



Smart Mobility Transition?

Prozesse und Konzepte eines digitalen
Wandels der Mobilität
Dr. Robert Schönduwe


11.06.2021, Berlin

[1]

Vorstellung und Ziele des Seminars

Vorstellung Dr. Robert Schönduwe

Arbeit im Spannungsfeld von Wissenschaft, Politik und Wirtschaft

 [linkedin.com/in/dr-robert-schoenduwe](https://www.linkedin.com/in/dr-robert-schoenduwe)

Politik



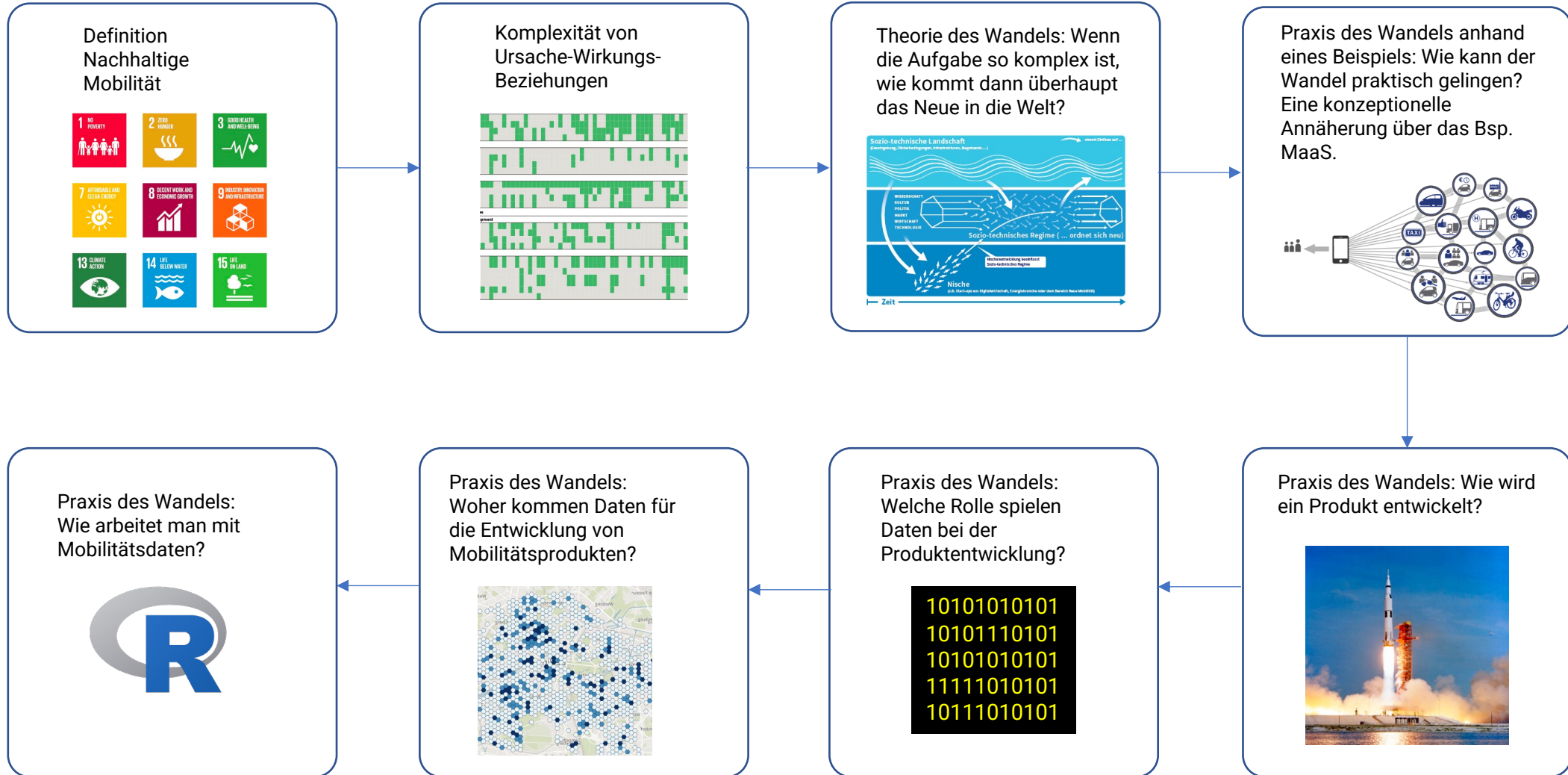
Wissenschaft



Wirtschaft

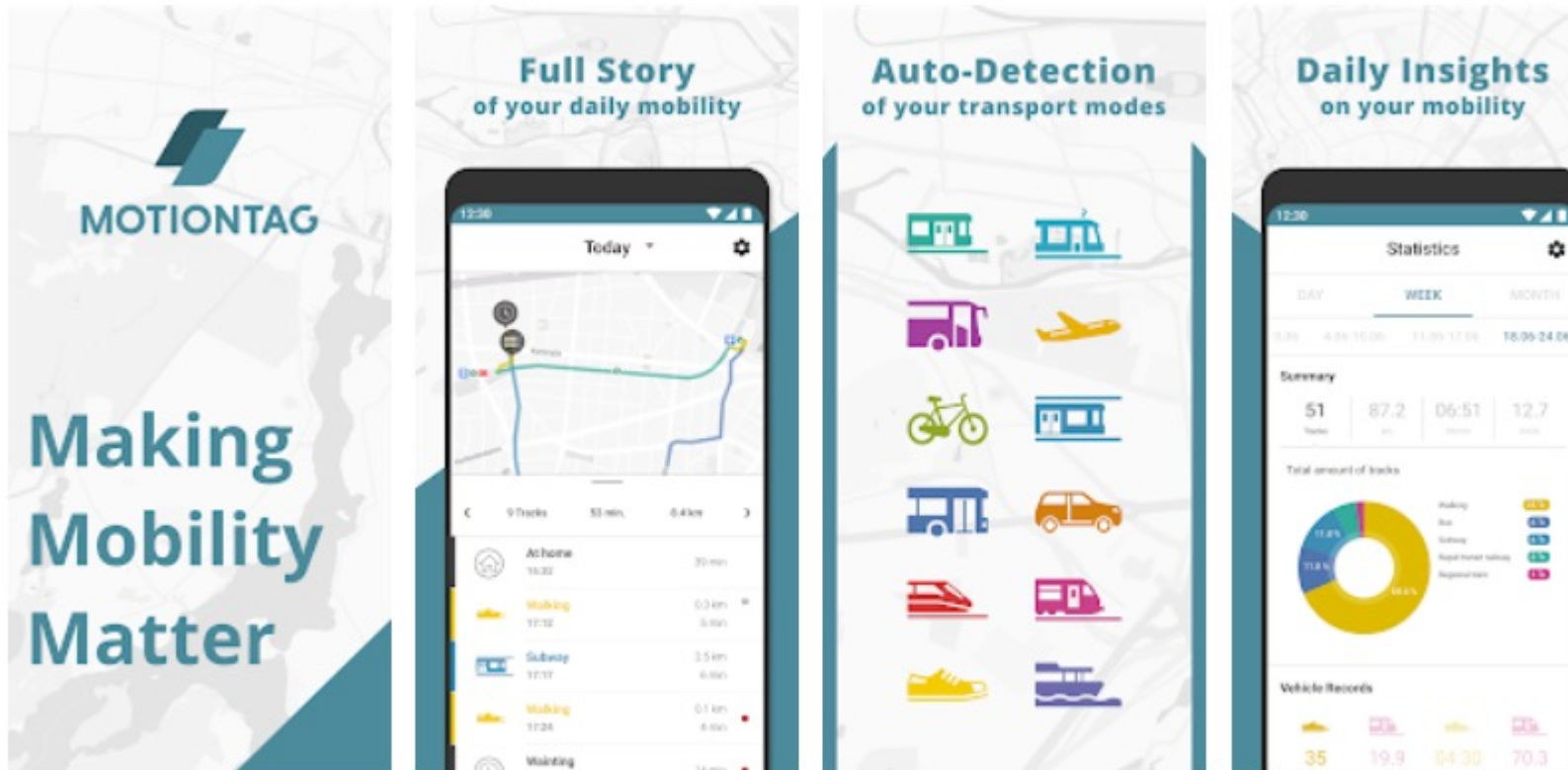


Vorstellung und Ziele des Seminars



Homework 1: Data collection for next lecture

Smartphone-based GPS tracking data



Download the MOTIONTAG-App from the store.
Use it for some days.

We will use the data in the next lecture on 18.06.2021



Bereitstellung der Daten über ein Auskunftsbegehren

Mail an: florian.duffner@motion-tag.com

Betreff: Auskunftsbegehren für das Seminar „Smart Mobility Transition?“

Lieber Herr Duffner,

Ich nutze die App MOTIONTAG. Hiermit möchte ich sie bitten, die aufgezeichneten Mobilitätsdaten für den Account meine@email.de bereitzustellen. Bitte senden Sie die Daten an schoenduwe@h2-mobility.de . Die Daten sollen im Rahmen des Seminars „Smart Mobility Transition?“ an der Goethe-Universität Frankfurt/Main genutzt werden.

Vielen Dank.

Beste Grüße

...

DSGVO 6.1 – Rechtmäßigkeit der Verarbeitung

1. Die Verarbeitung ist nur rechtmäßig, wenn **mindestens eine der nachstehenden Bedingungen** erfüllt ist:

a) Die betroffene Person hat ihre **Einwilligung** zu der Verarbeitung der sie betreffenden personenbezogenen Daten für einen oder mehrere bestimmte Zwecke gegeben;

b) die Verarbeitung ist **für die Erfüllung eines Vertrags**, dessen Vertragspartei die betroffene Person ist, oder zur **Durchführung vorvertraglicher Maßnahmen** erforderlich, die auf Antrag der betroffenen Person erfolgen;

c) die Verarbeitung ist **zur Erfüllung einer rechtlichen Verpflichtung erforderlich**, der der für die Verarbeitung Verantwortliche unterliegt;

d) die Verarbeitung ist erforderlich, **um lebenswichtige Interessen der betroffenen Person oder einer anderen natürlichen Person zu schützen**;

e) die Verarbeitung ist **für die Wahrnehmung einer Aufgabe erforderlich, die im öffentlichen Interesse liegt** oder **in Ausübung öffentlicher Gewalt** erfolgt, die dem für die Verarbeitung Verantwortlichen übertragen wurde;

f) die Verarbeitung ist zur **Wahrung der berechtigten Interessen des Verantwortlichen oder eines Dritten erforderlich**, sofern nicht die Interessen oder Grundrechte und Grundfreiheiten der betroffenen Person, die den Schutz personenbezogener Daten erfordern, überwiegen, insbesondere dann, wenn es sich bei der betroffenen Person um ein Kind handelt.

Unterabsatz 1 Buchstabe f gilt nicht für die von Behörden in Erfüllung ihrer Aufgaben vorgenommene Verarbeitung.

Homework 2

Install R and RStudio



Install the language and the interpreter R.

<https://cran.rstudio.com/>



The second step is to install the IDE

<https://rstudio.com/products/rstudio/download/#download>

[2]

Vorstellung der Seminarteilnehmer // Definition nachhaltiger Mobilität

Mural link

<https://app.mural.co/t/smartmobilitytransition5012/m/smartmobilitytransition5012/1622891749504/480f3b064cbb06f44836db8edd6062aae0d8880b?sender=u08687be2d228473203c05395>

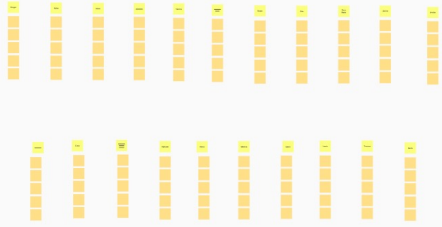
Definition nachhaltiger Mobilität

Facilitator All changes saved

1 1 Share

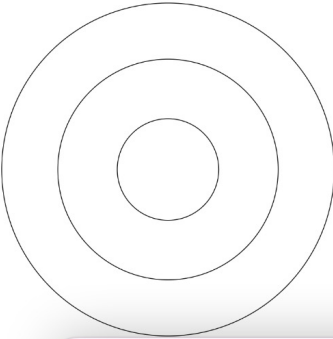
Smart Mobility

Was verbindet dich mit dem Begriff "Smart Mobility"?
Suche die Spalte mit deinem Namen, schreibe deine Gedanken auf die vorbereiteten Sticky Notes.
Die Zeit läuft noch und du hast noch weitere Ideen! Erstelle neue Sticky Notes und schreibe deine Ideen auf.




Verschiebe die Sticky Notes der Person rechts von deinem Namen auf das Smart Mobility Radar. Circle die Begriffe nach der von dir eingeschätzten Bedeutung. Wichtigste Begriffe kommen nach innen, weniger wichtige nach Außen.

Smart Mobility Radar



Gruppe 1

1. Diskutiert in der Gruppe zu welcher Kategorie die Trends zusammen sind und verschiebt die Karten auf das entsprechende Feld.
2. Benennt mindestens vier weitere Trends, die einen Erfolg des Markt-Konzepts fördern können, schreibt diese Trends auf ein Sticky Note und ordnet die Spalten den Kategorien zu.
3. Benennt eine Person in der Gruppe, die nach Ablauf der Zeit über Ergebnisse vorstellt.




Landscape

Regime

Niche

Gruppe 2

1. Diskutiert in der Gruppe zu welcher Kategorie die Trends zusammen sind und verschiebt die Karten auf das entsprechende Feld.
2. Benennt mindestens vier weitere Trends, die einen Erfolg des Markt-Konzepts fördern können, schreibt diese Trends auf ein Sticky Note und ordnet die Spalten den Kategorien zu.
3. Benennt eine Person in der Gruppe, die nach Ablauf der Zeit über Ergebnisse vorstellt.




Landscape

Regime

Niche

Gruppe 3

1. Diskutiert in der Gruppe zu welcher Kategorie die Trends zusammen sind und verschiebt die Karten auf das entsprechende Feld.
2. Benennt mindestens vier weitere Trends, die einen Erfolg des Markt-Konzepts fördern können, schreibt diese Trends auf ein Sticky Note und ordnet die Spalten den Kategorien zu.
3. Benennt eine Person in der Gruppe, die nach Ablauf der Zeit über Ergebnisse vorstellt.




Landscape

Regime

Niche

Gruppe 4

1. Diskutiert in der Gruppe zu welcher Kategorie die Trends zusammen sind und verschiebt die Karten auf das entsprechende Feld.
2. Benennt mindestens vier weitere Trends, die einen Erfolg des Markt-Konzepts fördern können, schreibt diese Trends auf ein Sticky Note und ordnet die Spalten den Kategorien zu.
3. Benennt eine Person in der Gruppe, die nach Ablauf der Zeit über Ergebnisse vorstellt.




