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Could an e-bike (+ walking, transit, scooter) city work?

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Publication date:
2023-08-09

Permanent link:
https://doi.org/10.3929/ethz-b-000625518

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Axhausen, K.W. (2023) Could an e-bike (+ walking, transit, scooter) city work?, headline presentation, *5th Bridging Transportation Researchers Conference*, on-line, August 2023.

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Could an e-bike (+ walking, transit, scooter) city work?

KW Axhausen

IVT
ETH
Zürich

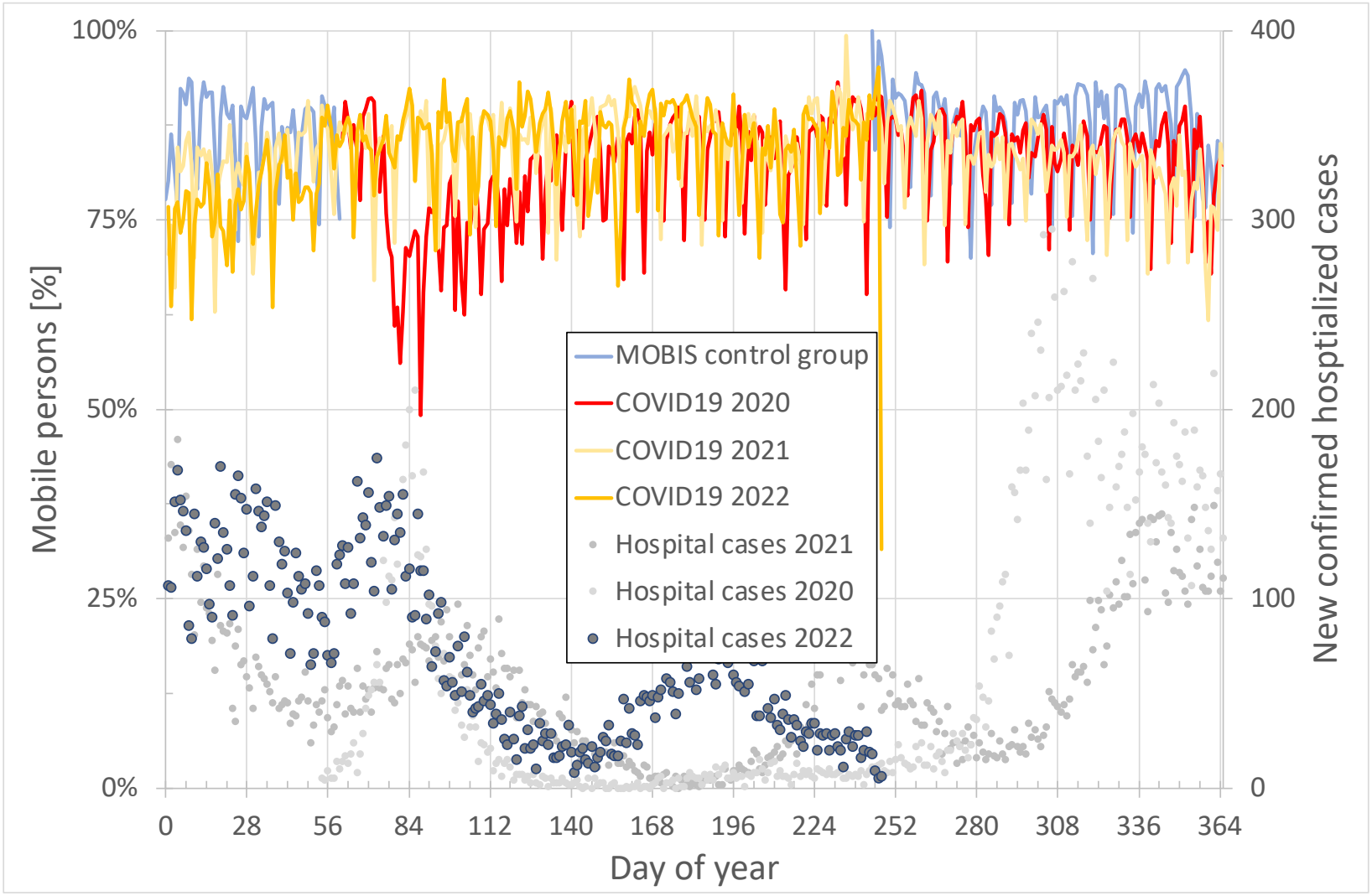
August 2023

D BAUG

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Prelude: Changebility of travel behaviour

