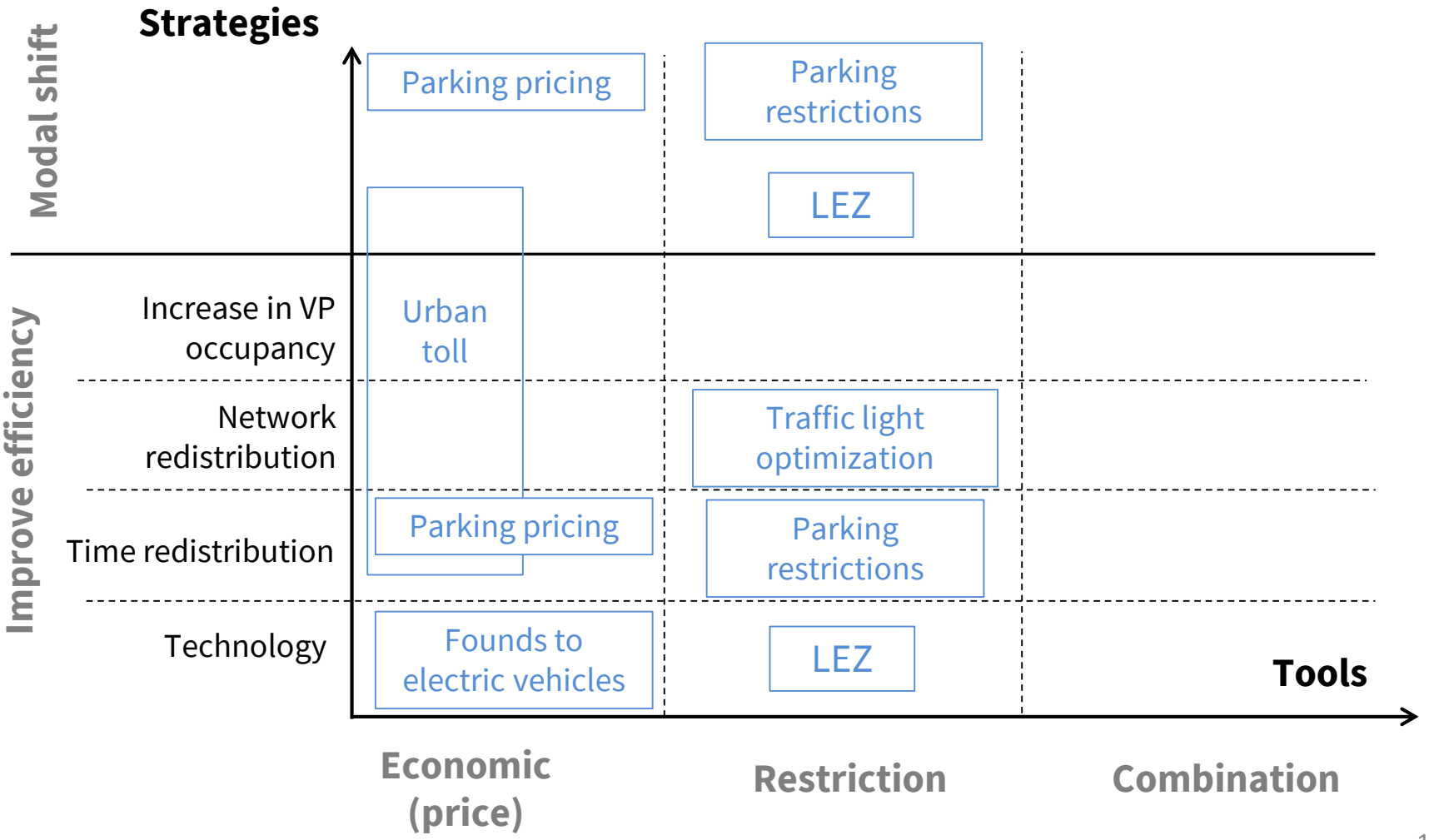
An overview of tools and framwork

Mobility management instruments



Major disruptive trends in transportation

ACES

A

Autonomous

Automation leads the trends. In the field of transportation, this takes various forms, among which stand out **driverless** or autonomous vehicles (AV, for its acronym in English).

C

Connected

Connectivity refers to the use of information and communication technologies (ICTs) to generate **and exchange data between vehicles** , roads, and other parts of the transportation system .

E

Electric

Electrification involves the use of **electric motors** to power vehicles. These receive electricity by recharging on the grid and storing the energy in batteries.

S

Shared

(*Shared*)

Shared use or ownership of cars, bicycles, skateboards, and trucks. The most common forms are (i) between company and consumer, a system by which a company maintains a fleet of vehicles that it **rents** to its customers; (ii) *ride-hailing* services , which offer ride-hailing by connecting drivers using their personal vehicles with passengers requesting a ride; (iii) bike sharing programs; and (iv) micro mobility programs.

Four converging trends — *Automation , Connectivity ,* Electrification , *and Sharing (* **ACES**) — *are* radically transforming the way people and goods move.