Landscape

Regime

Niche

Gruppe 5

1. Diskutiert in der Gruppe zu welcher Kategorie die Trends zusammen sind und verschiebt die Karten auf das entsprechende Feld.
2. Benennt mindestens vier weitere Trends, die einen Erfolg des Markt-Konzepts fördern können, schreibt diese Trends auf ein Sticky Note und ordnet die Spalten den Kategorien zu.
3. Benennt eine Person in der Gruppe, die nach Ablauf der Zeit über Ergebnisse vorstellt.



Landscape

Regime

Niche

RS

Zoom Settings 11%

[3]

Definitionen und Charakteristika nachhaltiger Mobilität und die Bedeutung der IKT

Multitude of challenges connected to transport



How to provide

- The requested amount of mobility with the lowest level of harming people and environment: safety, emissions (air quality and noise)
- And ensure the requested mobility in terms of “access to opportunities” for all people (“accessibility” to education, work, care)
- Affordable mobility from both an individual and a societal point of view

Globally growing

- Electrification of infrastructures and means of transport
- Convergence of transport and information and communication technologies
- Digitalization of mobility
- New players, strategies, new services

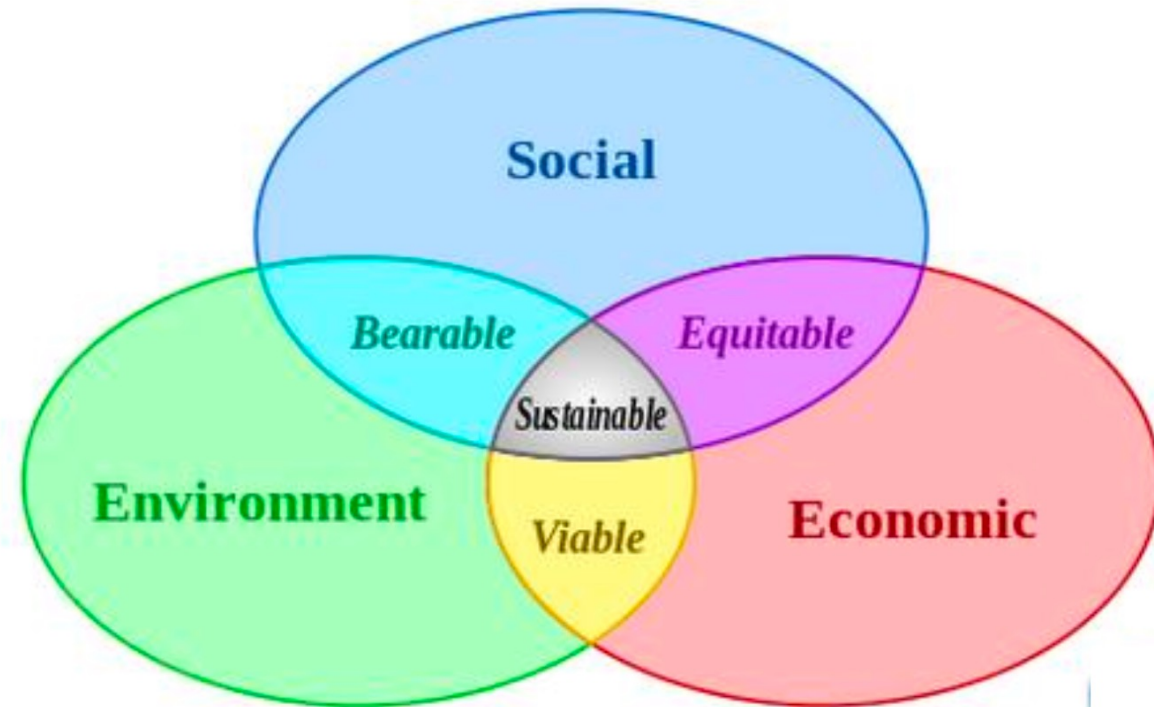
...radically changing the mobility industry

- **Shifting markets and revenues**
- **Fast diffusion of advanced and IT intense technology**
- **Changes in lifestyles and mobility behaviour**
- **New business models & mobility services**
- **New players & stakeholders,**
- **New competition and cooperation**

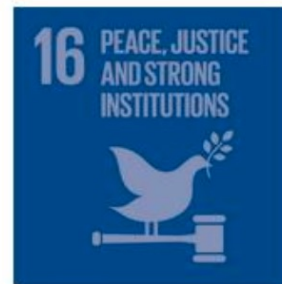
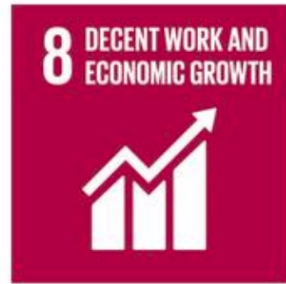
What does sustainability mean?

3 pillars:

- Societal and Social
- Environmental
- Economical

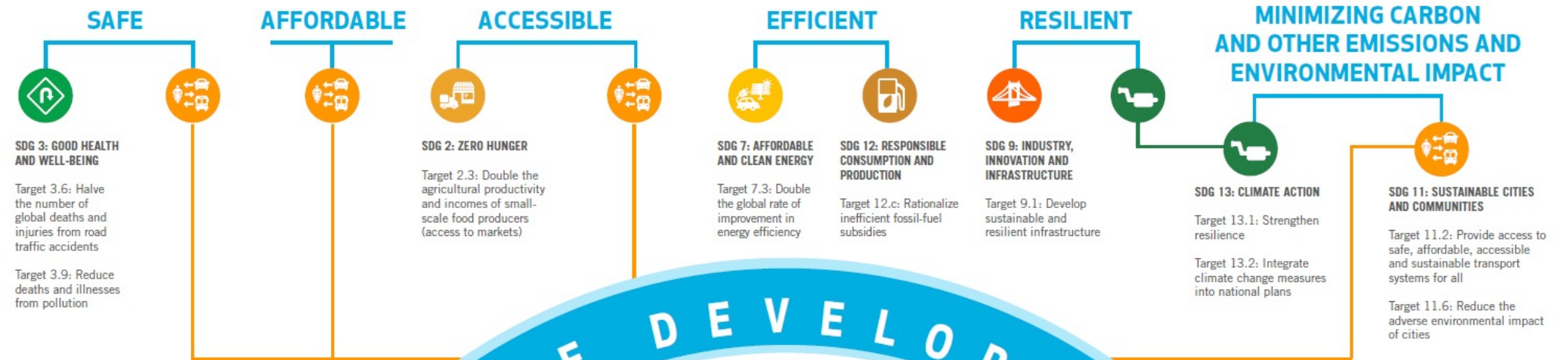


SDG // UN Sustainable Development Goals



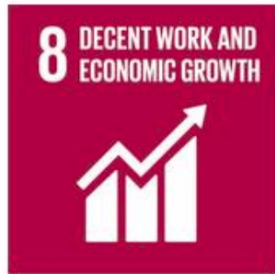
Direct transport targets of the sustainable development goals

SUSTAINABLE TRANSPORT IS:



Source: UN – 2016 - Mobilizing sustainable transport for development

SDG from a mobility perspective



SDGs related to mobility I



- Access to jobs
- Access to basic services



- Access to food
- Access for producers to markets

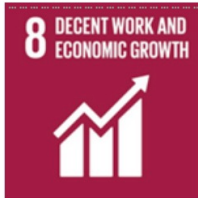


- By 2020, halve the number of global deaths and injuries from road traffic accidents

SDGs related to mobility II



- Access to opportunities independent from gender



- Access to decent work
- Access of producers to markets



- Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

SDGs related to mobility III



- By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

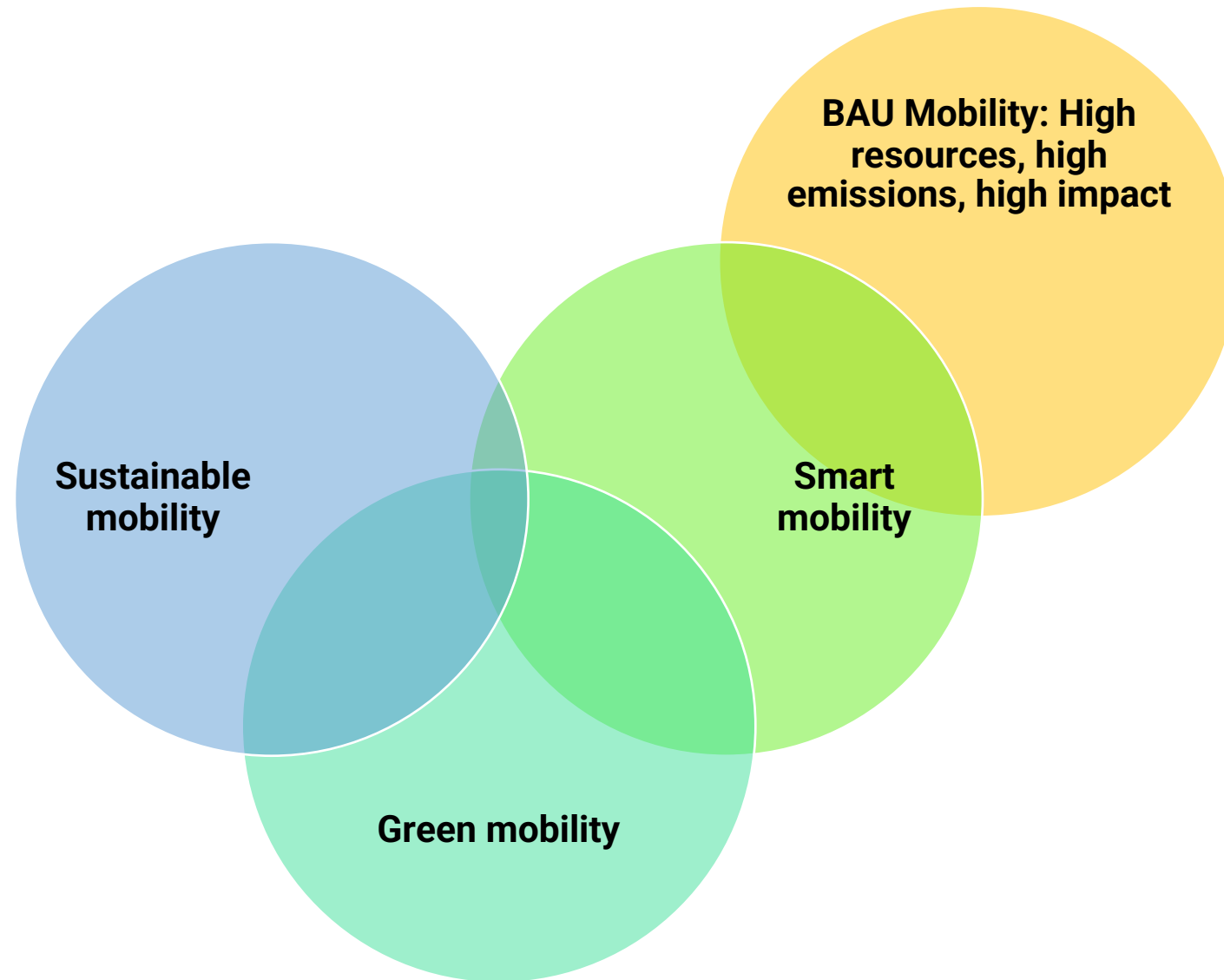


- By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses



- Integrate climate change measures into national policies, strategies and planning

**Goals have been set, but how are they to be achieved?
How does ICT help to provide sustainable mobility?**



Different sustainable mobility narratives

STRATEGY (What?)	AGENTS (Who?)		
	Leave it to the experts <i>(homo bureaucratís)</i>	Leave it to the people <i>(homo civitus)</i>	Leave it to the firms <i>(homo economicus)</i>
Efficiency (improve)	1. The green government	2. The green purchaser	3. The clean vehicles
Alteration (shift)	4. The public transport provider	5. The responsible traveller	6. The shared mobility schemes
Reduction (avoid)	7. The compact city	8. The essential life	9. The travelling electrons

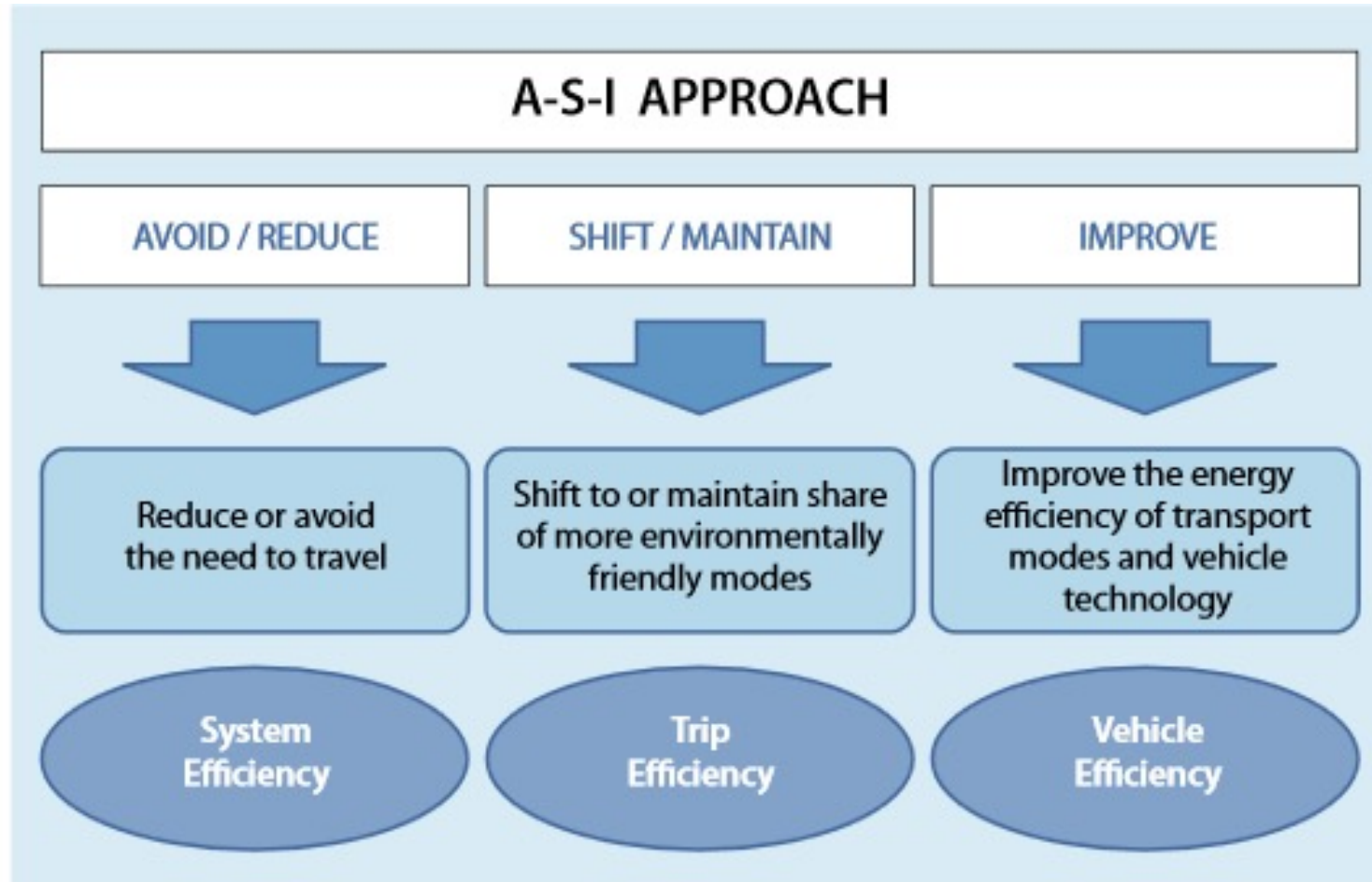
HOLDEN, ERLING, DAVID BANISTER, STEFAN GÖSSLING, GEOFFREY GILPIN, et al. (2020): Grand Narratives for sustainable mobility: A conceptual review. In: Energy Research & Social Science 65

[4]

Smart mobility transition I

Szenarien zum Wandel der Mobilität. Welche Optionen für einen Wandel gibt es und wie werden diese bewertet?