Share of mobiles since September 2019



Source: MOBIS/COVID19 GPS panel

Dilemma of transport policy

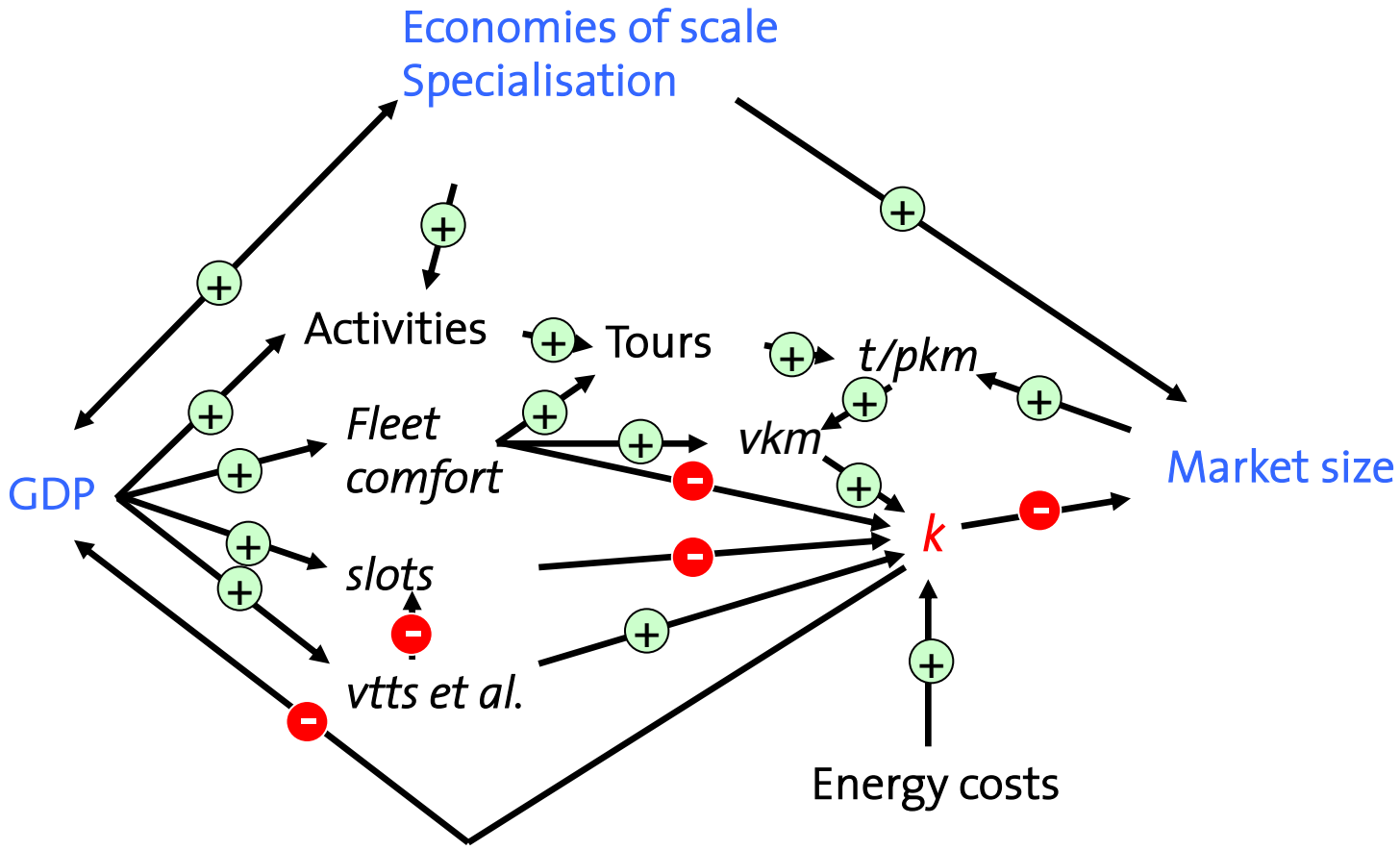
Transport

is a

Normal (private) good

i.e.. it has a negative generalized cost elasticity

Conceptual model: Goods markets



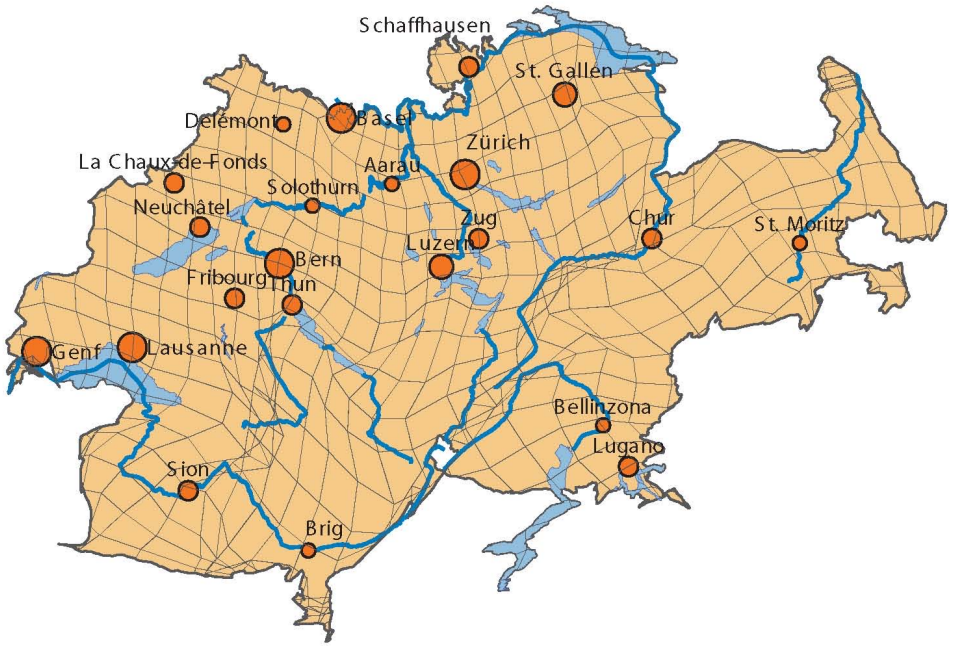
⊕ Elasticity > 0

⊖ Elasticity< 0

k: Generalised costs

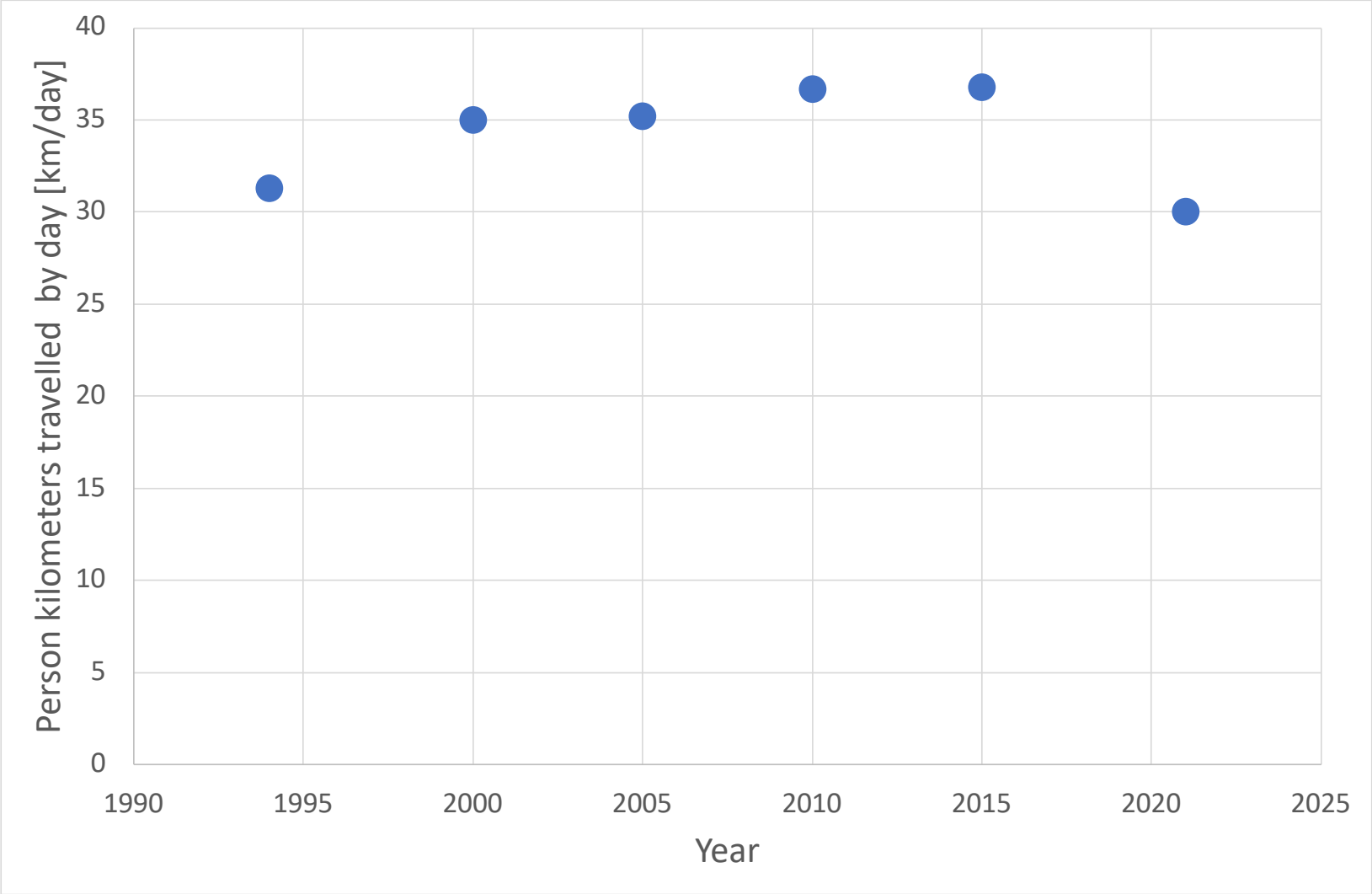
Shrinking "road" – Switzerland (1950)

Shrinking "road" – Switzerland (2000)



Scherer, 2004

Switzerland: Pkm change since the MZ 1994



5th BTR 23/08

What dilemma ?

What dilemma ?

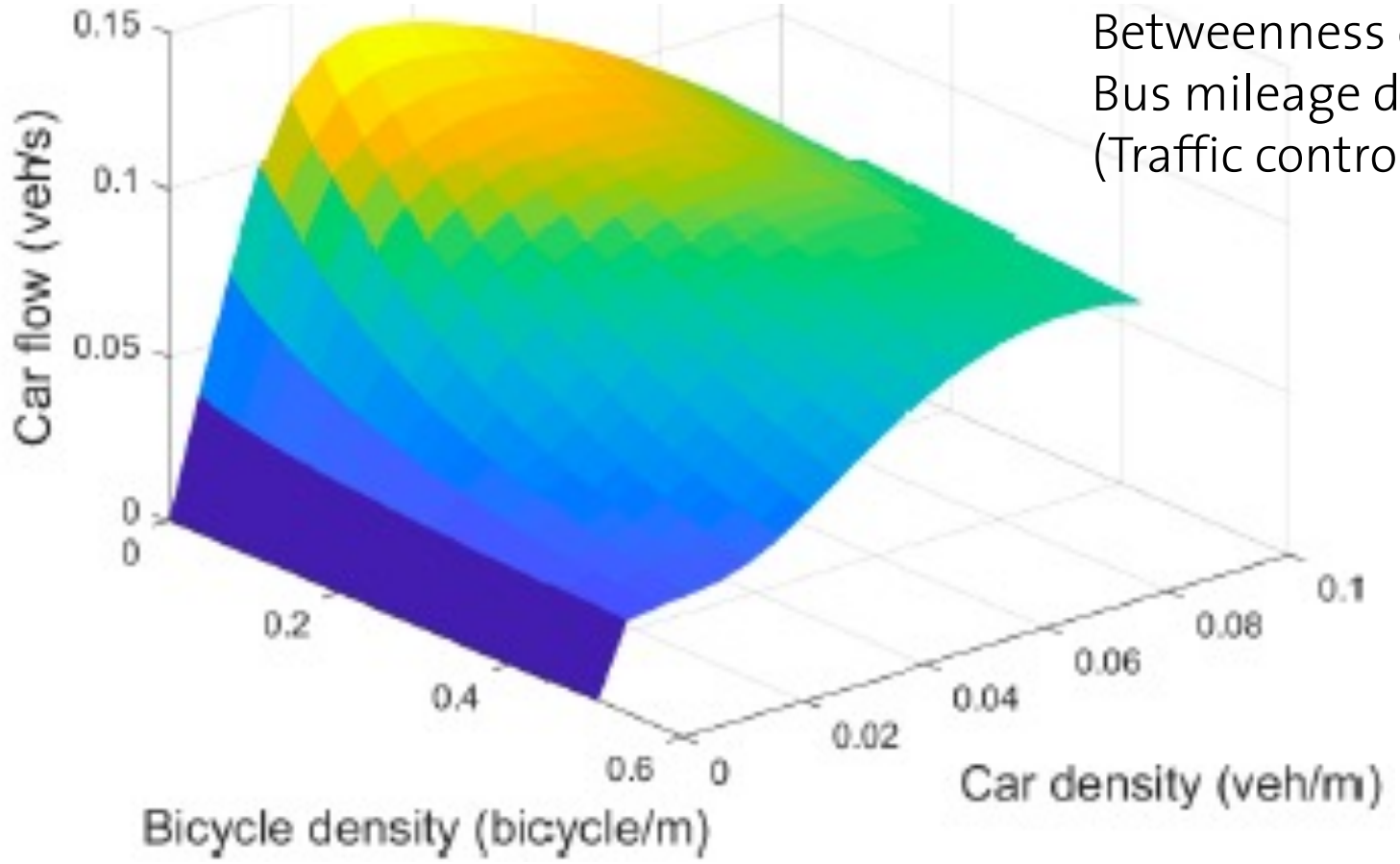
- Higher accessibility improves productivity and social capital