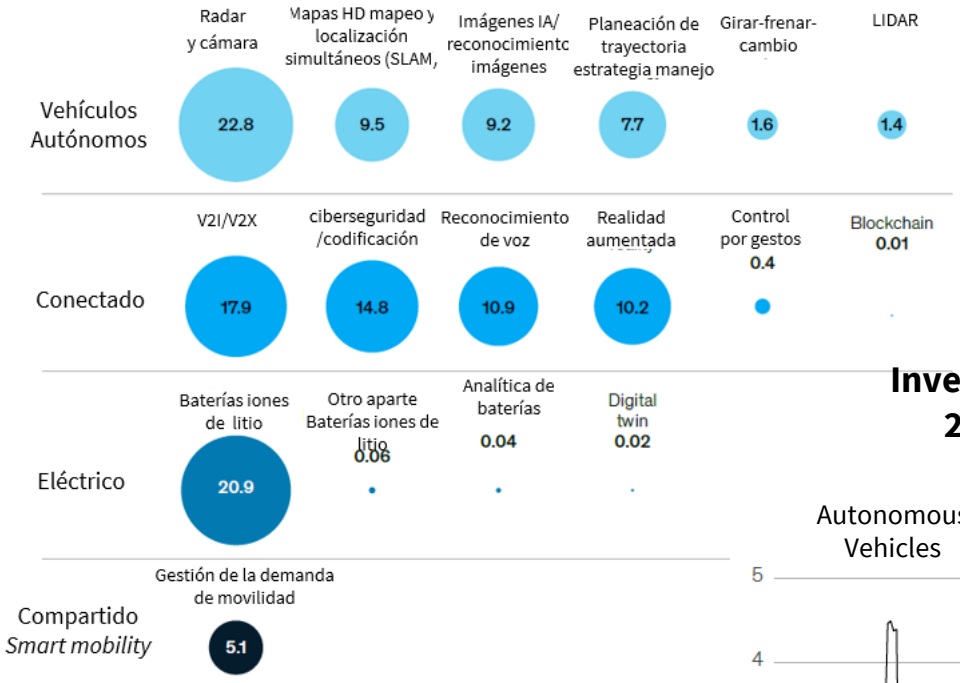
More efficient, inclusive and sustainable transport .

Sources: IDB, 2020 .

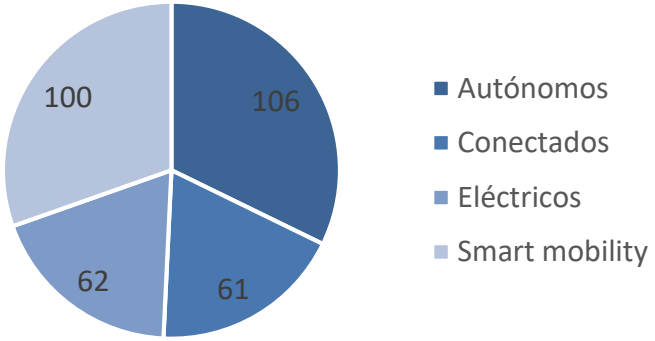
Technology investments in mobility - ACES

Autonomous, Connected, Electric, Shared (*Shared*)

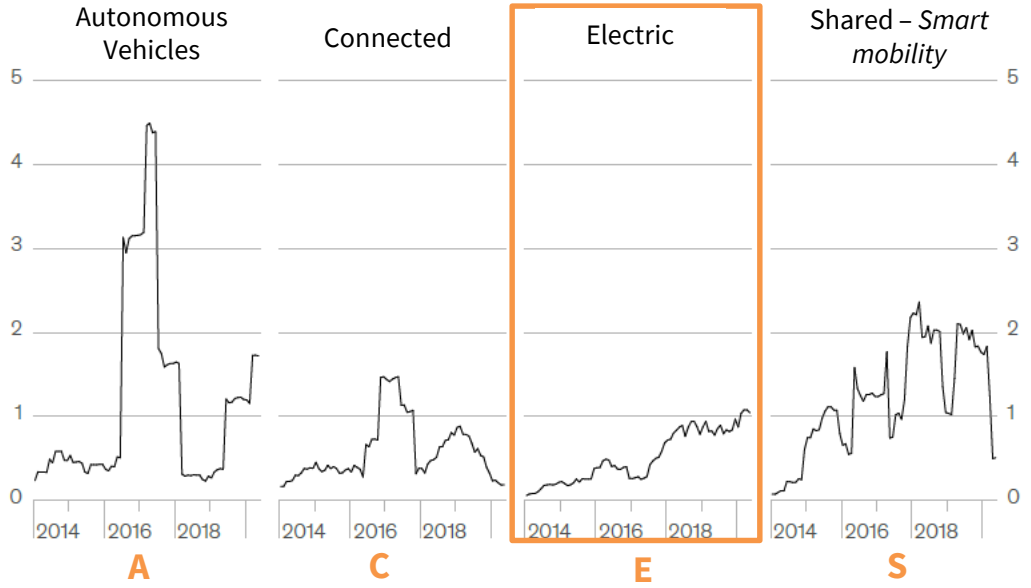
Total disclosed investment in 17 critical technology clusters since 2010 ($ trillion dollars)



Total disclosed investment in mobility technologies since 2010 by ACES trend ($ trillion dollars)



Investment in electrification has grown steadily since 2017, reaching US$1 trillion per month in 2020.



Fountain: McKinsey & Company, 2021 .