What are the policy tools to achieve sustainable mobility?



Evaluation of existing scenario and trend studies on decarbonisation in the transport sector



48 scenario studies: Detailed analysis of factors, models, indicators

Criteria:



2030 - 2100

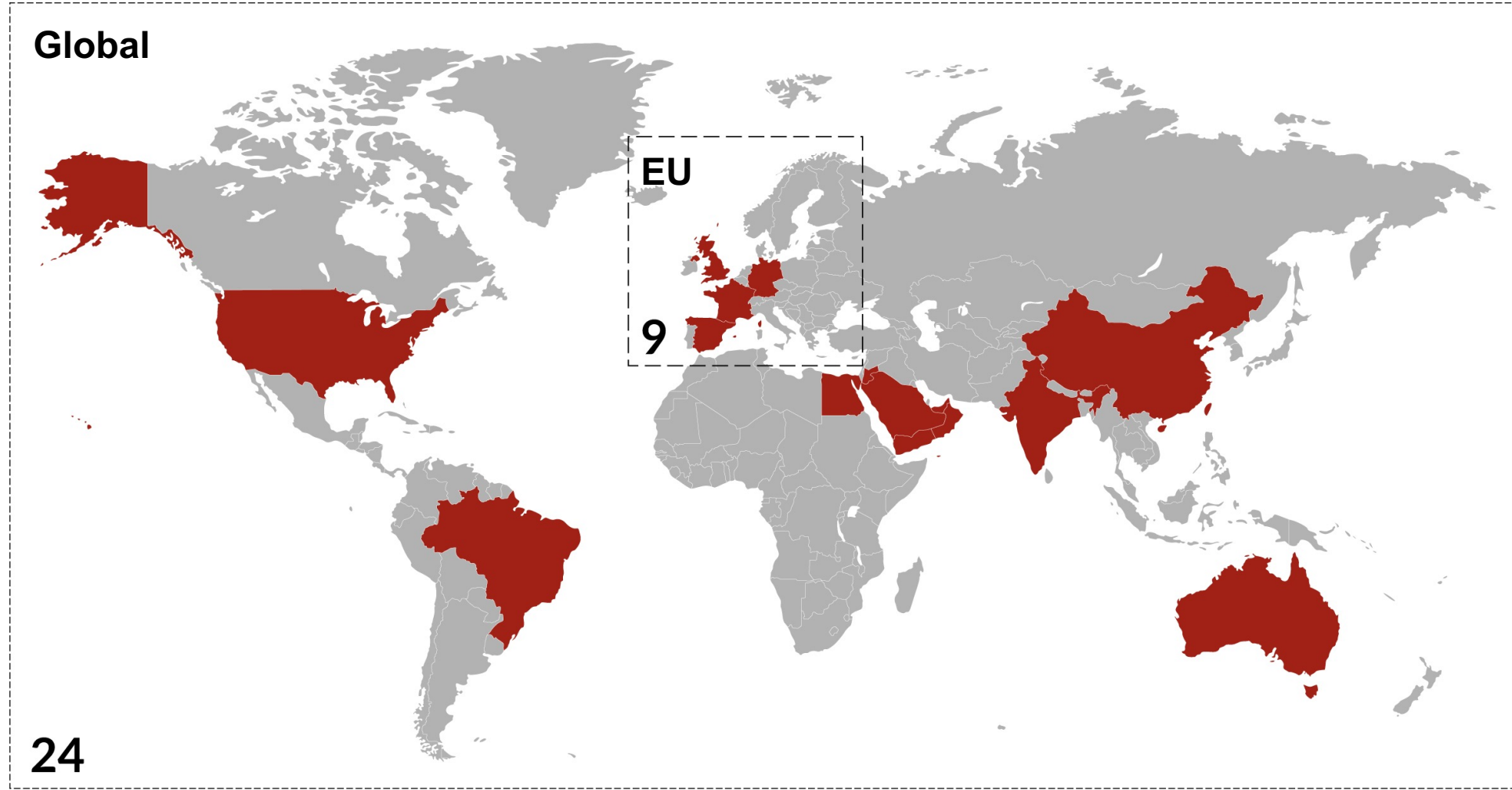


Only passenger transport



Decarbonisation is a topic, good documentation

Evaluation of existing scenario and trend studies on decarbonisation in the transport sector



Two-step review of transport scenarios: (1) Components of the scenarios: Model content and boundaries determine model output

A Spatial level

B Scenario type

C Type of model

- 1 Transport model
- 2 Energy- and emissions model

D Model complexity

E Model boundaries

- 1 Transport sector
- 2 Modes of transport
- 3 Traffic volumes
- 4 Emissions and environmental impact
- 5 Energy

F Modell components

- 1 Transport demand
- 2 Population
- 3 Economy
- 4 Accessibility and spatial structure
- 5 Transport supply
- 6 Energy
- 7 Policies

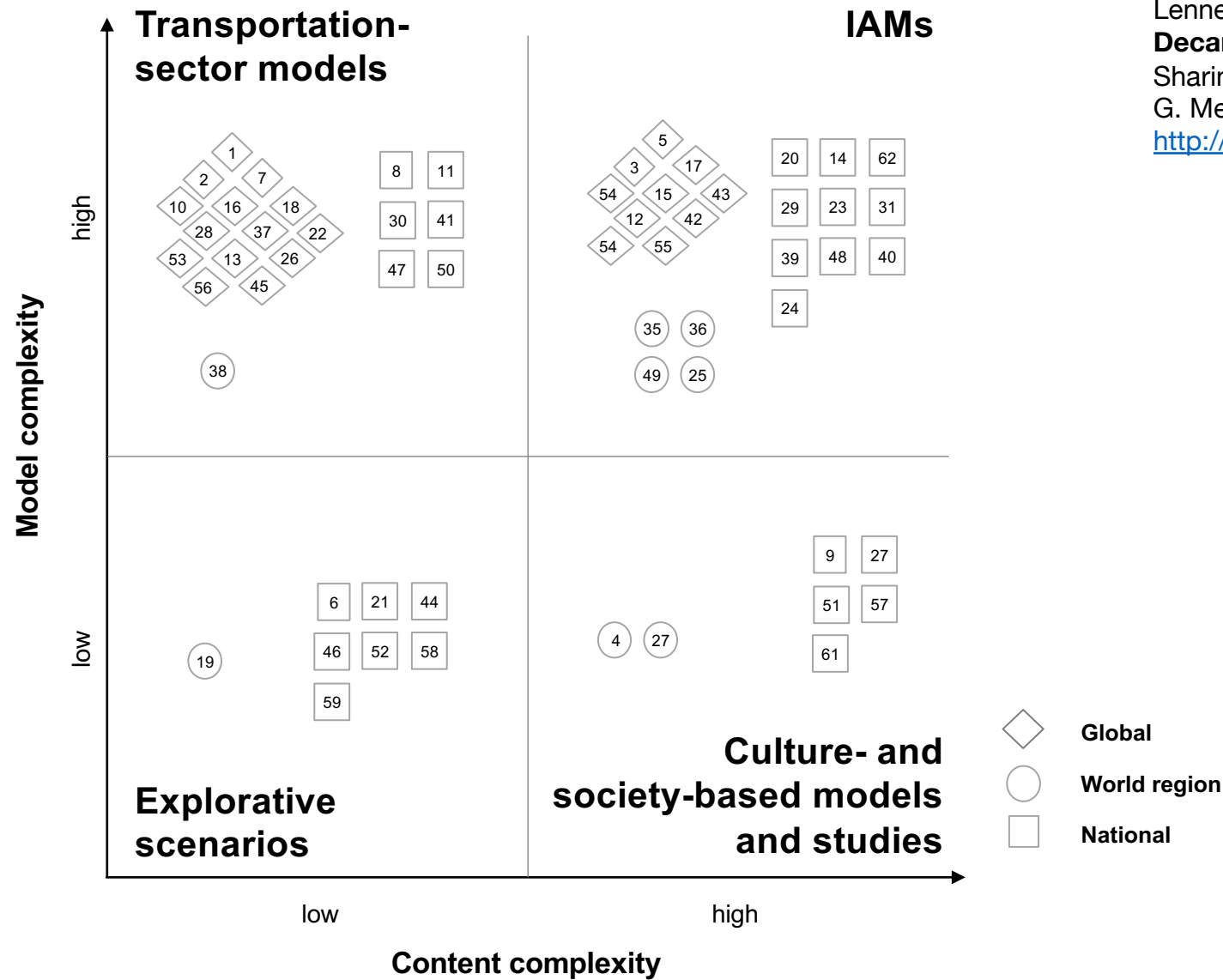
Typology of the scenarios:

Four types with different ontological and paradigmatic backgrounds

Type	Approach	Scope	Method	Solution space
1 Integrated assessment models (IAMs)	Deductive	Global, cross-sector	Cross-sectoral, econometric equilibrium models	Fuel shift, technological options
2 Transportation-sector models	Deductive/inductive	National / world regions, transport sector	Transport sector-specific econometric models	Efficiency, technological options
3 Culture- and society-based models and studies	Inductive	National / regional, transport sector, society	Backcasting, qualitative methods	Infrastructure and behavior, demand side solutions
4 Explorative studies	Inductive	National / regional, transport sector, society	Qualitative, explorative methods	Infrastructure and behavior, demand side solutions

*Based on
Creutzig (2015)*

Typology of the scenarios considered



Lennert, F. & R. Schönduwe (2017): **Disrupting Mobility: Decarbonising Transport?** In: *Disrupting Mobility: Impacts of Sharing Economy and Innovative Transportation on Cities*, edited by G. Meyer and S. Shaheen. Springer International Publishing 2017
http://dx.doi.org/10.1007/978-3-319-51602-8_14

Levers for change: Factors considered in the scenarios: 114 factors, categorized by six topics

- A** **Society**
- B** **Technology**
- C** **Energy and resources**
- D** **Spatial development
and infrastructures**
- E** **Transport and mobility**
- F** **Economy and policies**



(A) People and society-related factors

	Type ¹	1	2	3	4
People and Society	Total (n)	20	28	6	6
Population and demographics	Index²	1,6	1,3	1,5	1,7
Population dynamics	n	10	17	2	3
Age distribution		10	9	3	4
Stage of life		1	2	1	0
Cross-border migration		2	5	2	1
Household structure		8	3	1	2
Attitudes, values and lifestyles	Index	0,5	0,8	2,8	2,3
Change of behavioural and lifestyle patterns in general	n	6	6	4	4
Social acceleration and deceleration		0	1	2	1
Individualisation		1	1	2	2
Social polarisation		1	4	2	2
Environmental awareness		1	5	2	2
Attitudes towards new technologies and „digital lifestyles“		0	4	4	3
Data protection and privacy		0	1	1	0
Cultural aspects of travel	Index	0,5	0,3	0,5	0,8
Car ownership and status	n	4	6	1	4
Quality of service		5	1	2	0
Mobility styles		1	0	0	1

- 1 - IAMs
- 2 - Transportation-sector models
- 3 - Culture- and society-based models and studies
- 4 - Explorative Studies

Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

(B) Technology-related factors 1: Vehicle technologies

Technology	Type ¹	1	2	3	4
	Total (n)	20	28	6	6
Vehicle technologies	Index ²	2,8	1,8	2,5	2,3
Propulsion systems	n	16	17	4	4
Alternative fuels		15	13	4	4
Automation in road transport		2	3	1	1
Automation in rail transport		1	1	0	1
Battery technologies		6	6	1	1
Recuperation and waste heat recovery		3	1	0	0
Microcars and lightweight materials		4	5	1	0
Aviation innovation		4	4	3	2
Rail innovation (HSR, Maglev, Hyperloop)		4	1	1	1

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(B) Technology-related factors 2: ITS and connected infrastructures and connected travel

Technology	Type ¹	1	2	3	4
	Total (n)	20	28	6	6
Connected infrastructures and connected travel	Index²	0,6	0,6	1,7	1,3
Cyber-Physical-Systems / Internet of things	n	1	1	2	1
Connected car (C2C, C2X)		3	2	1	2
Platooning		1	3	1	0
Connected Infrastructure (X2X)		3	3	1	2
Intermodal connections		4	3	3	2
Global navigation satellite systems		0	2	1	1
Standardised data formats and Open data		0	2	1	0
Intelligent Transportation Systems (ITS)	Index	1,9	1,4	2,7	2,5
Traffic management centre	n	5	5	2	4
Demand responsive traffic management		6	5	2	3

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(B) Technology-related factors 3: Logistics, Services and production sector technologies

	Type ¹	1	2	3	4
Technology	Total (n)	20	28	6	6
Logistics	Index				
Freight modal split	n	11	13	2	2
Intelligent freight traffic management		3	5	4	3
Intelligent and flexible load carriers		2	4	1	0
Urban goods distribution centres		5	2	1	3
Reduced shipment size		1	3	1	0
New carriers (e.g. Cargolifter, drones)		1	1	1	0
Cargo bike		0	1	1	0
Reverse logistics		4	1	1	0
Services (based on real time information)	Index	0,3	0,3	0,8	0,2
Location-Based-Services and augmented reality	n	0	0	1	0
Traffic incident management		1	1	1	0
Mobility-as-a-Service (MaaS)		3	4	1	0
Seamless access, e-tickets		1	2	2	1
Production sector technologies	Index	0,1	0,0	0,2	0,0
3D printing		1	1	0	0
Robotics		0	0	1	0