- Underused unpriced off-peak capacity due to (additional) capacity for population (growth) in the peak (roads, parking, transit) encourages overuse otherwise
- Induced demand due to the lower GC of electric and automated private and public transport
- Working from home making PT less relevant for many

- CO_2 reduction requirements
- Sprawl limitations
- VMT growth and congestion

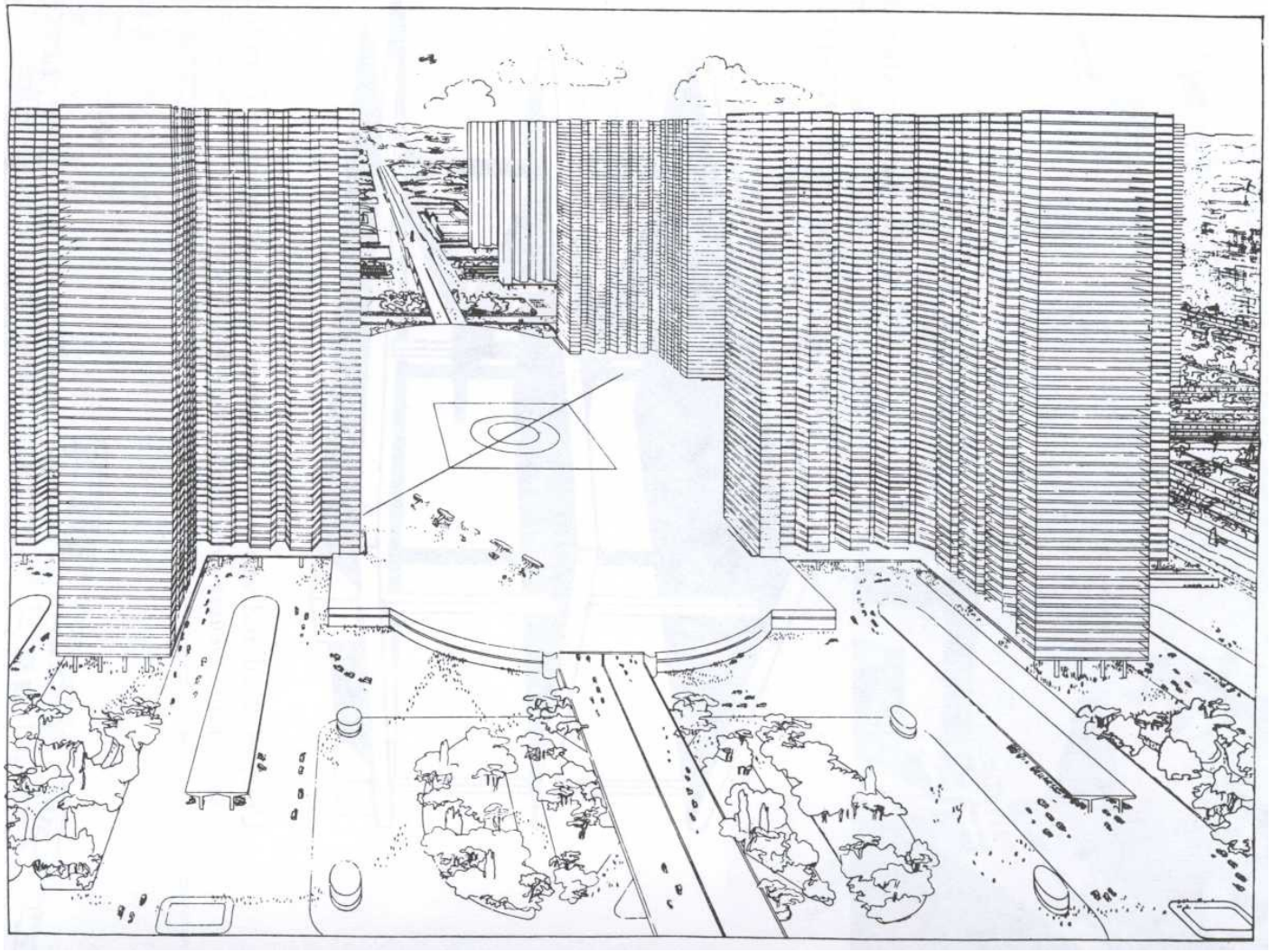
Nearly fixed urban network capacity =

Junction density,
Lane miles density
Betweenness centrality,
Bus mileage density
(Traffic control)

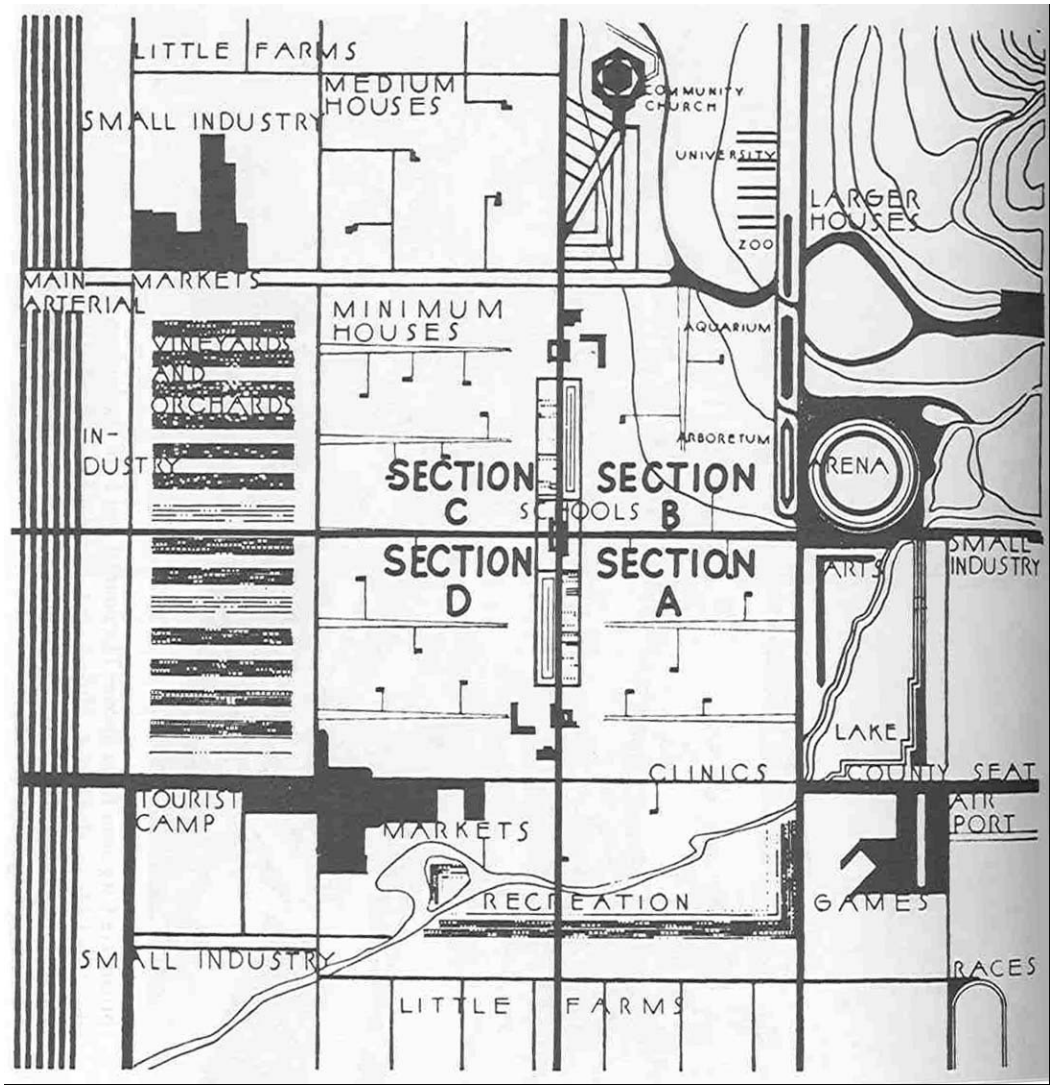


What were the past visions ?