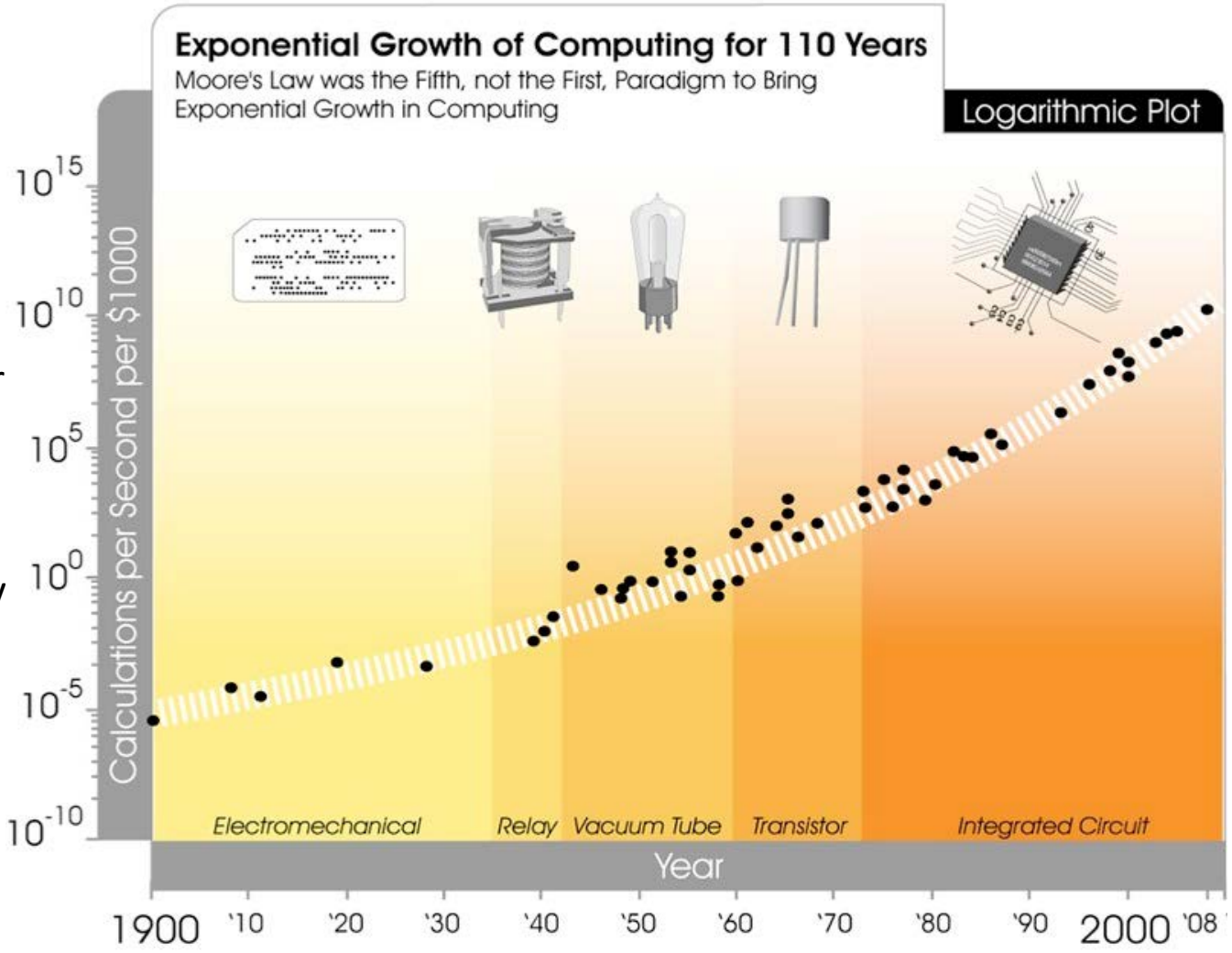
The impacts of technology

Law of accelerating returns

Open evolution of systems (all its components evolve over time)

Evolutionary process that grows exponentially Moore's Law

Calculation capacity, speed, etc.



Kurzweil , R. (2005) *Singularity es near .*

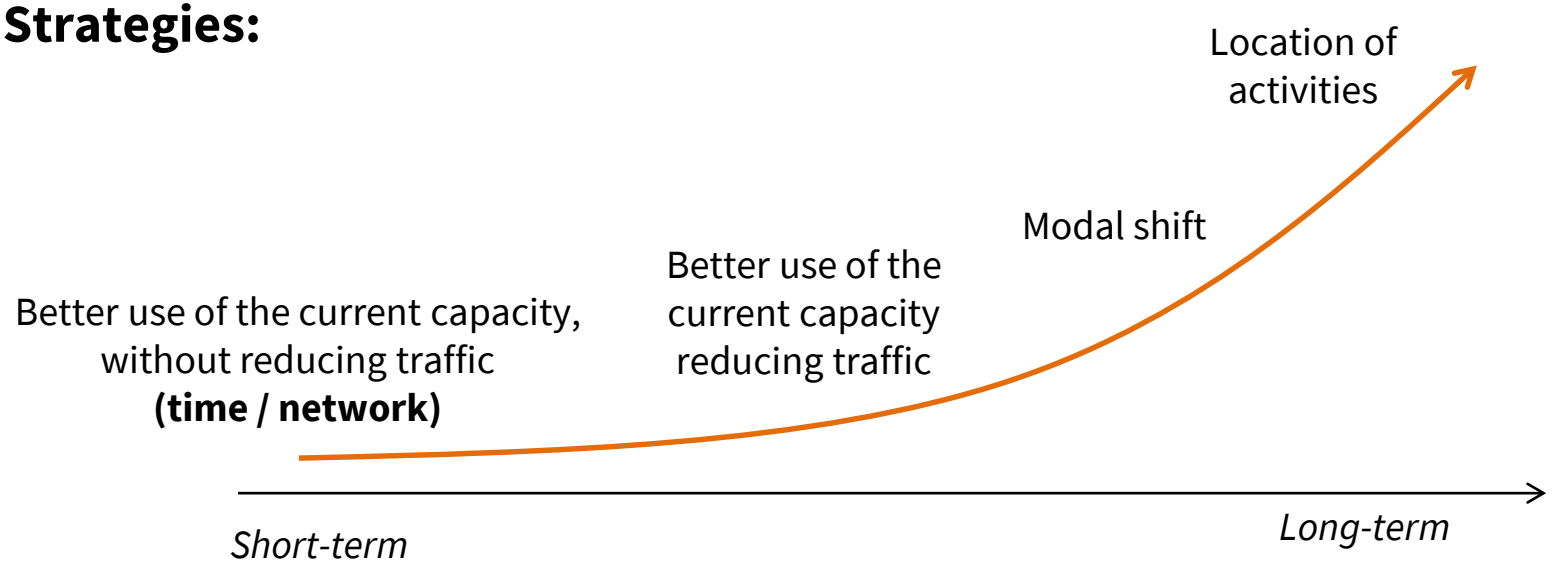
A SOLUTION?