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Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

(B) Technology-related factors 4: Disruptive innovations and events

	Type ¹	1	2	3	4
Technology	Total (n)	20	28	6	6
Disruptive innovations and events	Index	0,1	0,1	0,2	1,0
eHighway		1	1	1	0
Radical concepts and technologies for aviation		0	0	0	1
Hoverboards		0	0	0	1
Radical concepts and technologies for shipping		0	0	0	1
Radical concepts for replacing travel		0	0	0	1
Environmental disruptions		1	3	0	2

Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

- 1 - IAMs
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(C) Factors related to energy and resources

	Type ¹	1	2	3	4
Energy and resources	Total (n)	20	28	6	6
Energy supply	Index²	3,2	2,4	2,0	1,2
Renewable energy: Solar	n	14	12	2	1
Renewable energy: Wind		14	12	2	1
Renewable energy: Other		13	11	3	2
Increasing energy efficiency		14	8	1	1
Electric vehicles and the electricity market		3	6	1	1
Power grids		4	9	2	0
Energy storage		2	8	1	1
Fossil resources and emissions	Index	0,7	0,6	0,8	0,5
Resource scarcity	n	4	6	3	1
Carbon Capture and Storage / Carbon sequestration (CCS)		10	11	2	2

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Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

(D) Factors related to spatial development and infrastructures

Spatial development and infrastructures					
Spatial inequalities and regional development	Index	0,3	0,3	0,8	0,2
Urbanisation	n	0	0	1	0
Reurbanisation		1	1	1	0
Land use patterns		3	4	1	0
Urban sprawl		1	2	2	1
(Transport) infrastructures	Index	1,0	0,8	1,3	1,2
(selective) Expansion of (transport) infrastructures		10	10	3	3
Maintenance requirements		0	3	1	0
Expansion of new specialized infrastructures		5	3	1	2
Congested transport infrastructures		4	3	3	2
Shared space		1	2	0	0
Climate change	Index	0,3	0,4	0,5	0,5
Increase of environmental disasters		1	6	1	1
Local air pollution		2	3	2	2
Temperature changes		3	1	0	0

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Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

(E) Transport and mobility-related factors

	Type ¹	1	2	3	4
Transport and mobility	Total (n)	20	28	6	6
Transport demand	Index²	1,5	1,1	1,7	1,7
Distances travelled	n	15	19	4	3
Long-distance travel		4	4	2	3
Leisure travel		4	1	2	2
Inter- and multimodality		4	5	2	1
Influences of political situation on tourism		2	1	0	1
Vehicle supply	Index	1,7	1,6	1,2	1,5
New vehicle registrations	n	8	12	1	2
Vehicle stock		10	16	1	2
Public transport		10	10	3	2
Cycling and Pedelecs		5	7	2	3
Sharing	Index	0,5	0,3	1,0	0,7
Bikesharing	n	2	2	1	1
Carsharing		4	4	3	2
Ridesharing		2	1	2	1
Rideselling		2	0	0	0
Mobility costs	Index	1,9	1,1	1,3	1,7
Oil price and price of gas		16	19	3	4
Energy costs		7	3	1	1
Individual mobility budget		8	7	2	3
Individual mobility time budget		6	3	2	2

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Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

(F) Factors related to the economy and policies 1: Political framework and work environment

	Type ¹	1	2	3	4
Economy and politics	Total (n)	20	28	6	6
Political framework	Index²	1,5	1,3	2,8	2,0
Liberalisation and privatisation	n	4	2	2	1
Legal regulations		4	6	2	0
Global trade policies		4	4	2	2
Global co-operation		5	7	3	1
Shift of economic centers of powers		1	7	0	1
Alternative financial market models		1	1	1	0
Governance structures / Transport policy competences		2	3	3	1
Carbon pricing		8	4	3	4
Shop opening hours		0	1	1	2
Work environment	Index	0,6	0,4	2,0	1,5
New employment models	n	0	2	3	2
Employment rate		5	2	3	2
Increasing degree of automatisisation		0	2	1	0
Flexibilisation of the labour market		1	2	2	2
Telework, telemeetings		6	2	3	3

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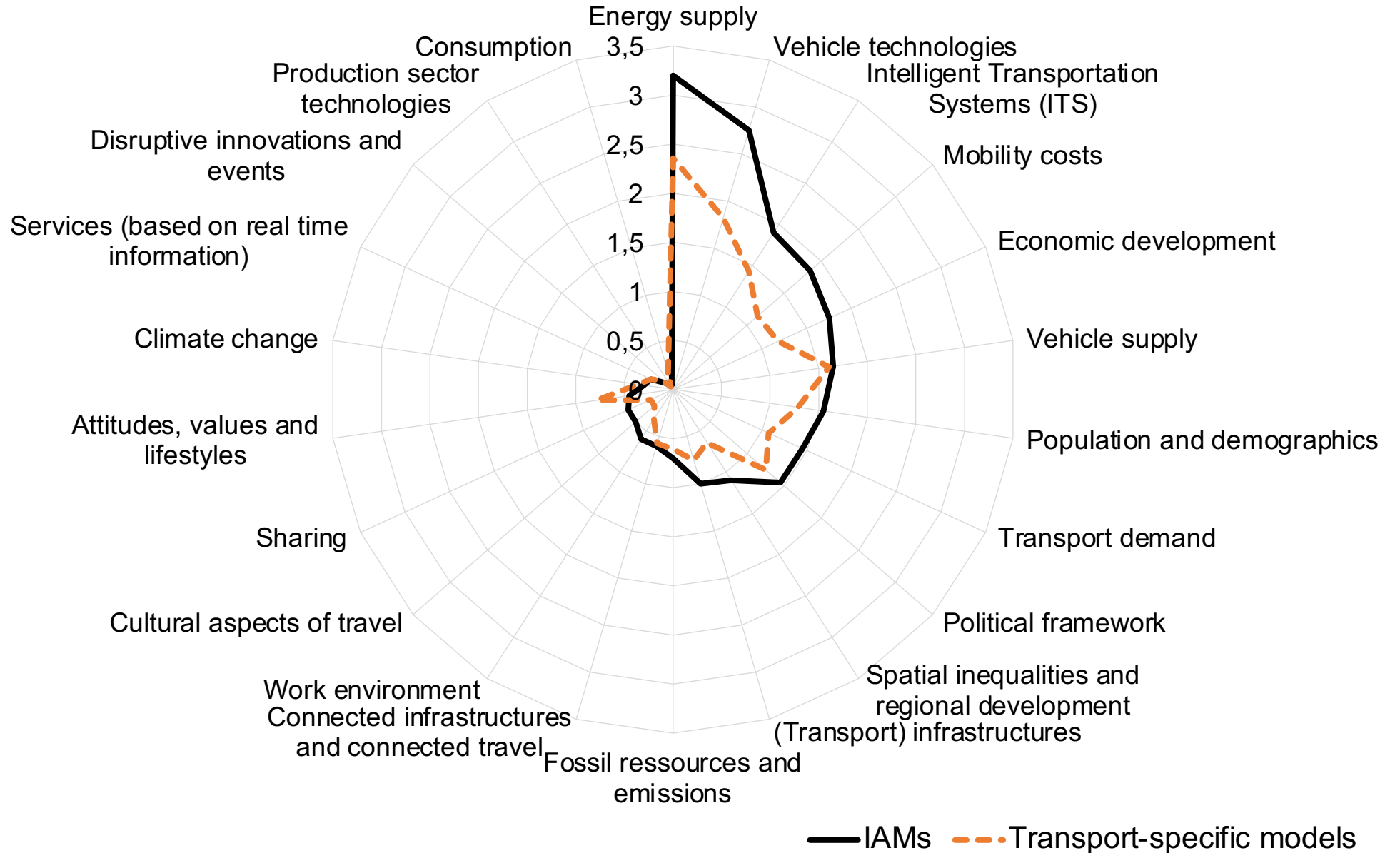
(F) Factors related to the economy and policies 2: Consumption and economic development

	Type ¹	1	2	3	4
Economy and politics	Total (n)	20	28	6	6
Consumption	Index	0,1	0,2	1,0	0,7
Local added value	n	1	1	2	2
Rise of the prosumer		0	1	0	0
Shareconomy		0	2	2	1
e-Commerce		0	1	2	1
Economic development	Index	1,8	1,2	2,2	2,0
Gross domestic product (GDP)		17	17	3	3
Alternative economic models		0	1	1	1
Income distribution		6	2	2	2
Globalisation		7	4	4	4
Global freight transport costs		5	9	3	2

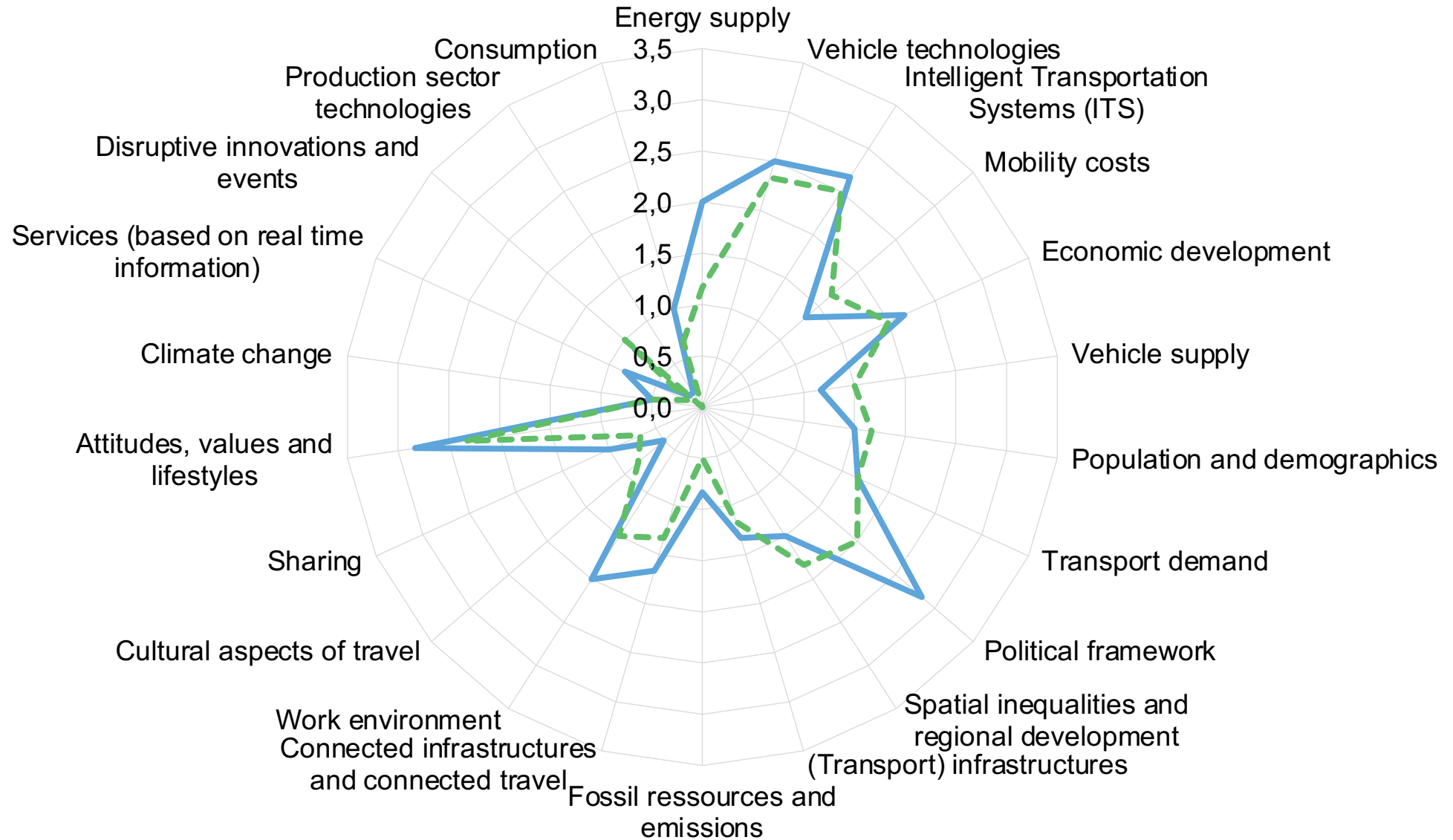
- 1 - IAMs
- 2 - Transportation-sector models
- 3 - Culture- and society-based models and studies
- 4 - Explorative Studies

Index computed as scenario-type specific sum of factors mentioned divided by total number of studies; highest value marked green

IAMs and Transportation-sector models with narrow focus on quantifiable factors



Society-oriented and explorative models with wider range of factors (but often not quantified)



— Culture- and society-based models - - - Explorative scenarios

Sometimes, it is just a bucket a paint and someone who does something



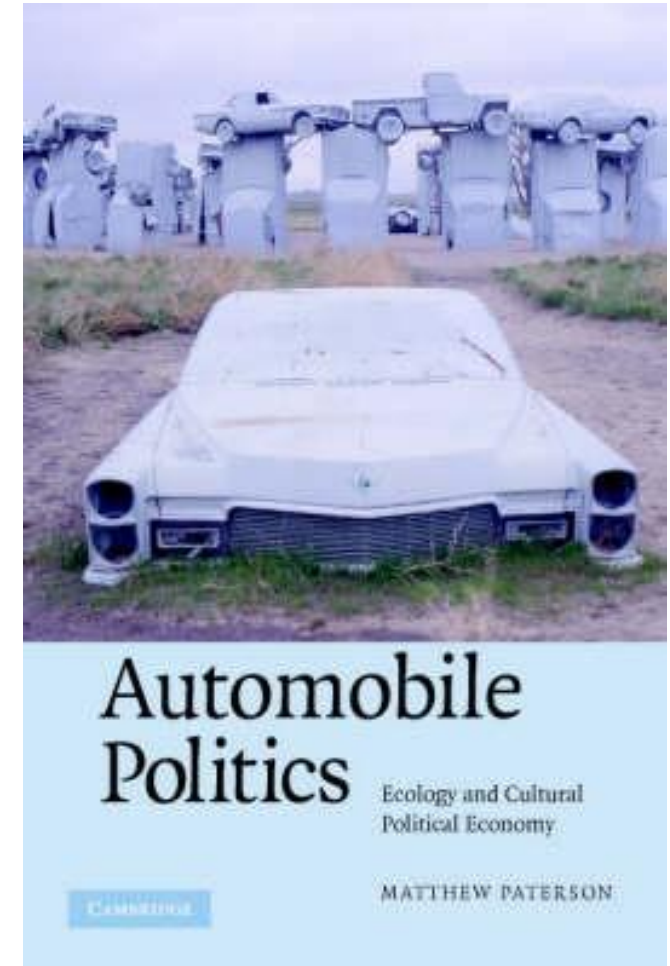
[6]