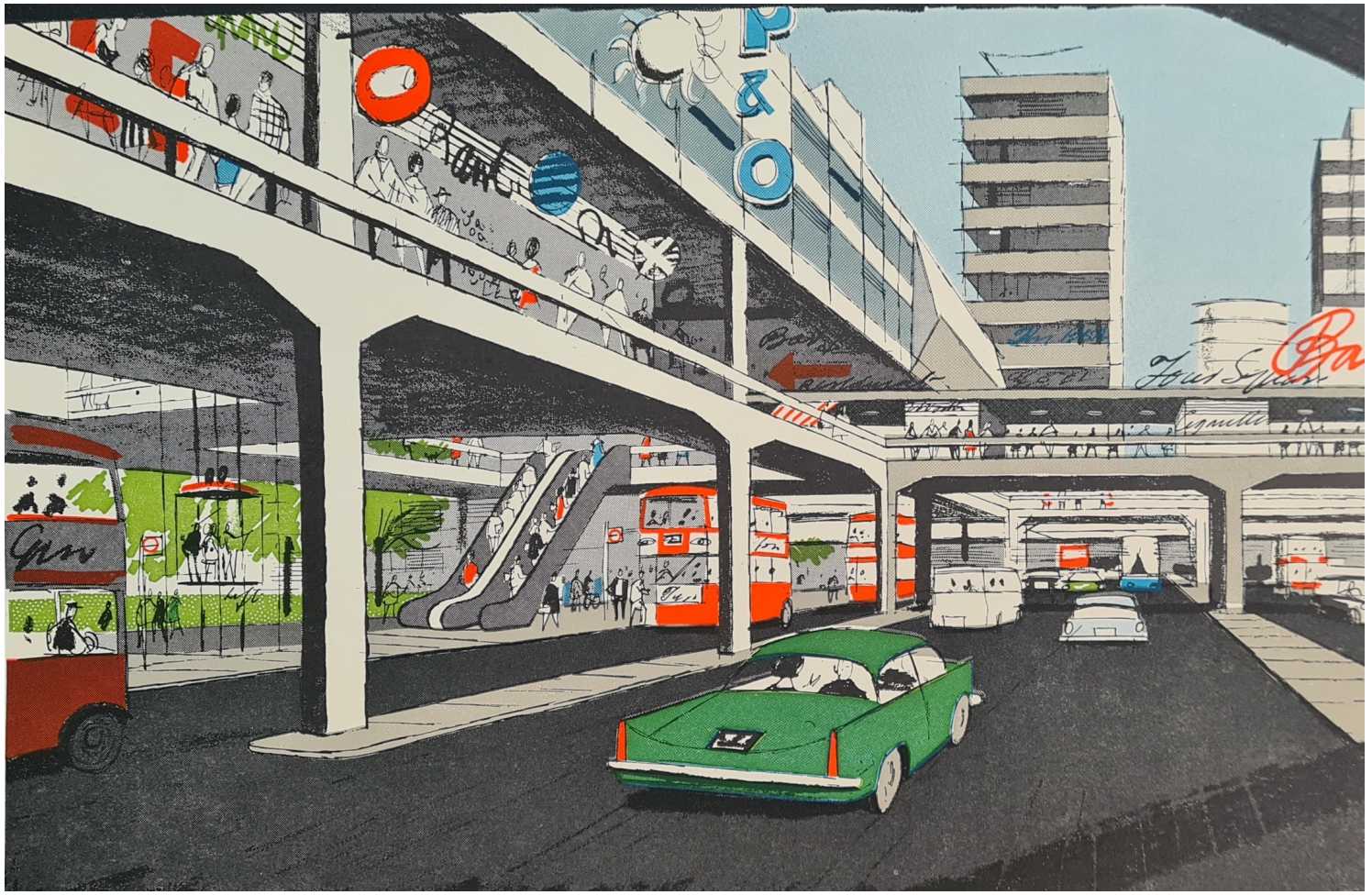
Radical dreams: Le Corbusier's City radieuse



Past radical dreams: Lloyd Wright's Usonia

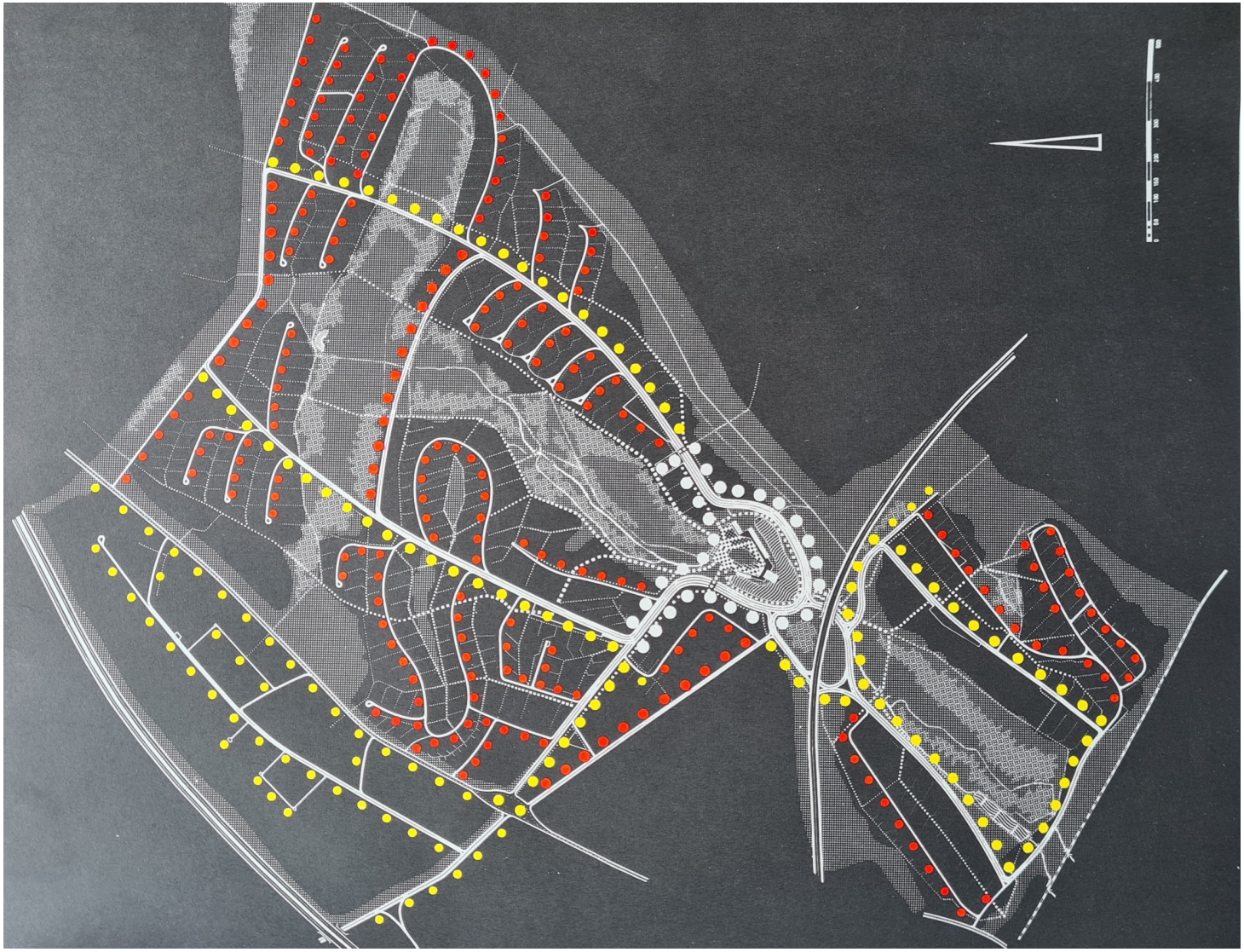


Past radical dreams: Buchanan's two-level central London



Source: Buchanan Report (1963)

Past radical dreams, realised: «Autogerechte Stadt»



Source: Reichow (1963), p. 24

Past radical dreams, realised: Motorways

Dr. Wolf Strache, Public domain, via Wikimedia Commons

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Which future are we discussing?