A mix of solutions

Regional/Metropolitan solutions of global problems

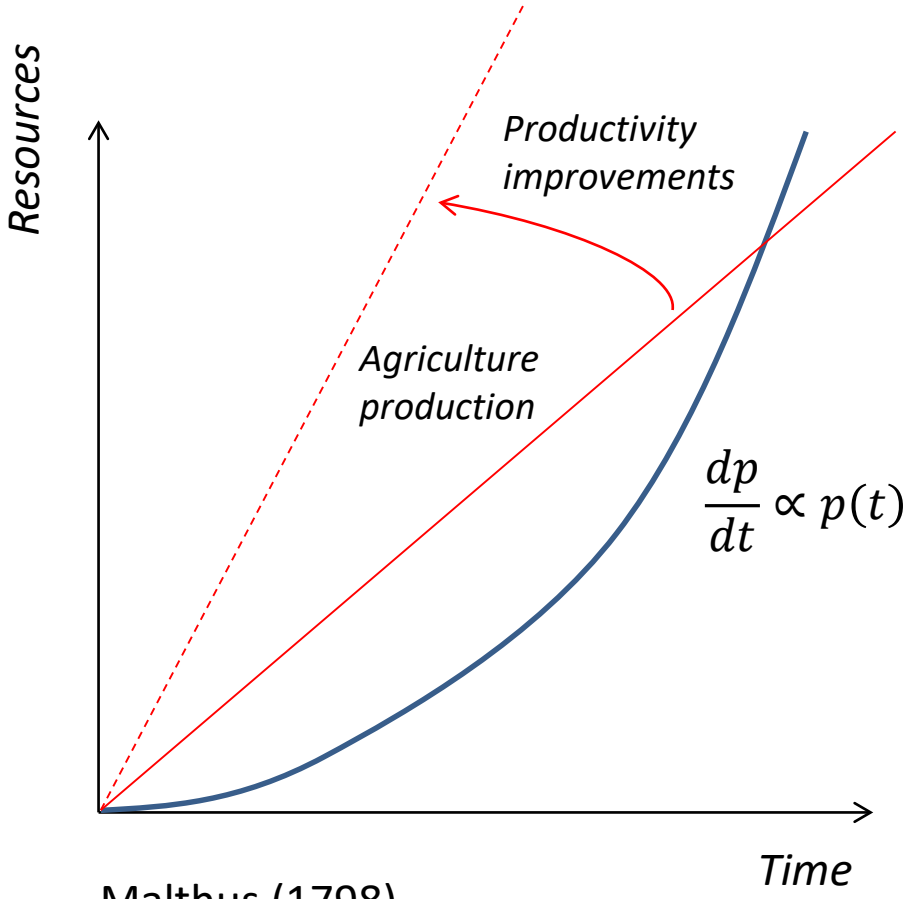
Leadership of the public sector

Strategies:



Technologies and the post-Malthusian world

Reconcile 3rd phase (habitable city) with mobility



Malthus (1798)

Improvements in the productivity (recent) of space and consumption of other resources
Δ number of people / m2-unit of time

Redefinition of the concept of the vehicle / modular vehicle / energy efficiency...

An example….in the best of scenarios

The European Commission presented its ' **Sustainable and Intelligent Mobility Strategy'** for the next four years.

2030	2035	2050
+ At least 30 million **zero emission cars** will circulate on European roads + 100 European **cities will be climate neutral** . **High-speed rail** traffic will double across Europe. + **Collective trips** scheduled for trips of less than 500 km must be carbon neutral. + **Automated mobility** will be deployed on a large scale. + Zero emission	+ Large **zero emission aircraft** will be ready for the market.	+ Nearly all new cars, vans, buses, and heavy-duty vehicles will be **zero-emissions** . + **Rail** freight traffic will double. + **Trans-European Transport Network** (TEN-T) multimodal and fully operational for sustainable and intelligent transport with high-speed connectivity.