Smart mobility transition II

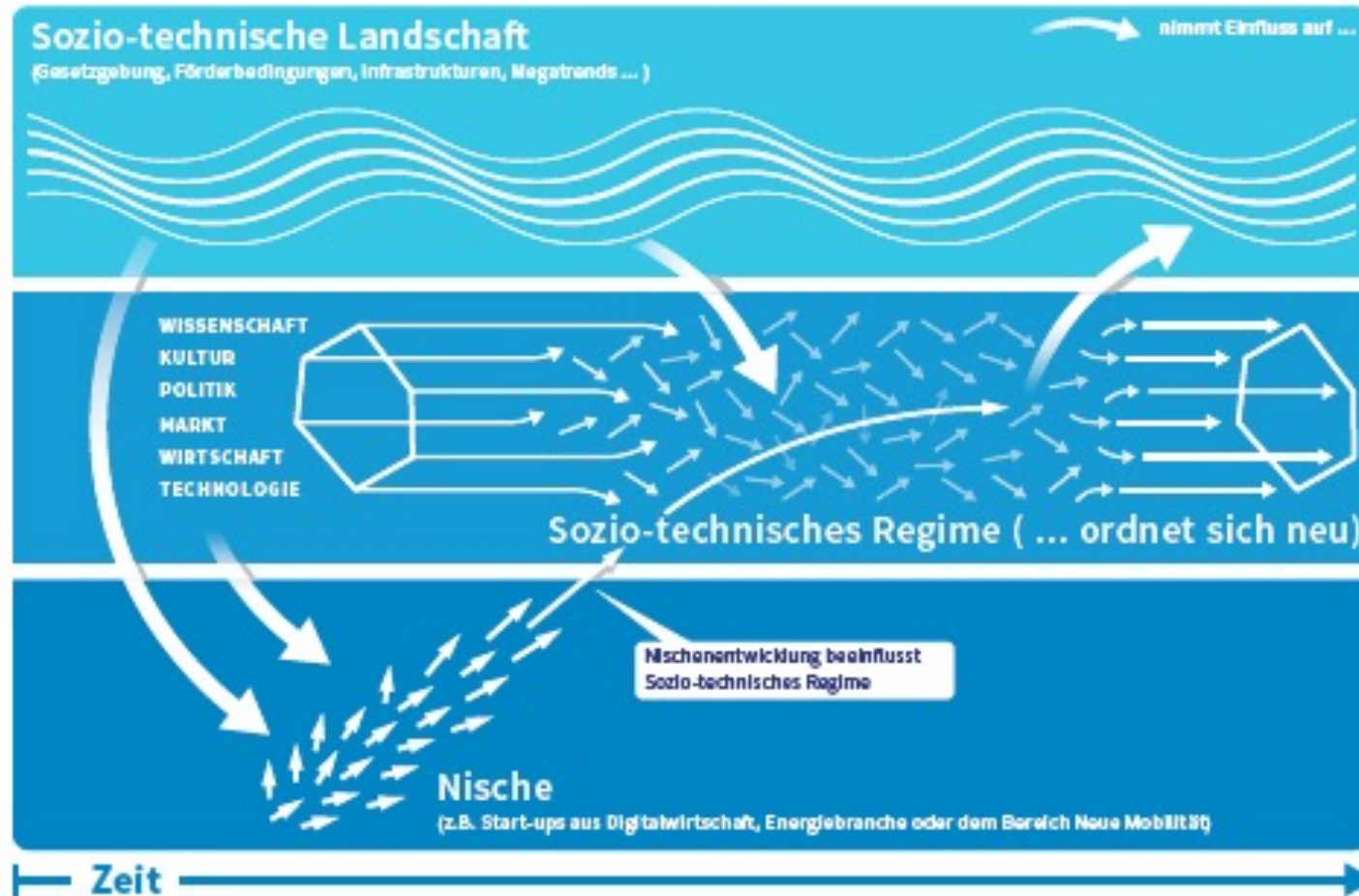
Von der Theorie zur praktischen Umsetzung. Wie kommt das neue in die Mobilitätswelt?

How can we achieve a transition towards sustainability in transport?

- This will not just be a technical transition but a socio-technical transition
- Mobility and transport are shaped by society!
- Mobility cultures are embedded in wider cultural framework
- Political decisions shape how transport develops



From Geels theoretical ML perspective to a practice oriented, implementation perspective



Geels, Frank W. & Johan Schot (2007): Typology of sociotechnical transition pathways. In: *Research Policy* 36 (3), S. 399-417.

Niche, regime and landscape

Landscape (Macro level)

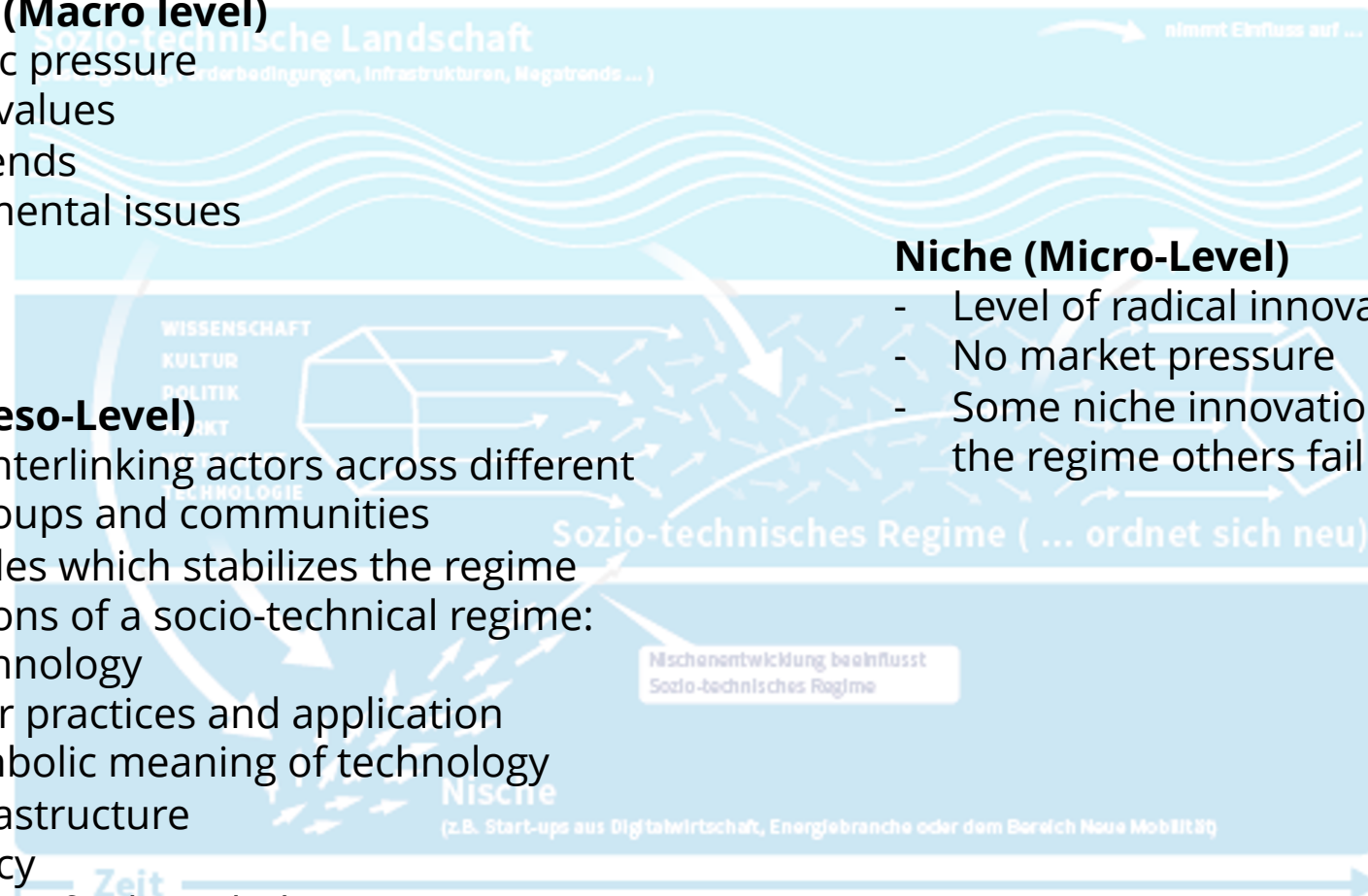
- Economic pressure
- Cultural values
- Social trends
- Environmental issues

Regime (Meso-Level)

- Web of interlinking actors across different social groups and communities
- Set of rules which stabilizes the regime
- Dimensions of a socio-technical regime:
 - Technology
 - User practices and application
 - Symbolic meaning of technology
 - Infrastructure
 - Policy
 - (scientific) knowledge

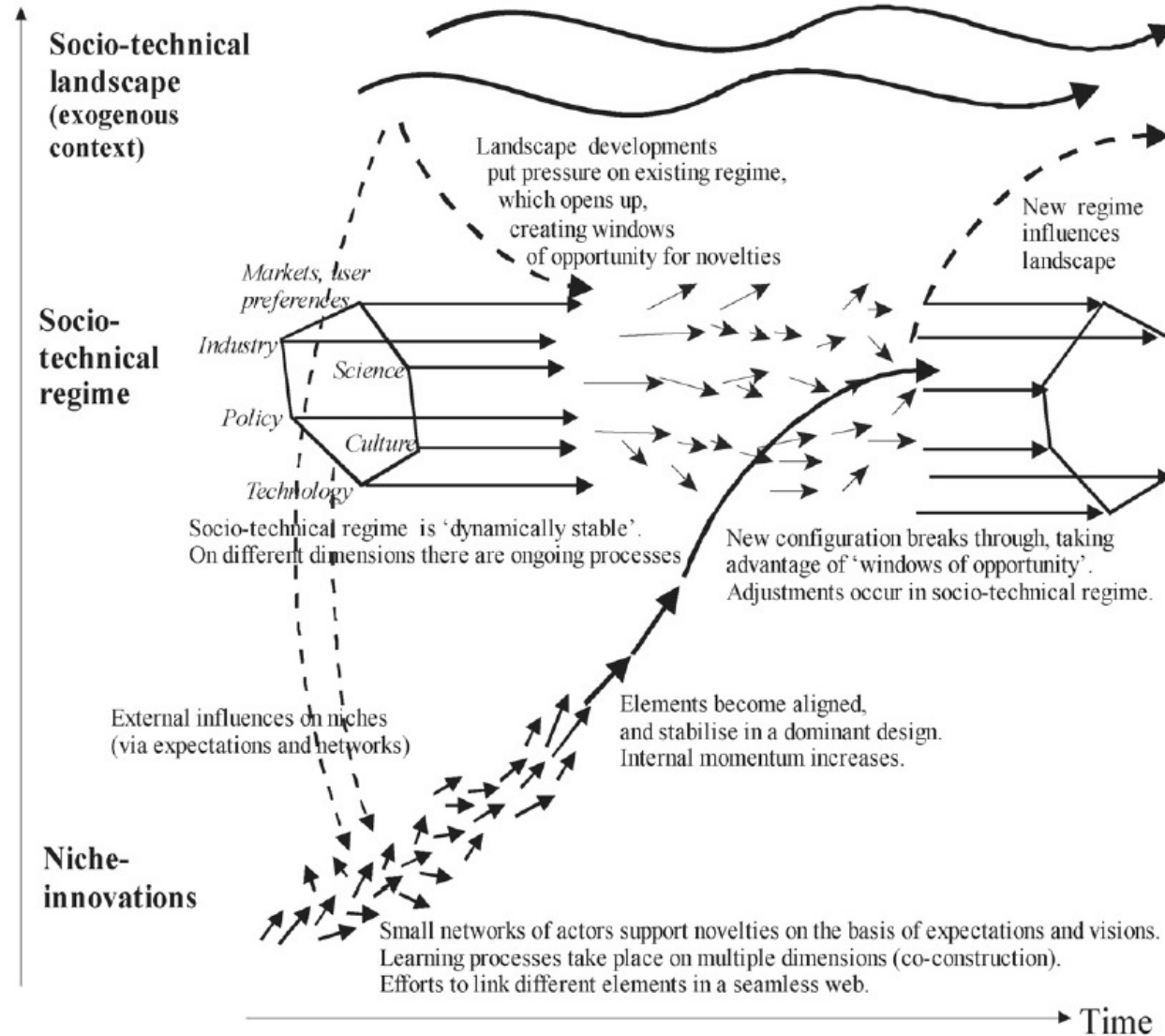
Niche (Micro-Level)

- Level of radical innovations
- No market pressure
- Some niche innovations will challenge the regime others fail