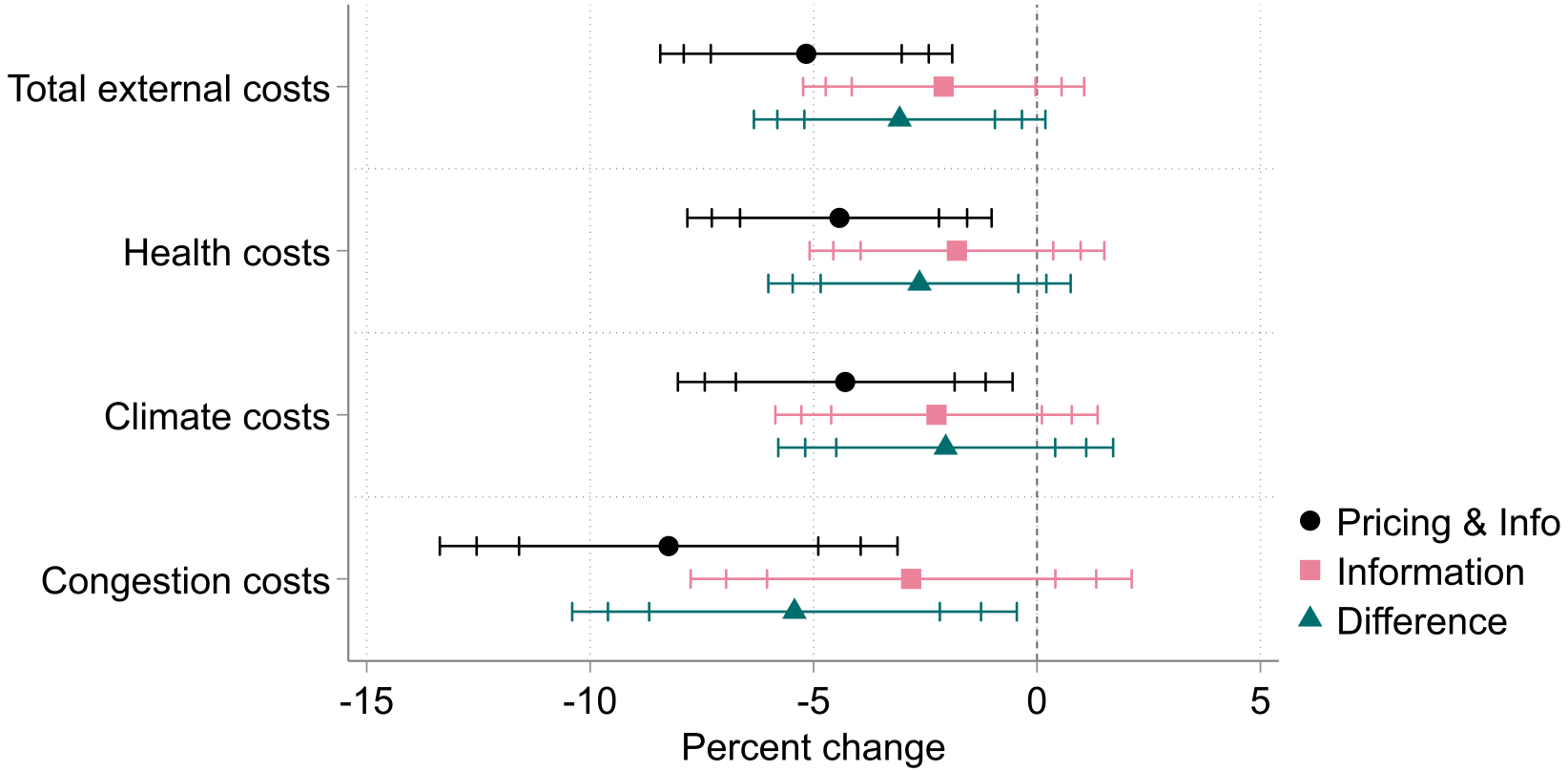
A managed/co-ordinated one

A managed/co-ordinated one

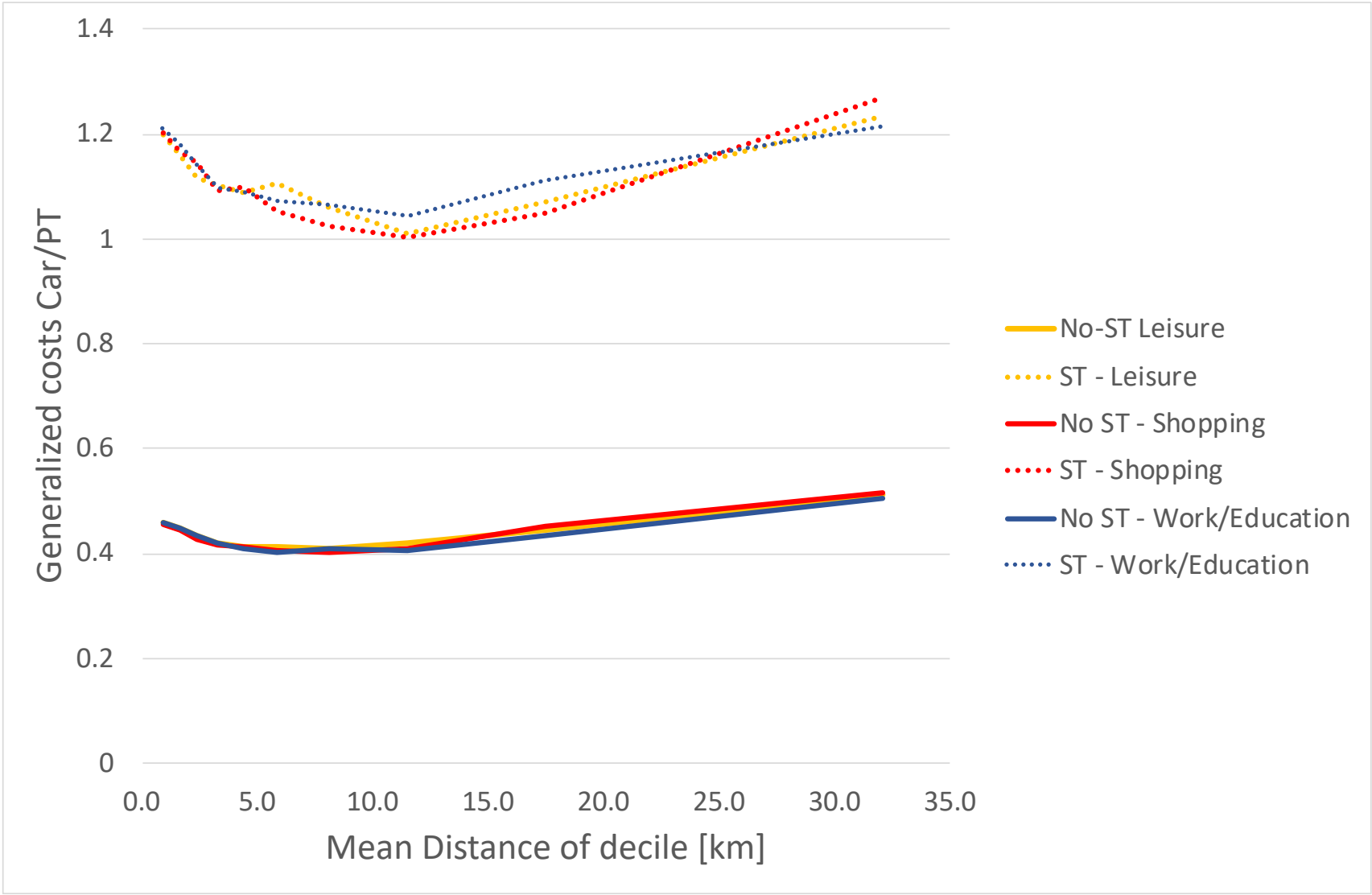
- *Mobility pricing*
  - Two-part tariffs for infrastructure
    - Option fee
    - Pay-as-you-go for usage
  - Congestion pricing
  - (Demand responsive) parking pricing
  - GHG (CO_2) pricing
  - Local emission pricing