Source: European Commission, 2020

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Energy as scarce resources

Misuse of the concept of sustainability

- Since the eighteenth century there has been a constant increase in energy and accelerated consumption
- Social efficiency ≠ sustainability
- Need for a sustainable energy model
- Complete life cycle

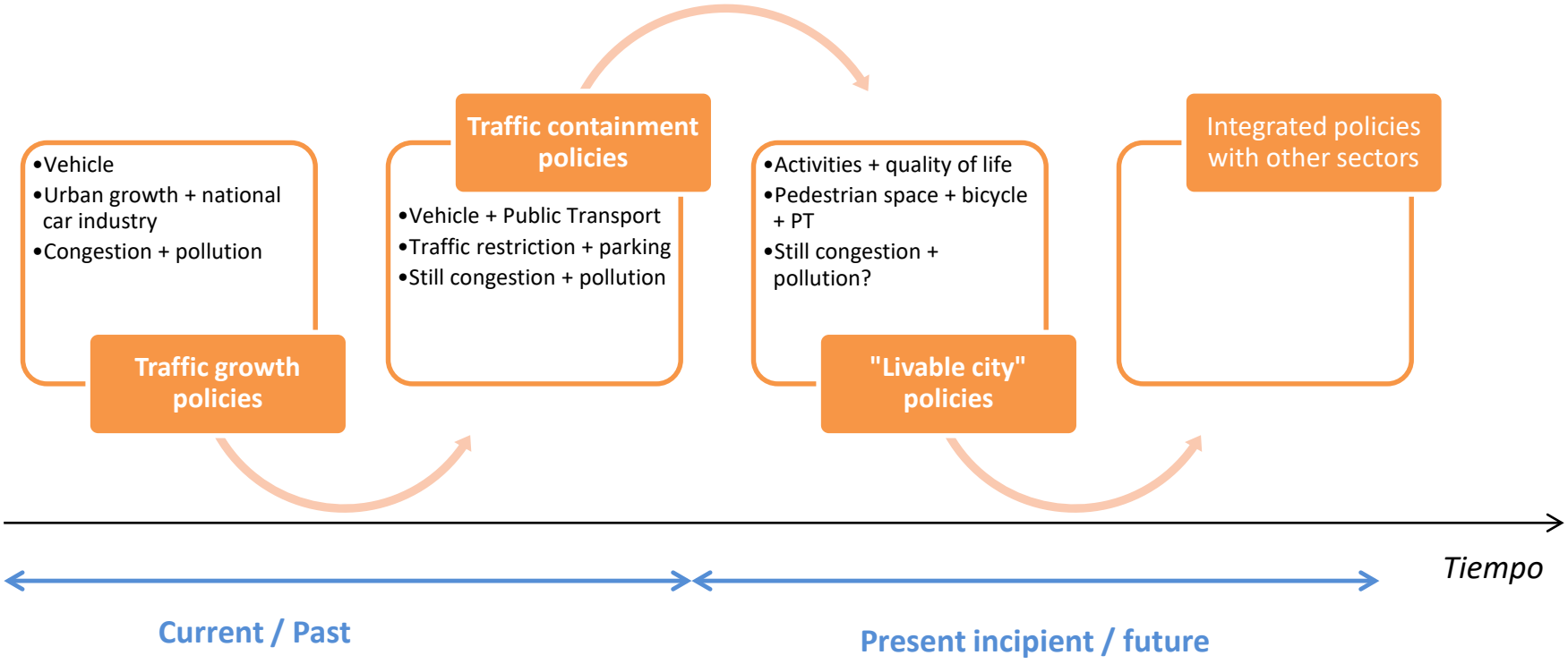
The trend scenario

"... to believe that radio control from a helicopter of traffic jams and traffic jams is a test of supreme technical efficiency, rather than seeing it for what it really is: a revelation of the glaring **failure of contemporary engineering as well as road planning, social management or urban planning**"
Lewis Mumford (1970)

We are currently projecting the future of transport with the **same paradigm** in which it has led us to the current situation, despite technological advances, and **transferring part of the current externalities to other areas exogenous to transport.**

Paradigms in mobility planning

Three stages (Jones, 2014):



Some examples of solutions implemented/studied in Barcelona

Urban Freight Distribution: Micro Distribution Centers

Pilot case. GrowSmarter. Barcelona, 2019

GrowSmarter
Transforming cities for a smart, sustainable Europe

Micro distribution of freight in Barcelona **objectives**:

- More efficient and effective freight transport system in the city.
- Reduction in CO2 emission
- Test a new sensoric system to track position of cargo bikes, monitor pollutants and other environmental parameters.

LOGISTIC OPERATORS

MICRO-DISTRIBUTION PLATFORM

RETAILERS

96%

Reduction in CO2 emissions

98%

Reduction in energy (Kwh) use

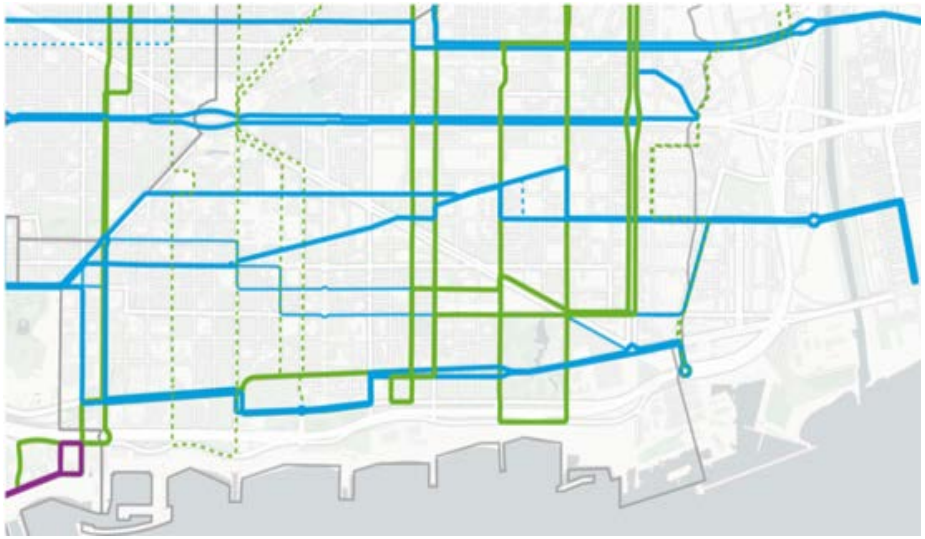
21,7%

Reduction in noise (dB)