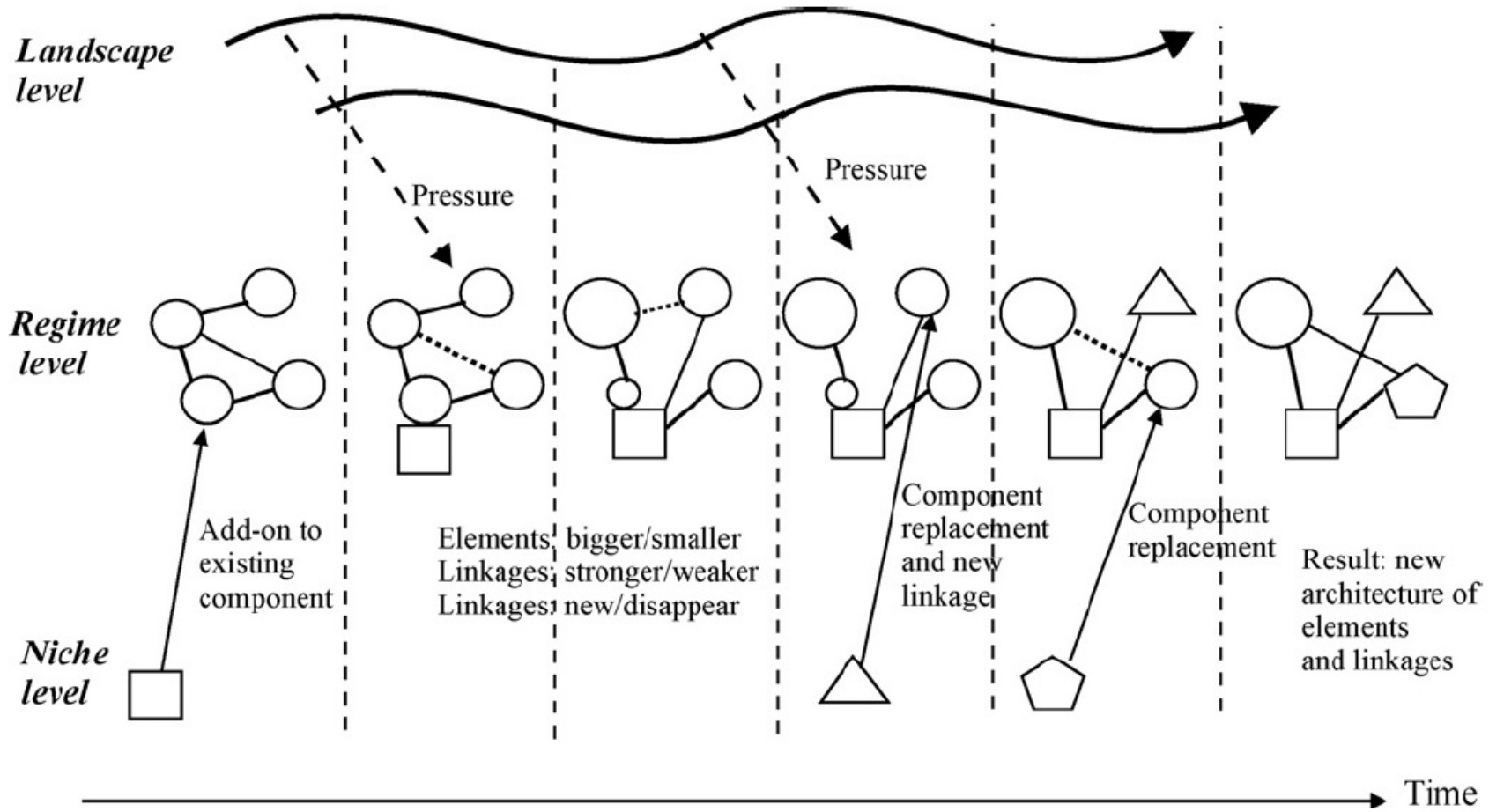


Multilevel perspective on transition

Increasing structuration of activities in local practices

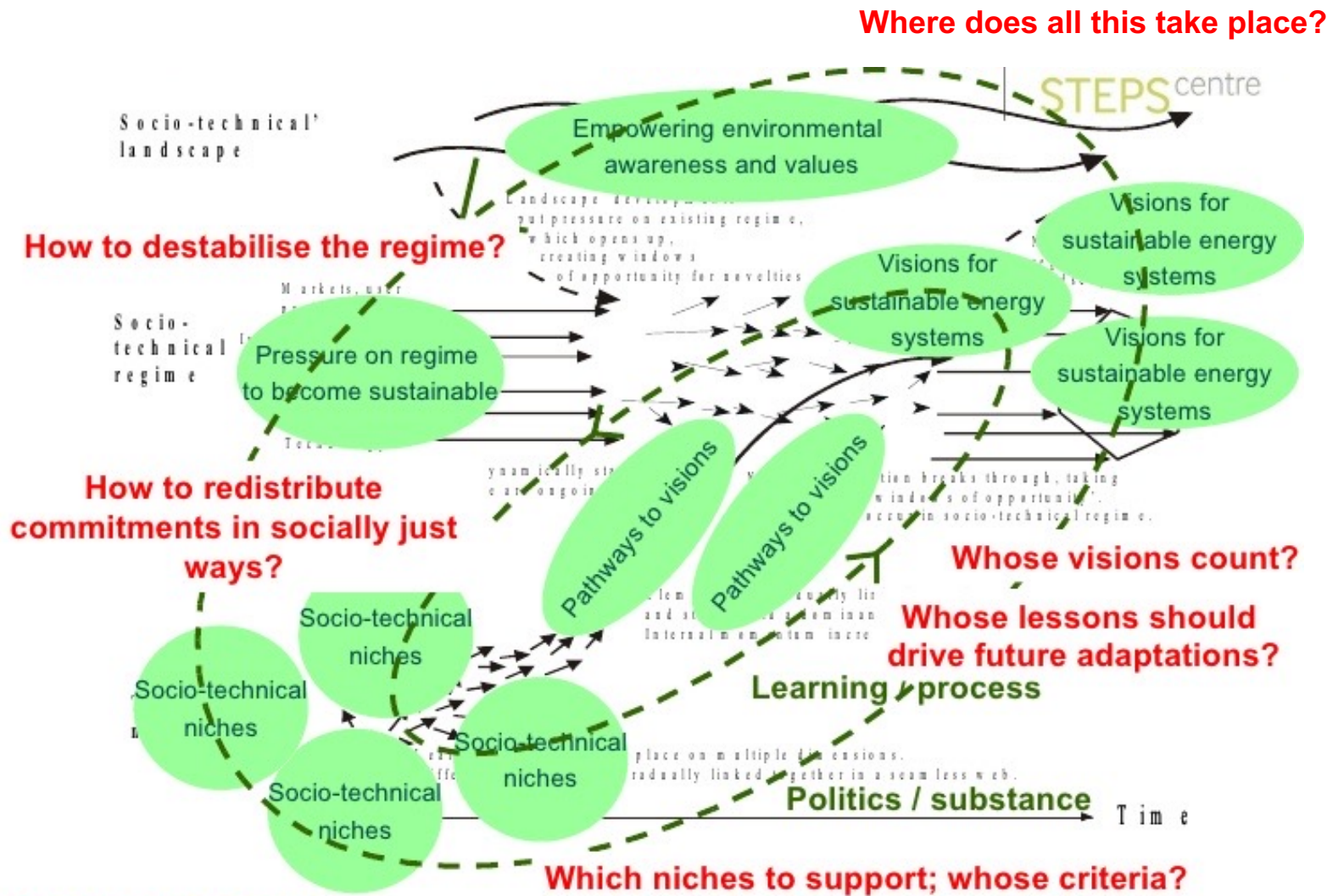


Reconfiguration pathway



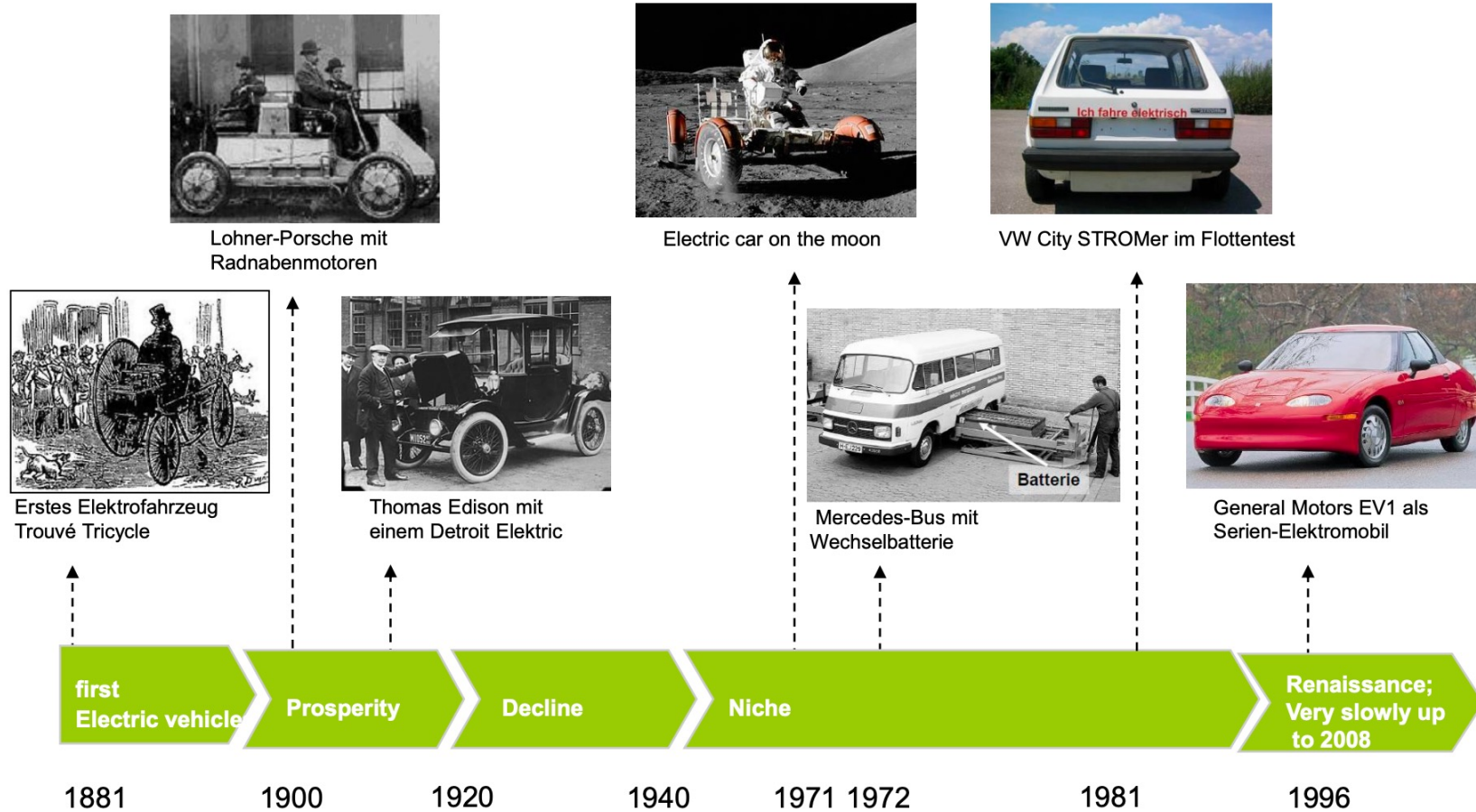
Framing transition governance

How to use this framework to support action towards sustainable development



Smith, Adrian (2011): Governing low carbon transitions.

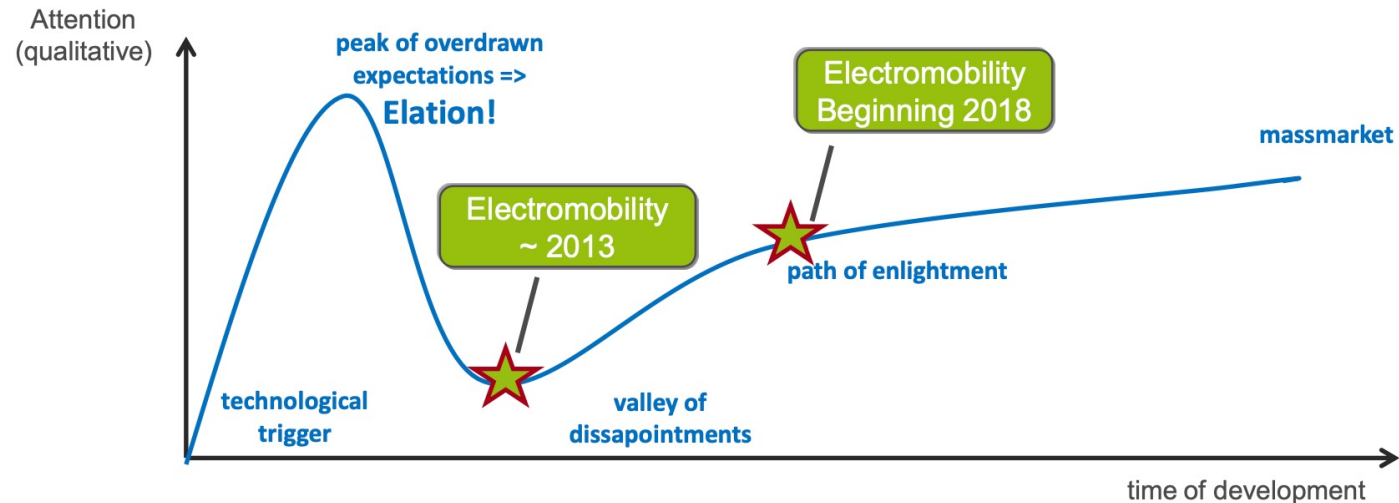
History of Electromobility – some milestones



How often do you have to go through the valley of disappointment?

Electromobility - We passed the „valley of dissapointment“ (...?)

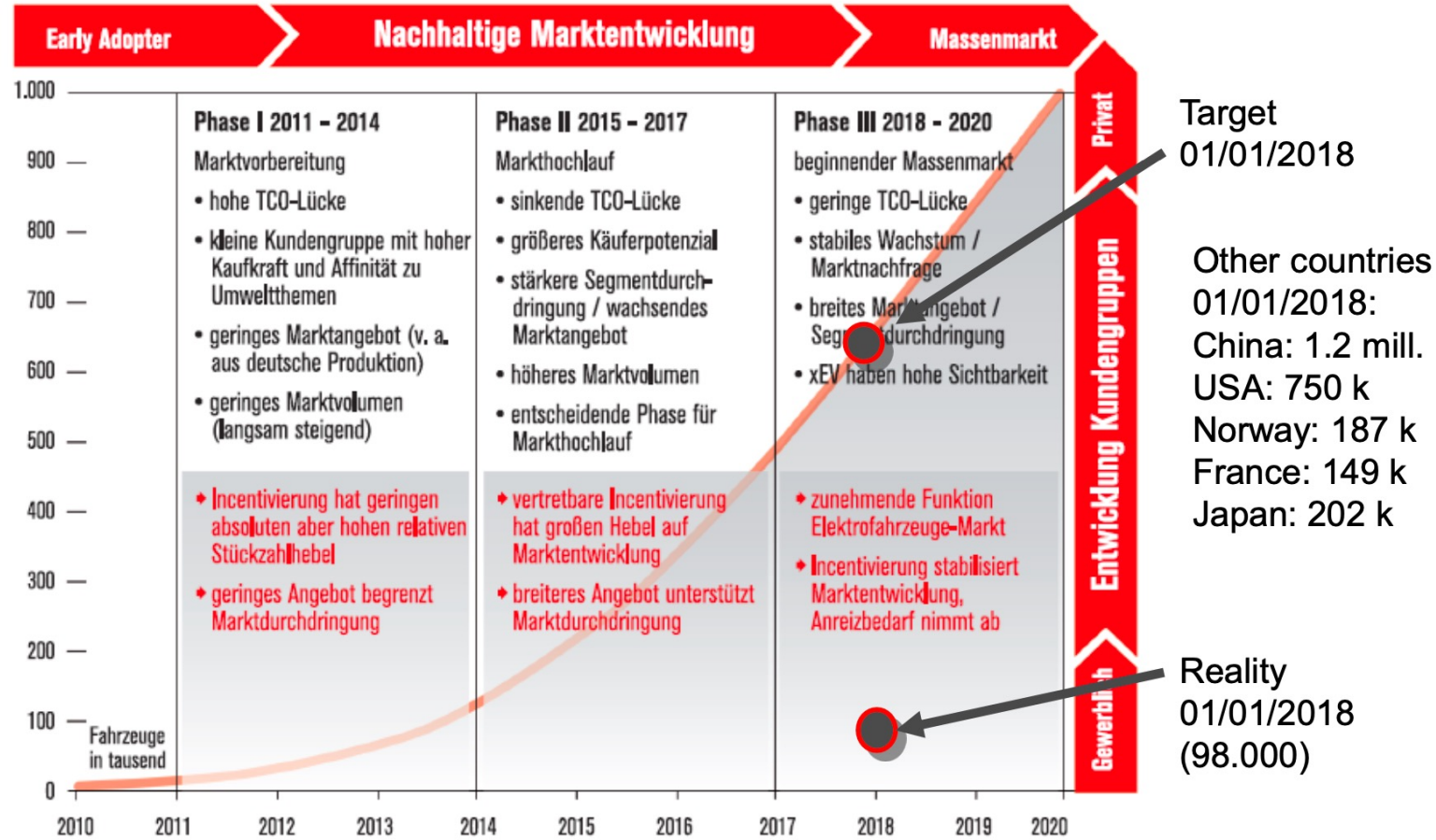
- Introducing electromobility requires patience – like almost all new types of technologies, it will take time