- MaaS improved shared mobility

Pricing effects – MOBIS average treatment effect

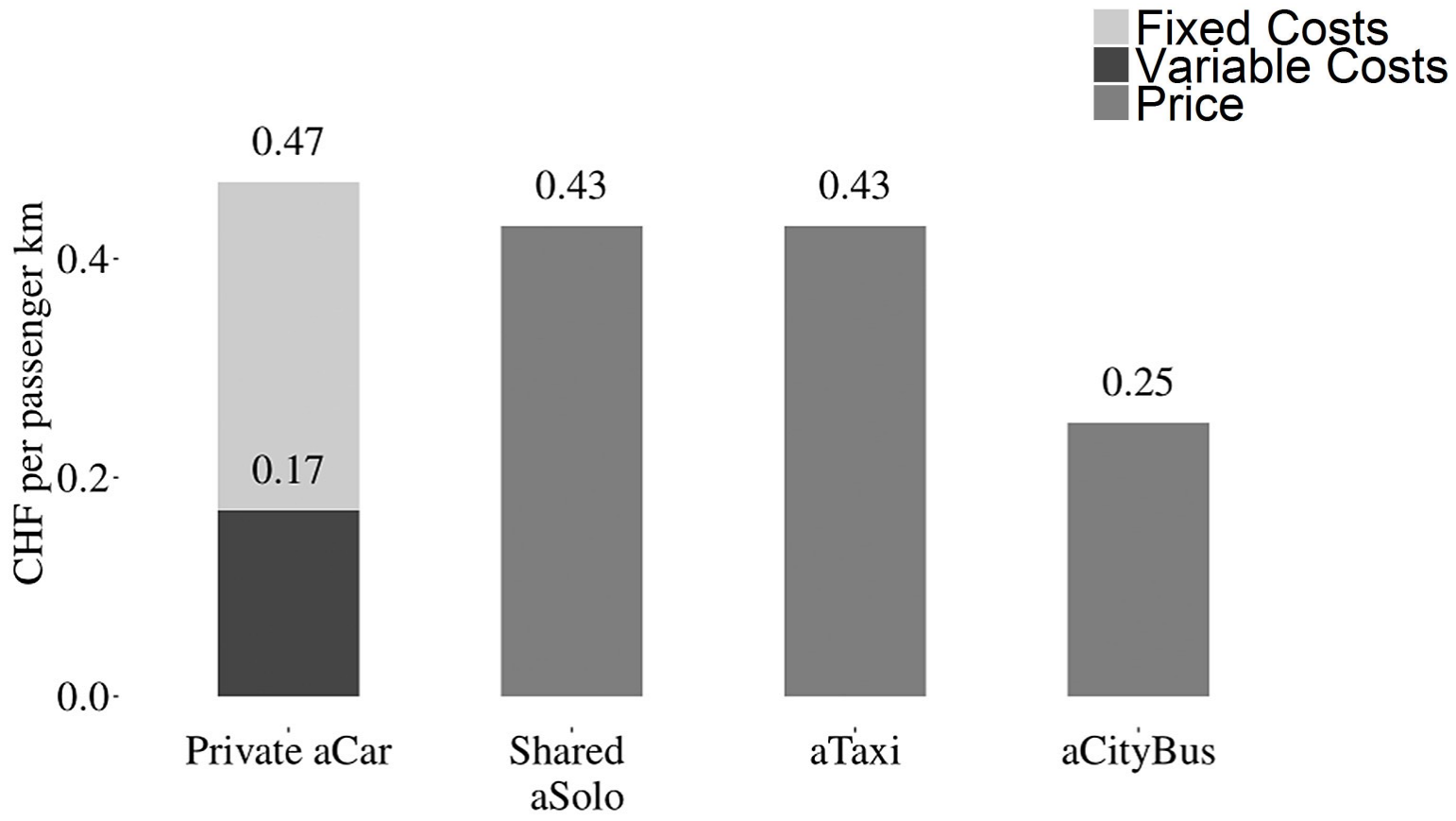


A managed/co-ordinated one? Comparison of MOBIS GC



An automated one? First robust cost estimates

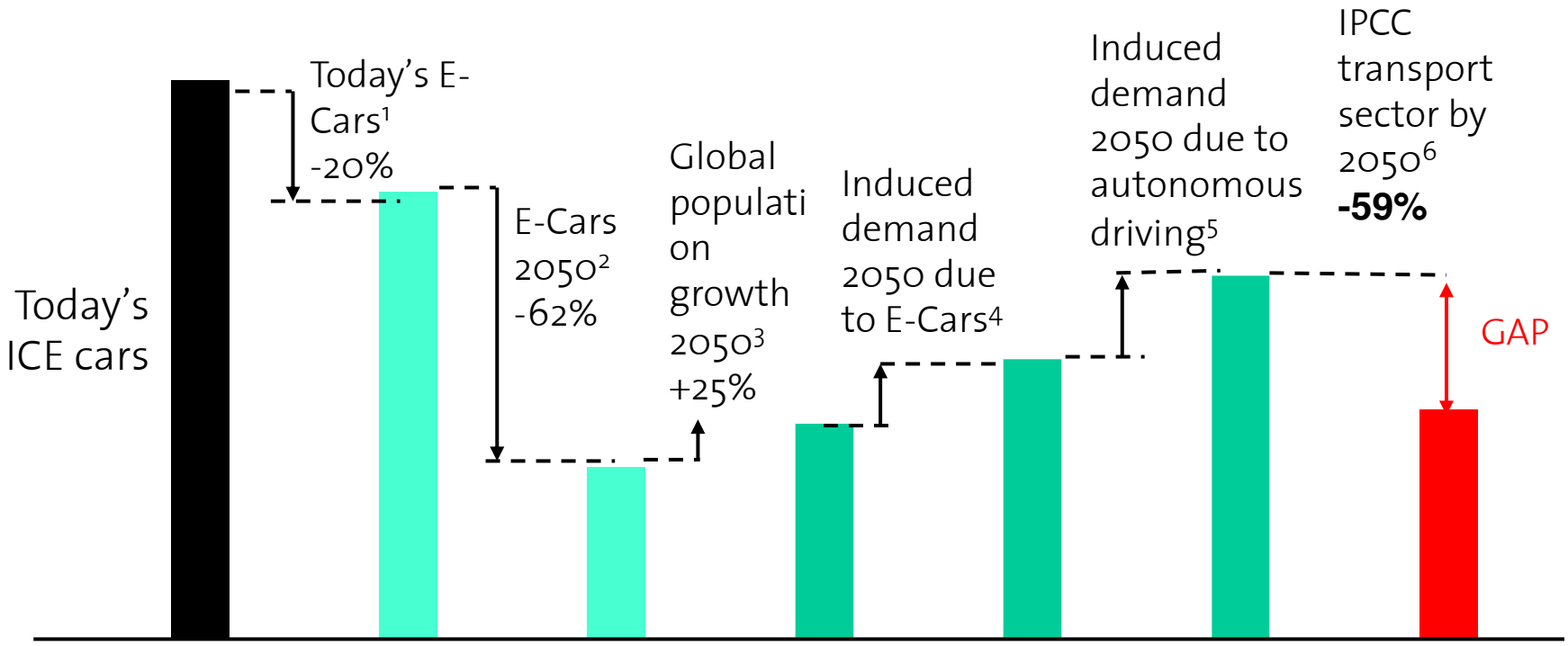
Structure of the pkm full costs for today's usage levels



Source: Bösch, Becker, Becker and Axhausen (2017)

An electrical autonomous one,

An electrical autonomous one,



Source: Livingston (2022)

Note: These are optimistic estimates of how many CO_2 emissions can be avoided through technology.