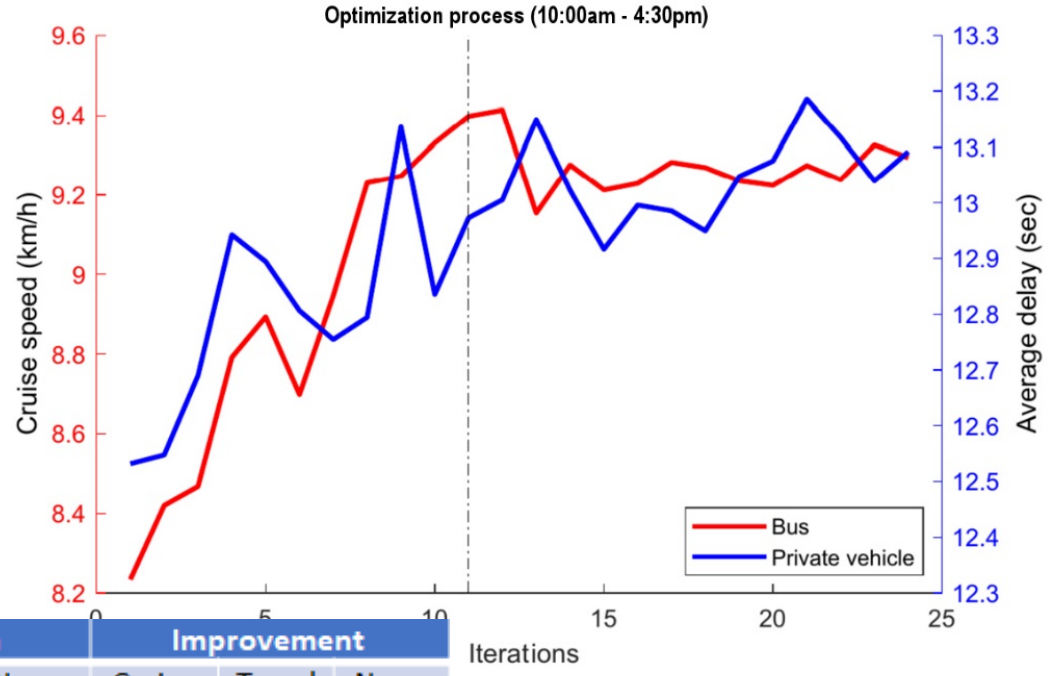
Smart Mobility Solutions: Traffic light optimization for buses