Source: eMO with reference to Jackie Fenn

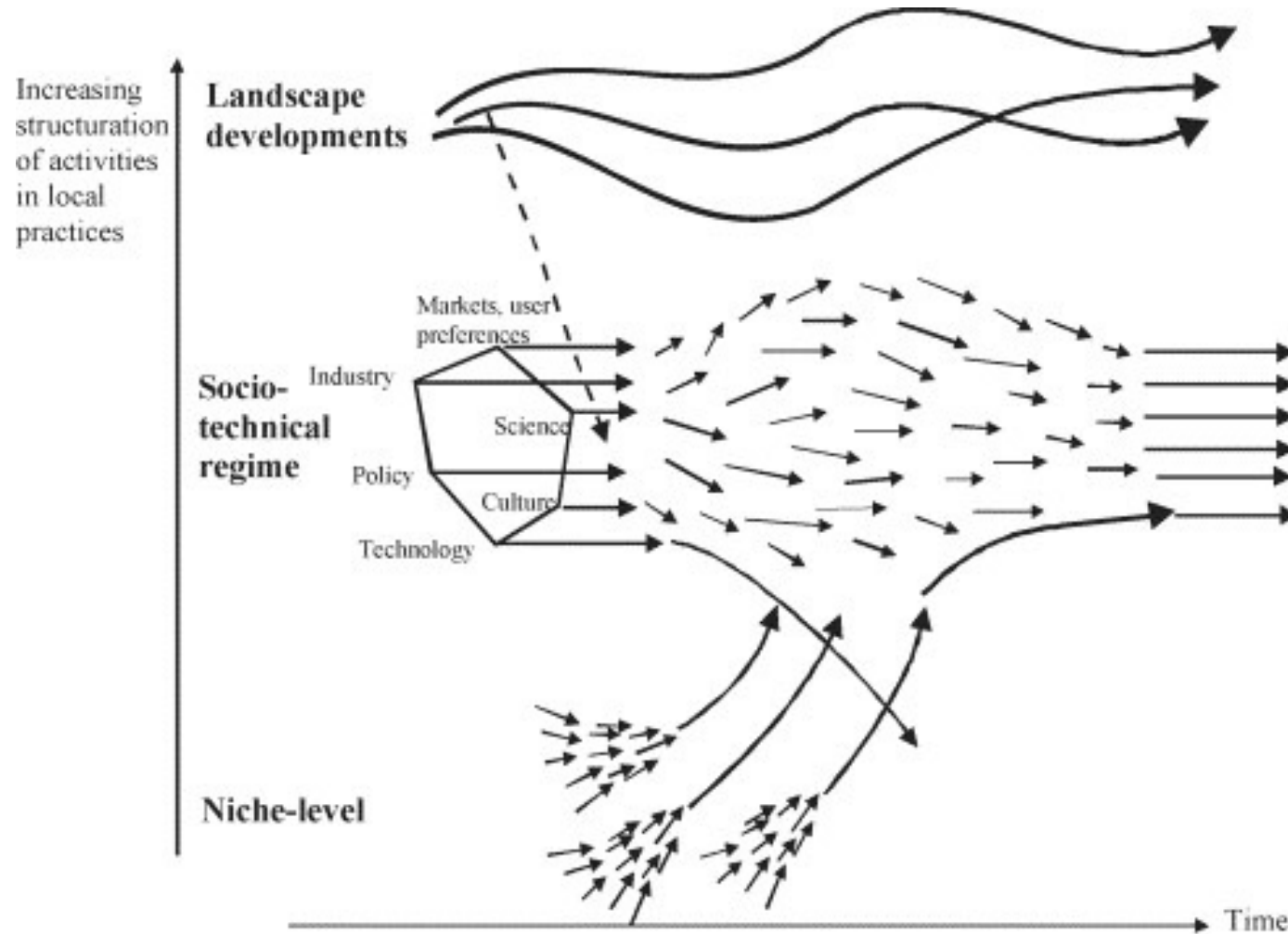
How often do you have to go through the valley of disappointment?

Electromobility – original target curve for market development in Germany (lead market? lead supplier?)



Source: 3rd progress report of the National Platform for Electromobility, 05/2012, S. 46

From Geels theoretical ML perspective to a practice oriented, implementation perspective



Do you already know other theoretical perspectives on transition?

Geels, Frank W. & Johan Schot (2007): Typology of sociotechnical transition pathways. In: *Research Policy* 36 (3), S. 399-417.

Geels compared to other transition models: innovation models

Table 3

MDM system levels compared to other design and innovation models.

MDM system levels	Design for the real world (Papanek, 1985)	Design for Sustainability (Brezet et al., 2001a)	Intelligent products (Andrews, 2003)	Systems Engineering (Haugan, 2001)	Transition Management (Geels, 2005)	Levels of discourse (Brown and Vergragt, 2007)	Means-end-chain (Rozenburg and Eekels, 1998)
S: Societal System		System Innovation	Rethinking Values	System	Transitions (landscape)	Preferences relative to social order	Values
R: Socio-Technical System	'The Real Problem'	Function Innovation	Systemic Context	SubSystem	System innovations (socio-technical regime)	Dominant interpretive frame	Needs
Q: Product-Service System	'General Case'	Function Redesign	Ecological Context	Element	Process innovations (niche)	Problem definition for particular technology society coupling	Functions Characteristics
P: Product-Technology System	'Special Case'	Product Improve-ment	Immediate Context	Component	Product-innovations (niche)	Problem solving	Form

Joore, Peter & Han Brezet (2015): A Multilevel Design Model: the mutual relationship between product-service system development and societal change processes. In: Journal of Cleaner Production 97, S. 92-105.

[7]

Smart mobility transition III

Neue Mobilitätsregime. Das Beispiel MaaS

Smart Mobility is driven by ...

- Technologies (IT & Mobility)
- Industry players & profits
- New business models
- Competition & cooperation

Smart Mobility ...

- **Is ambivalent (environmental & social impact)**
- **Is not necessarily sustainable**
- **Is often road/car-focused**
- **Has sustainability potentials**

A typical smart mobility vision

Text box 2: Overview of the high-disruption vs. the low-disruption scenario

	High	Low
Diverse mobility		
City policies discouraging private vehicles	Intensified	Steady
New, on-demand business models	Prevalent	Limited
Modal shift away from car ownership to shared mobility	Significant	Limited
Autonomous driving		
Regulatory challenges are overcome	Fast	Gradual
Development of safe and reliable technical solutions	Comprehensive	Incomplete
Consumer acceptance and willingness to pay	Enthusiastic	Limited
Electrification		
Battery prices continue to decline	Rapid	Protracted
Regulator-driven emission restrictions	Intensified	Gradual
Consumer demand for electrified powertrains	Widespread	Restrained
Connectivity		
Uptake of car connectivity globally	Vast majority	Partial
Consumers regularly using paid content	Mainstream	Limited

Source: 2016 McKinsey Auto 2030 report

ITS history: The PROMETHEUS project
PROgramMme for a European Traffic of Highest Efficiency and Unprecedented Safety

PROMETHEUS



Program for a European traffic system with highest efficiency and unprecedented safety

- Funded by EUREKA
- 01.01.1987 – 31.12.1994
- 749 mill. EURO project costs => biggest EU project to improve efficiency, environmental compatibility and safety of road transport
- Consortium encompassed 11 OEM, 103 suppliers, 124 research institutes

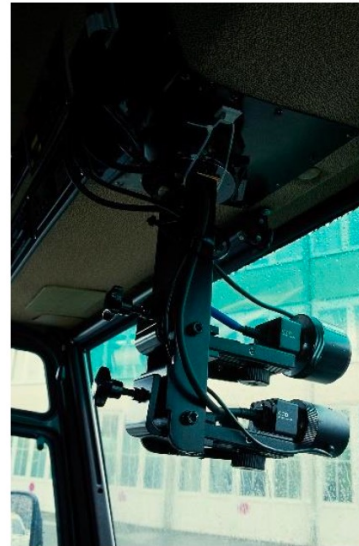
ITS history: The PROMETHEUS project

PROgramMme for a European Traffic of Highest Efficiency and Unprecedented Safety

PROMETHEUS

The project program at a glance – the “common European demonstrators”

- Vision enhancement
- Proper vehicle operation (up to autonomous driving)
 - Friction monitoring and vehicle dynamics
 - Lane keeping support
 - Visibility range monitoring
 - Driver status monitoring
- Collision avoidance
- Co-operative driving
- Autonomous intelligent cruise control
- Automatic emergency call
- Fleet management
- Dual mode route guidance
- Travel and traffic information systems

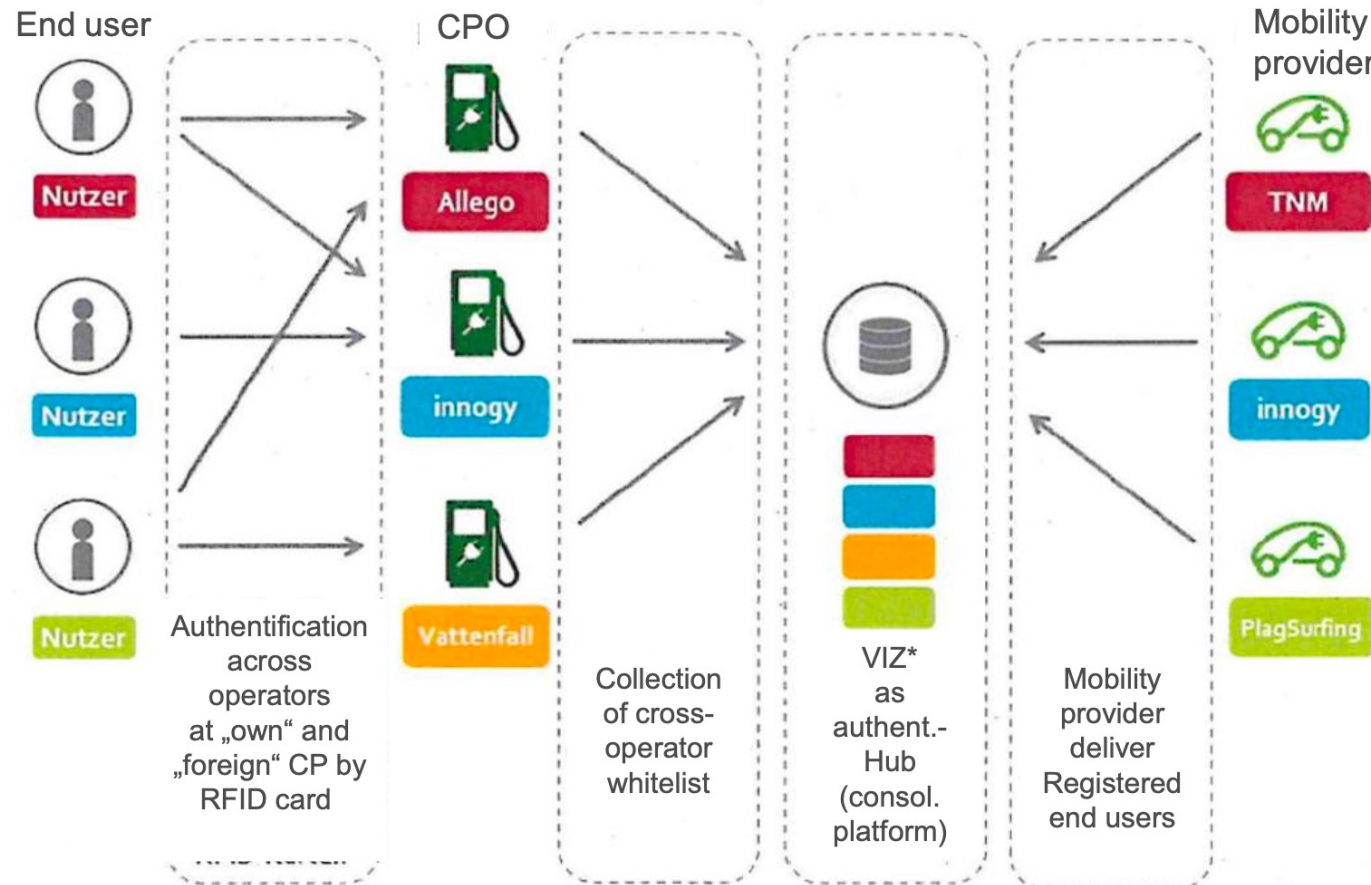


=> PROMTHEUS is still the fundament for most of the technologies used in modern road transport, i.e in the car industry

Charging Infrastructure on public space in Berlin

Principle chart

*VIZ: Traffic Information Centre (private operator with public contract)



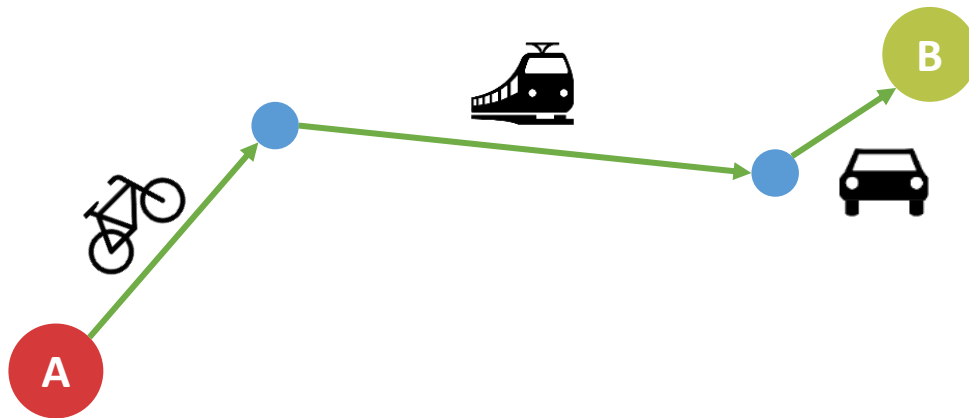
Changing transport planning paradigm: the old planning paradigm favored automobile-oriented transportation improvements. The new one expands the range of objectives, impacts and options considered

	Old Paradigm	New Paradigm
Definition of <i>Transportation</i>	<i>Mobility</i> (physical travel!)	<i>Accessibility</i> (people's overall ability to reach services and activities)
Modes considered	Mainly automobile	Multi-modal: Walking, cycling, public transport, automobile, telework and delivery services
Objectives	Congestion reduction; roadway cost savings; vehicle cost savings; and reduced crash and emission rates per vehicle-kilometer	Congestion reduction; road and parking cost savings; consumer savings and affordability; accessibility for disadvantaged people; safety and security; energy conservation and emission reductions; public fitness and health; efficient land use (reduced sprawl)
Impacts considered	Travel speeds and congestion delays, vehicle operating costs and fares, crash and emission rates.	Various economic, social and environmental impacts, including indirect impacts
Favored transport improvement options	Roadway capacity expansion.	Improve transport options (walking, cycling, public transit, etc.). Transportation demand management. More accessible land development.
Performance indicators	Vehicle traffic speeds, roadway Level-of-Service (LOS), distance-based crash and emission rates	Quality of accessibility for various groups. Multi-modal LOS. Various economic, social and environmental impacts.