A car free/reduced one,

A car free/reduced one,

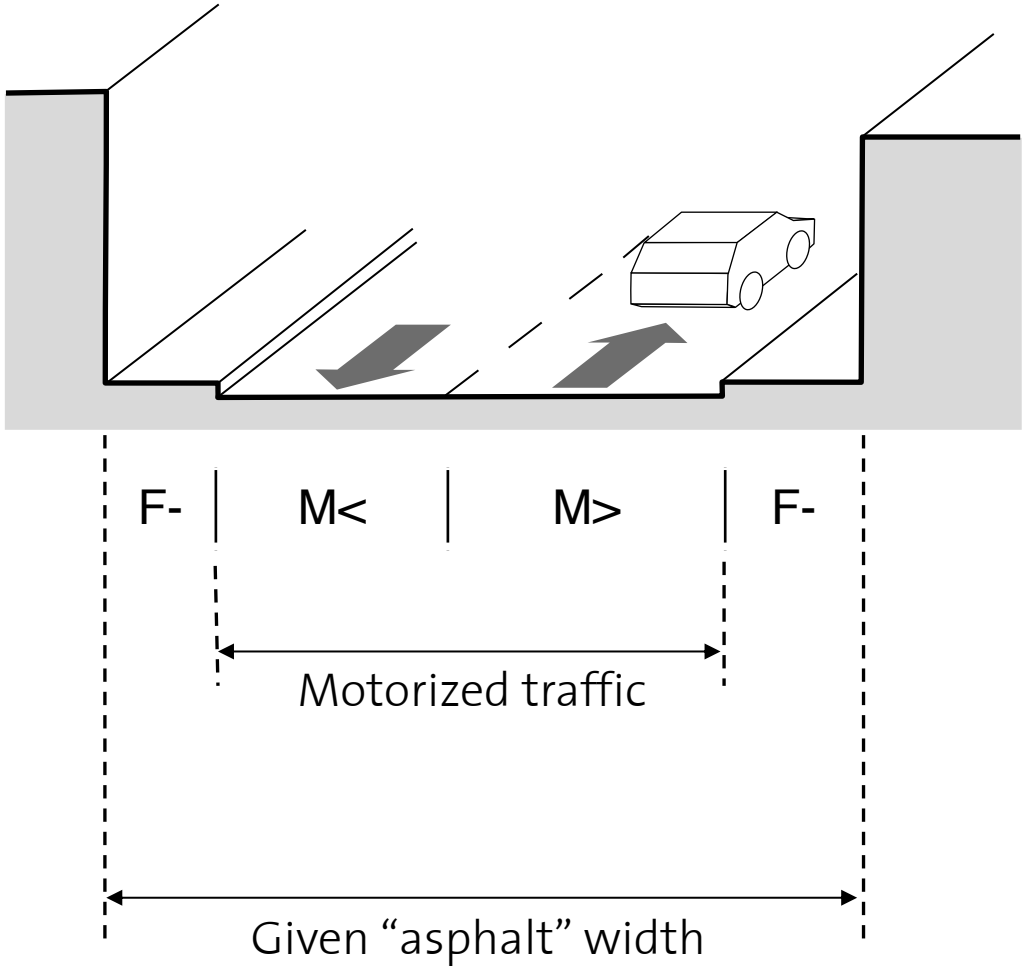
- a 15 min city ?
- a net-zero CO_2 city ?
- an e-Bike city ?

An e-bike city?

The idea of an e-bike city

- 50% of road space for slow vehicles (e-bike, bike etc.)
- Maintaining of current accessibility levels (for all)
- Integration with shared services for the larger demand variations

The idea of an e-bike city



The idea of an e-bike city: Birchstrasse, Zürich

Source: Ballo, 2023

Short term loosers & winners

- Current and future cyclists and micro-mobility
- Current and future pedestrians
- Urban residents
- Future generations
- (Urban public transport users – fewer stops, more services & lines)
- Suburban in-commuters

- Urban car users
- Suburban car users
- (Urban consumers)

Which further questions arise ?

- Optimal one-way street networks
- Cost of reconstruction
- Today's ebike behaviour
  - Route choice models and non-chosen alternatives
- Future mode choice/demand
- Modelling schedule adjustment
- CO_2 – impacts and LCA forecasts
- Future accessibilities
- Equity impact

- Freight traffic deliveries
- Service delivery & retail structure
- Road safety

e-bike city team by subproject

E-Bike City PIs:

- K.W. Axhausen (C, H)
- M. Bierlaire (EPFL)
- F. Corman (B)
- A.Kouvelas (D)
- *M. Makridis* (D)
- M. Raubal (E)
- S. Hellweg (F)
- D. Kaufmann (G)
- B. Adey (I)

E-Bike City co-ordinator

- C.V. Livingston

E-Bike City researchers:

- L. Ballo (C, H)
- F. Fuchs (B)
- C.V. Livingston (C)
- M. Makridis (D)
- A.D. Marra (B)
- H. Martin (E)
- A.H.G. Meister (C)
- L. Meyer de Freitas (H)
- Y-C. Ni (D)
- J. Pougala (EPFL)
- S. Pfister (F)
- V. Schenker (F)
- J. Stephan (G)
- N. Wiedemann (E)
- M. Wiki (G)
- D. Zani (I)

Questions?

- www.ivt.ethz.ch
- ebikecity.baug.ethz.ch/
- ebis.ethz.ch/

Footnotes to slide 30

[1] ITF (2020) Good to go? Assessing the environmental performance of new mobility, International Transport Forum, Corporate Partnership Board, Paris.

[2] Cox, B., C.L. Mutel, C. Bauer, A. Mendoza Beltran and D.P. van Vuuren (2018) Uncertain environmental footprint of current and future battery electric vehicles, Environmental Science & Technology, 52 (8) 4989–4995. – middle of the expected range

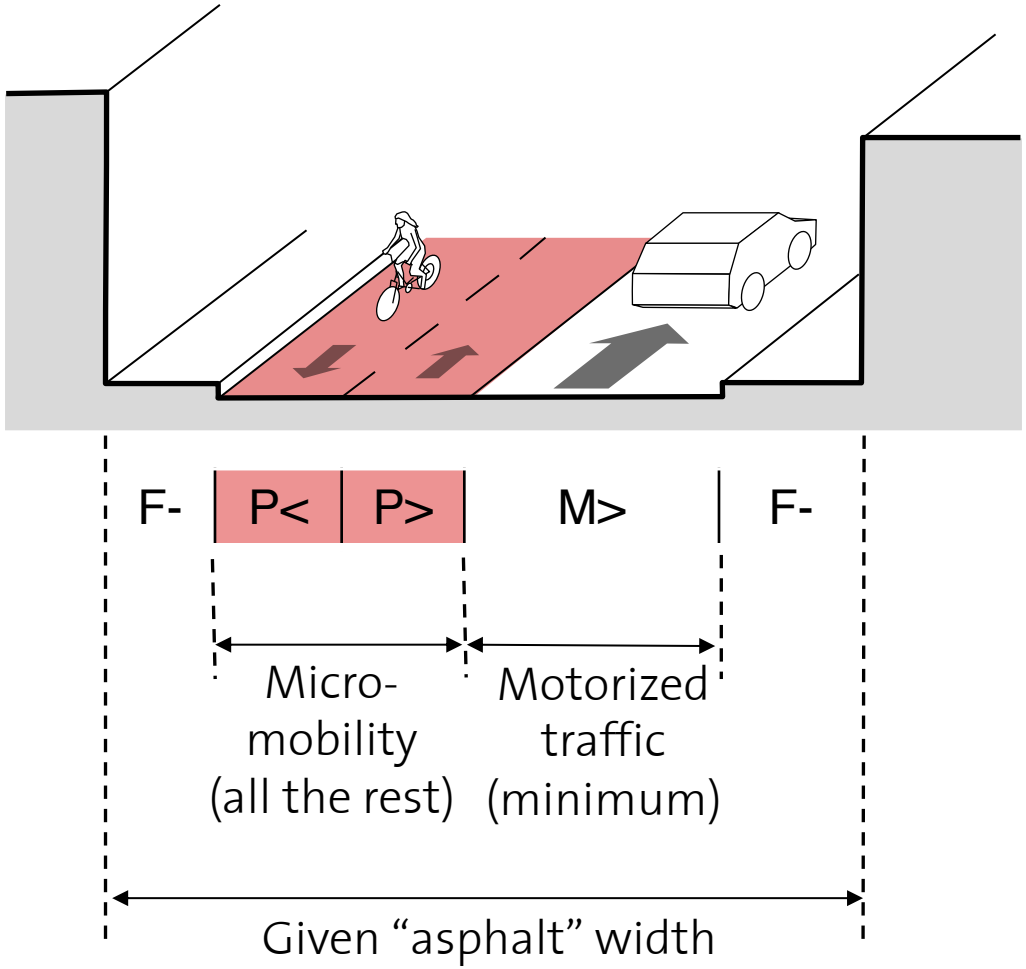
[3]UN (2019) World urbanization prospects: The 2018 revision, United Nations, Department of Economic and Social Affairs, Population Division, New York.

[4]Assumption due to growing wealth, better infrastructure and lower cost of batteries for future E-Cars: Schmidt, O., A. Hawkes, A. Gambhir and I. Staffell (2017) The future cost of electrical energy storage based on experience rates, Nature Energy, 2 (8) 17110.