Traffic light optimization for the 22@ area

Bus network



Level of traffic

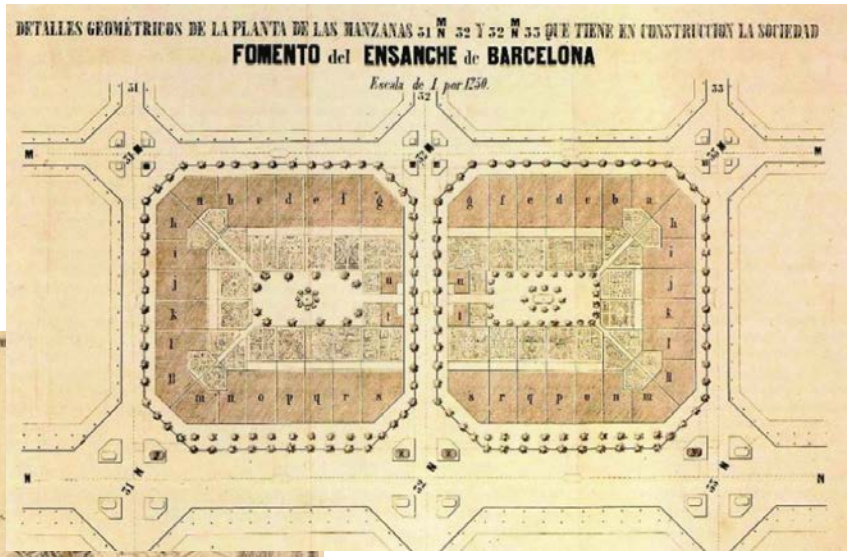


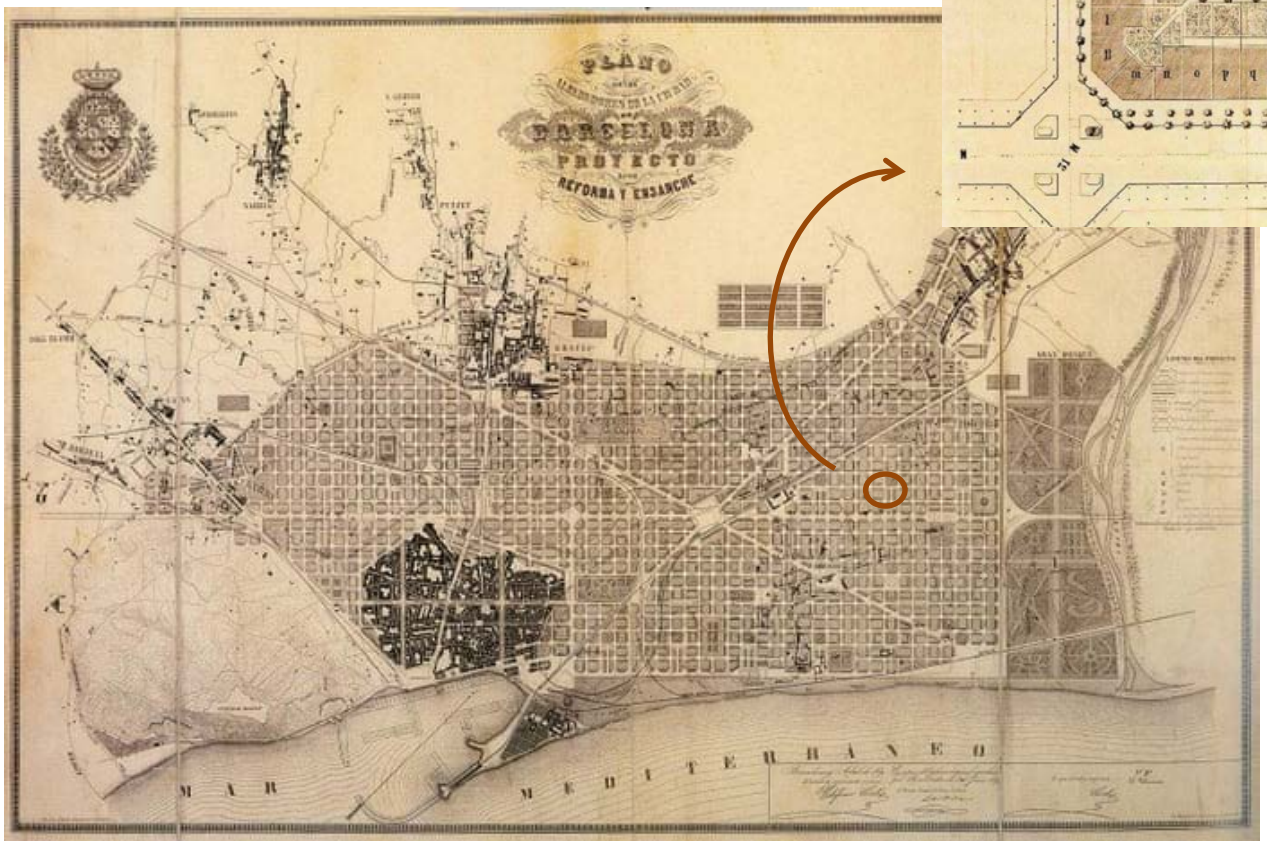
Line	First iteration			Best iteration			Improvement		
	Cruise speed (km/h)	Travel time (min)	Num. Stops (#)	Cruise speed (km/h)	Travel time (min)	Num. Stops (#)	Cruise speed (%)	Travel time (%)	Num. Stops (%)
H14-0	9,7	21,9	23,6	10,6	20,1	19,3	9,1%	-8,4	-18,1
H14-1	7,1	18,9	20,5	7,9	17	18,3	11,7%	-10,1	-10,6
H16-0	6,9	20,6	22,1	7,5	19	21,9	8,7%	-8,0	-0,7
H16-1	6,2	21,6	22	7	19,1	18,5	14,3%	-11,7	-15,9
V21-0	8,2	14,1	14,1	9	12,9	12,7	9,1%	-8,4	-10,0
V21-1	8,6	13,2	14	8,4	13,5	12,1	-2,1%	2,2	-13,7
V27-0	9,7	21,7	22,4	11,4	18,5	20,8	17,1%	-14,6	-7,1
V27-1	5,8	20,1	20,6	10,9	12,4	16,7	88,4%	-38,5	-19,0
V29-0	10,1	9,8	11,7	14,6	6,8	7,1	44,7%	-30,0	-39,3
V29-1	11,2	15,9	16,7	13	13,7	15,2	16,4%	-13,7	-9,0
H31-0	8,3	15,6	15,8	8,9	14,5	15,5	7,2%	-7,1	-2,1
H31-1	5,9	15	16,9	7,6	11,7	19,7	29,3%	-22,0	16,3
Mean	8,1	17,4	18,4	9,7	14,9	16,5	21,2%	-14,2	-10,8

And the urban planning dimension


Barcelona

Smart Planning





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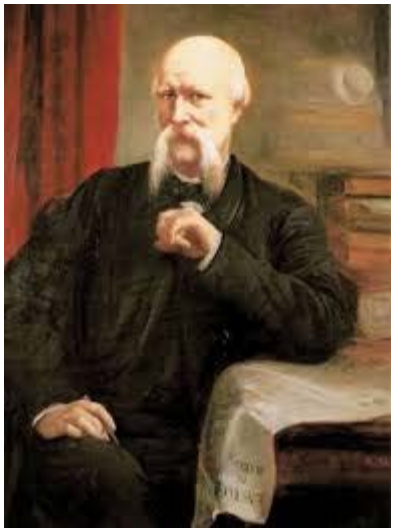
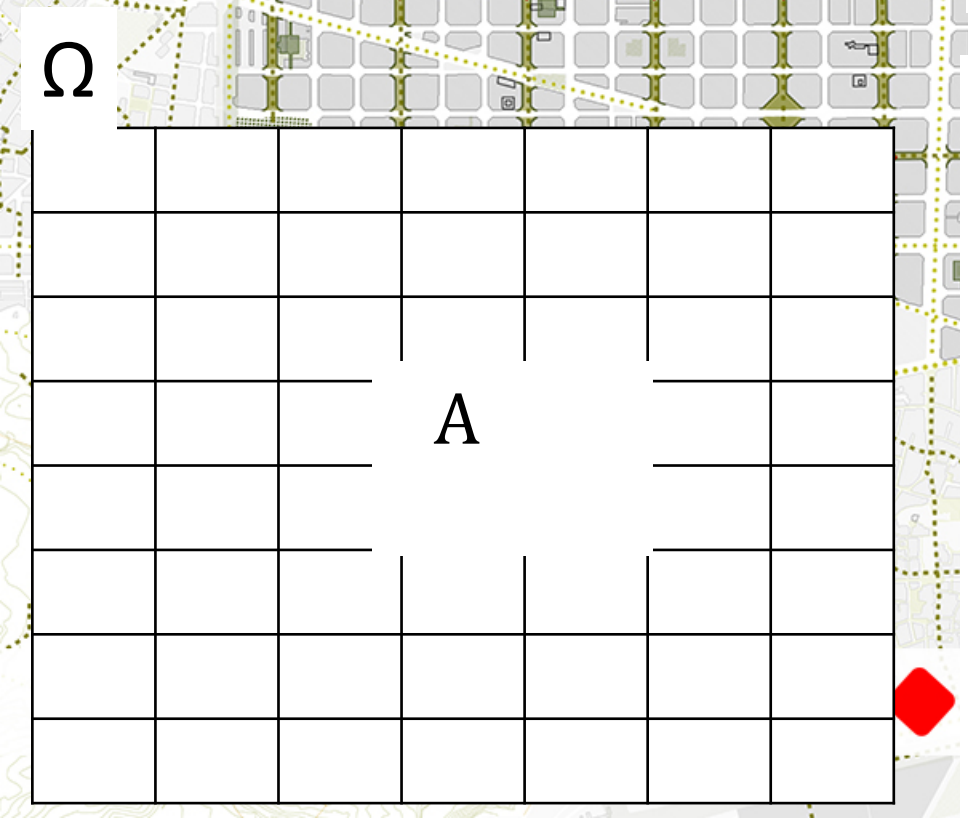
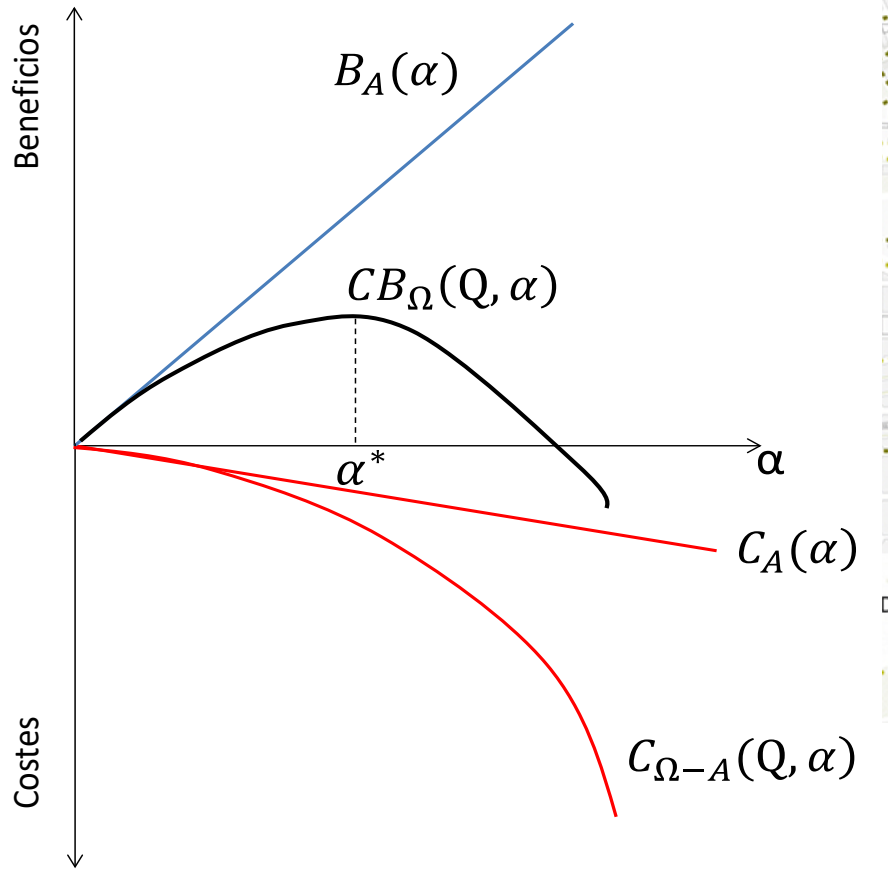


Idelfons Cerdà
Civil Engineer

Urban Planning: Macro blocks

$$CB_{\Omega}(Q,\alpha) = B_A(\alpha) - C_A(\alpha) - C_{\Omega-A}(Q,\alpha)$$





Thank you!

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Science
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