[5]Assumption based on Bösch, P.M., F. Ciari and K.W. Axhausen (2018) Transport policy optimization with autonomous vehicles, Transportation Research Record: Journal of the Transportation Research Board, 2672 (8) 698–707.

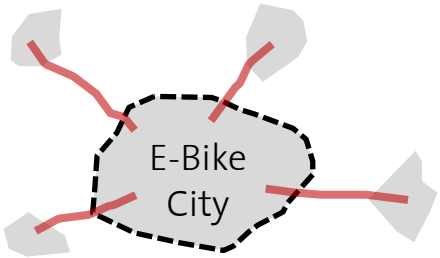
[6]IPCC (2022) Climate change 2022, mitigation of climate change, summary for policymakers, Intergovernmental Panel on Climate Change, Geneva.

The idea of an e-bike city: Design guidelines

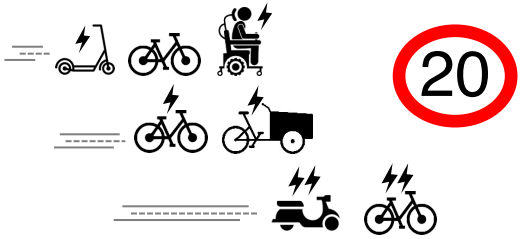


Which questions arise ?

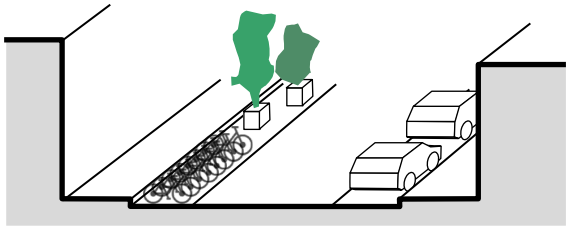
Special arrangements for emergency and utility vehicles



Intercommunal e-bike highways

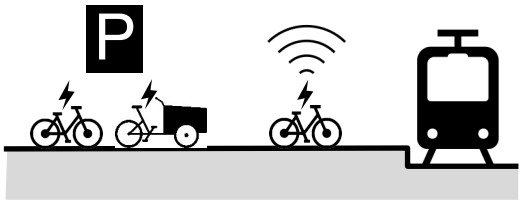


Infrastructure for heterogeneous micromobility vehicles and/or local speed limits

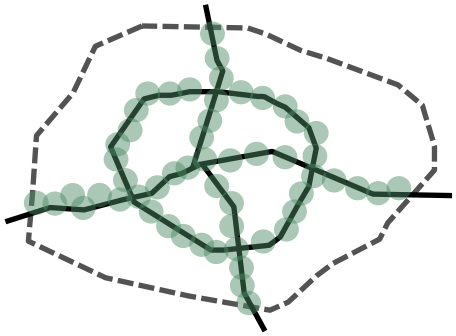


Converting a part of car parking into bicycle parking + parklets

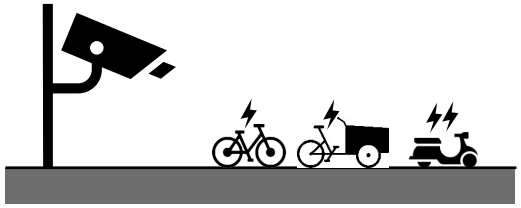
Which questions arise?



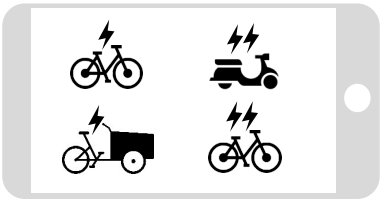
Integration with public transport for longer distances / bad weather



A basic cycling network with weather protection, e.g., by trees



Monitored parking for expensive e-bikes

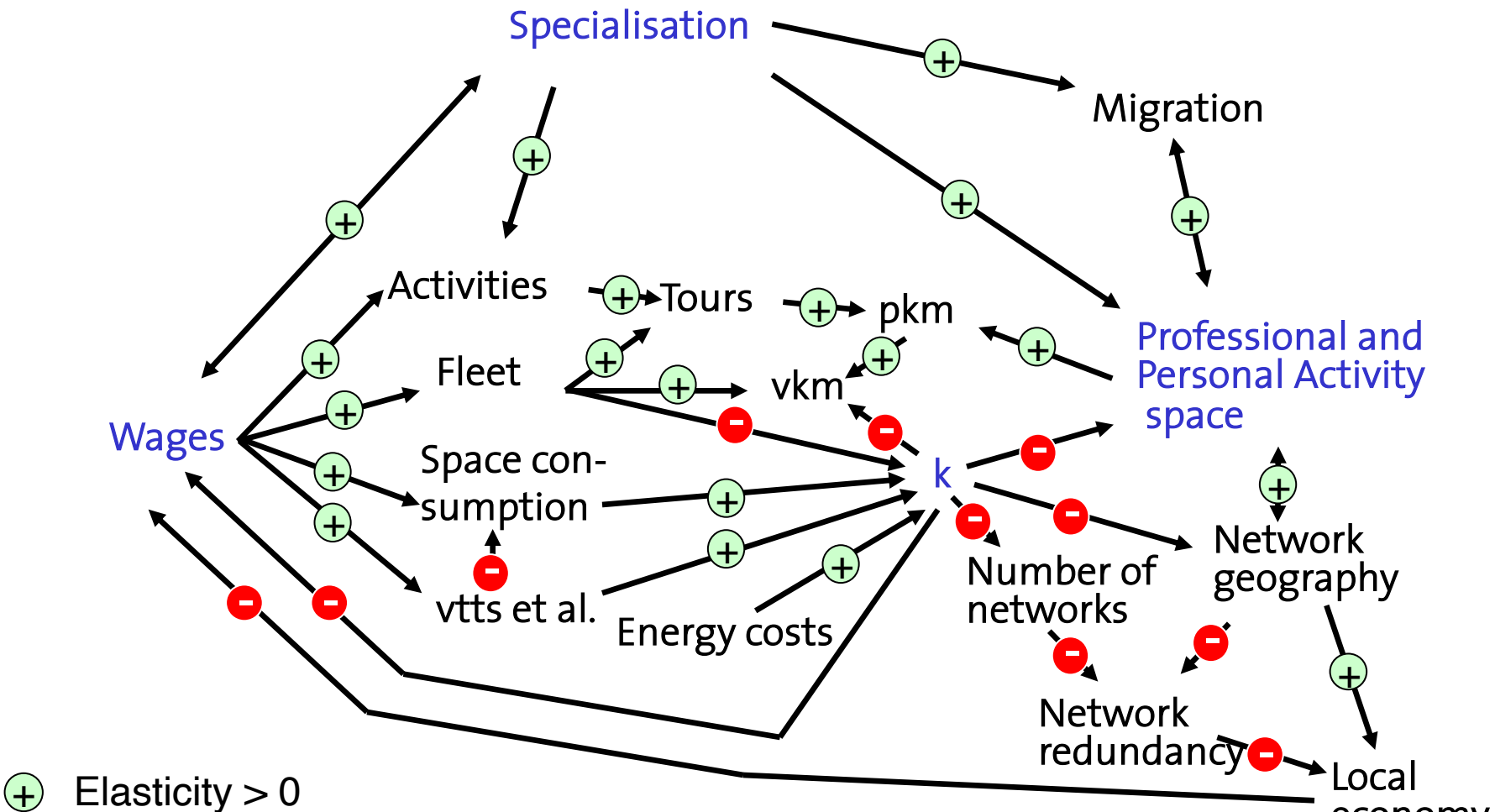


Sharing schemes provide everybody an access to the right vehicle

What tools and resources are available at ETH?

- Models
  - MATSim Switzerland (Zürich) (IVT)
  - National VISUM-based SBB model (SBB with EPFL support)
  - MFD-based approaches (Leclercq / Loder)
- Data
  - MOBIS & MOBIS/COVID (about 750k tracked days)
  - EBIS (about 300k+ tracked days)
  - TimeUse+ (about 36k tracked days and time budgets)

Conceptual model: Dynamic of activity space



Demand elasticities with respect to

Accessibility	Share of mobiles	0.61
	Number of trips	0.44
	Trips per hour	0.24
	Out-of-home time	0.10
	Total distance travelled	1.14
Transport price index	Share of mobiles	-0.06
	Number of trips	-0.19
	Trips per hour	-1.66
	Out-of-home time	-1.95
	Total distance travelled	-0.84

Source: Weis and Axhausen (2013)