Litman, 2013

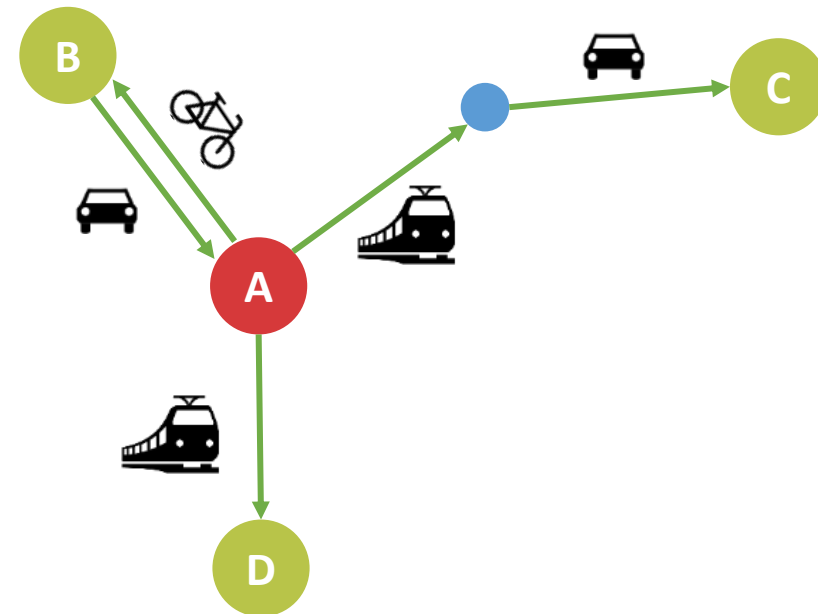
Multi- and Intermodal travel: multioptionality and optimizing individual mobility

An efficient chain of trips



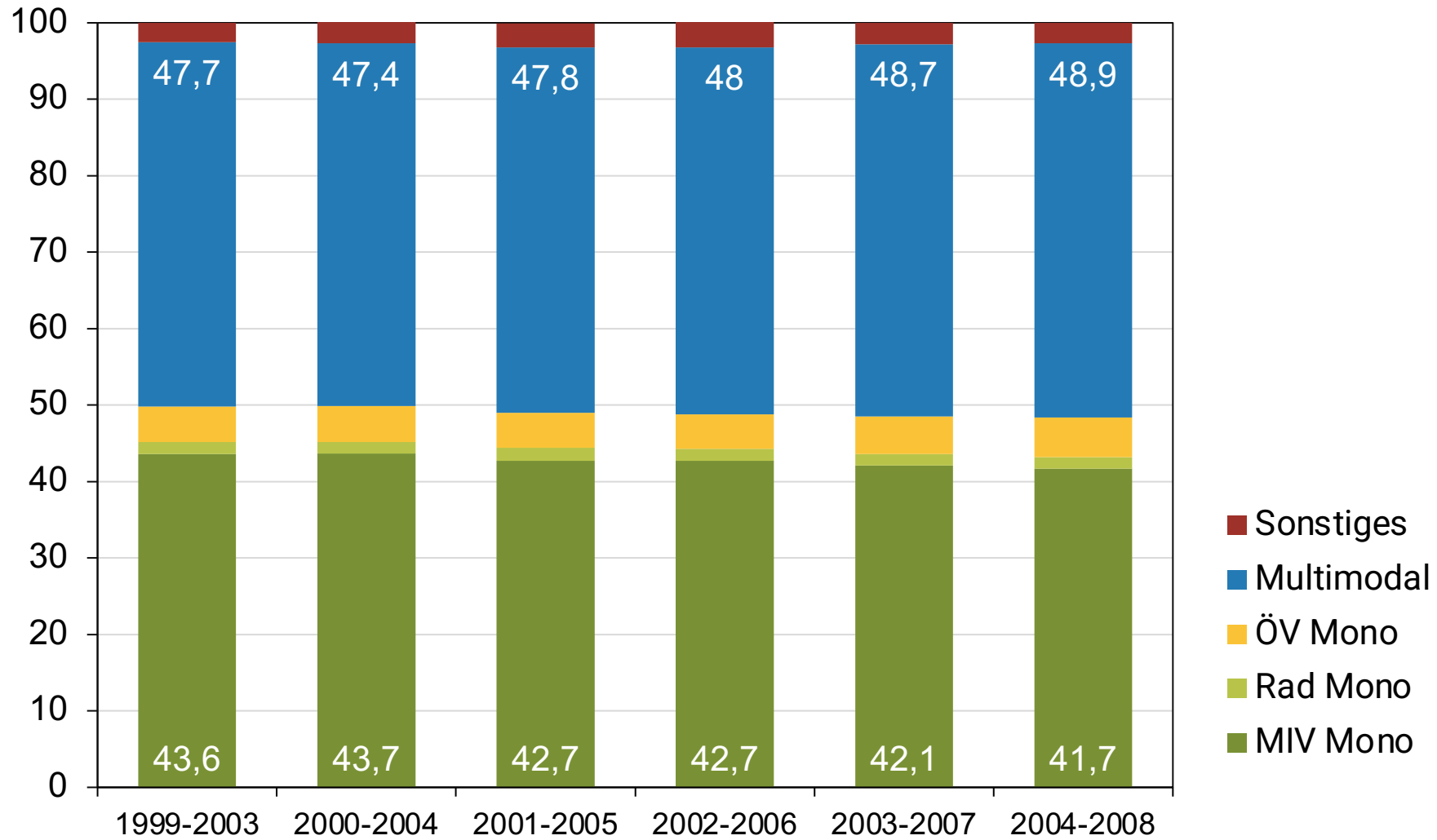
intermodal travel behavior: Use of different means of transport on a single route.

The right mode of transport for any situation



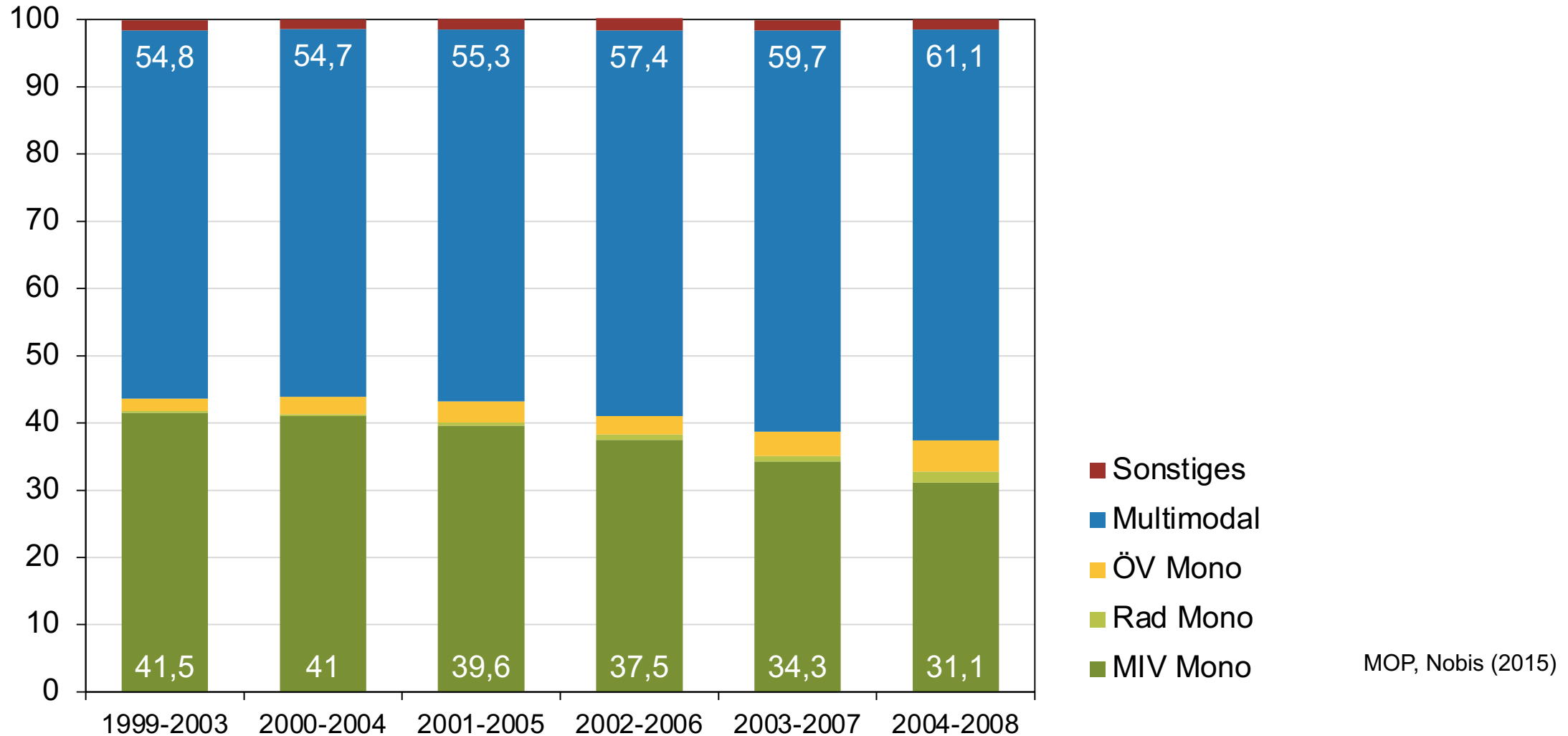
multimodal travel behavior: Use of different means of transport within a certain period of time

Multimodality is not new: only a small change in the proportion of multimodal persons over time



Multimodality in the 18-25 age group

Monomodal MIV use declines, multimodality increases

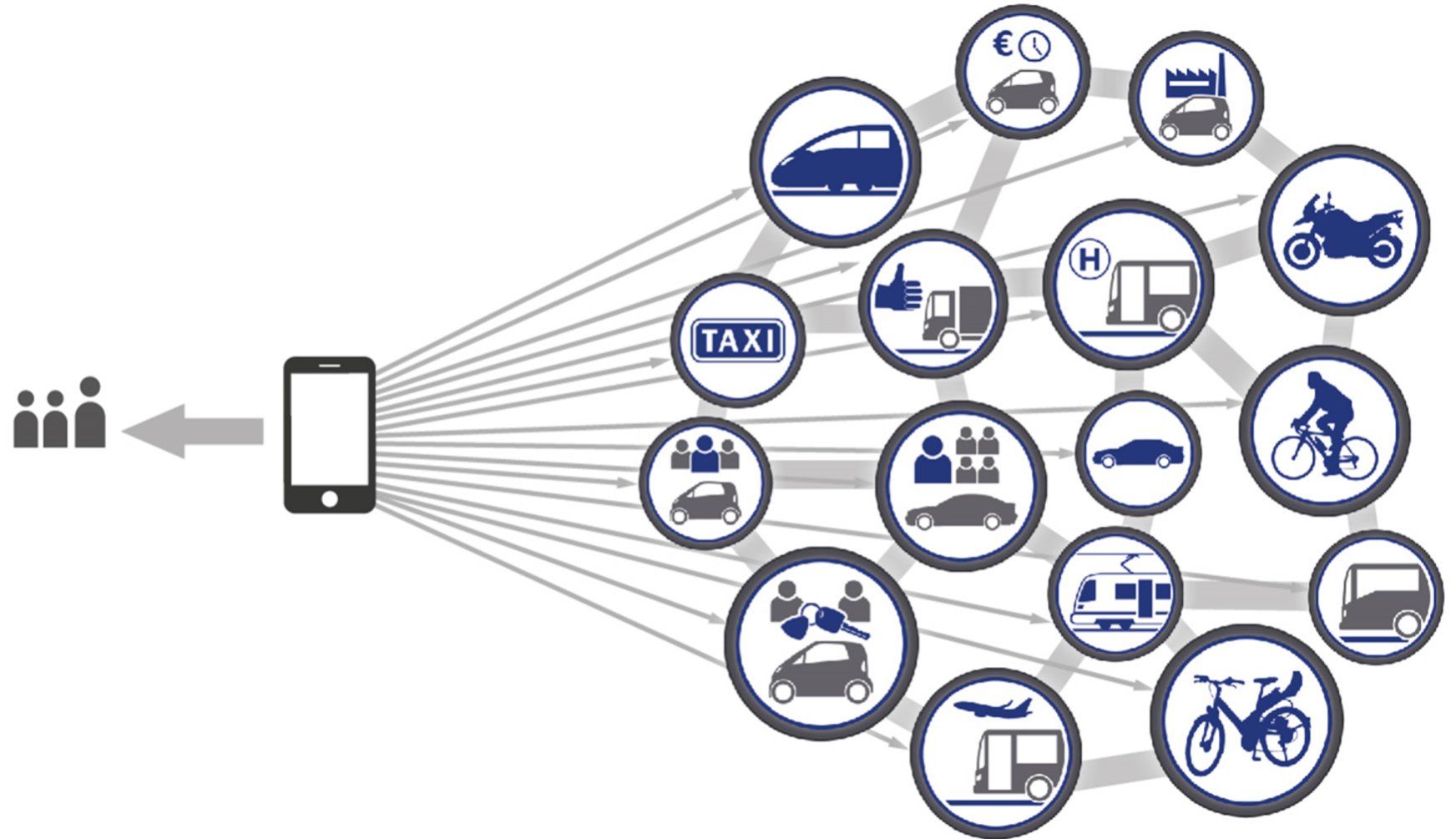


MOP, Nobis (2015)

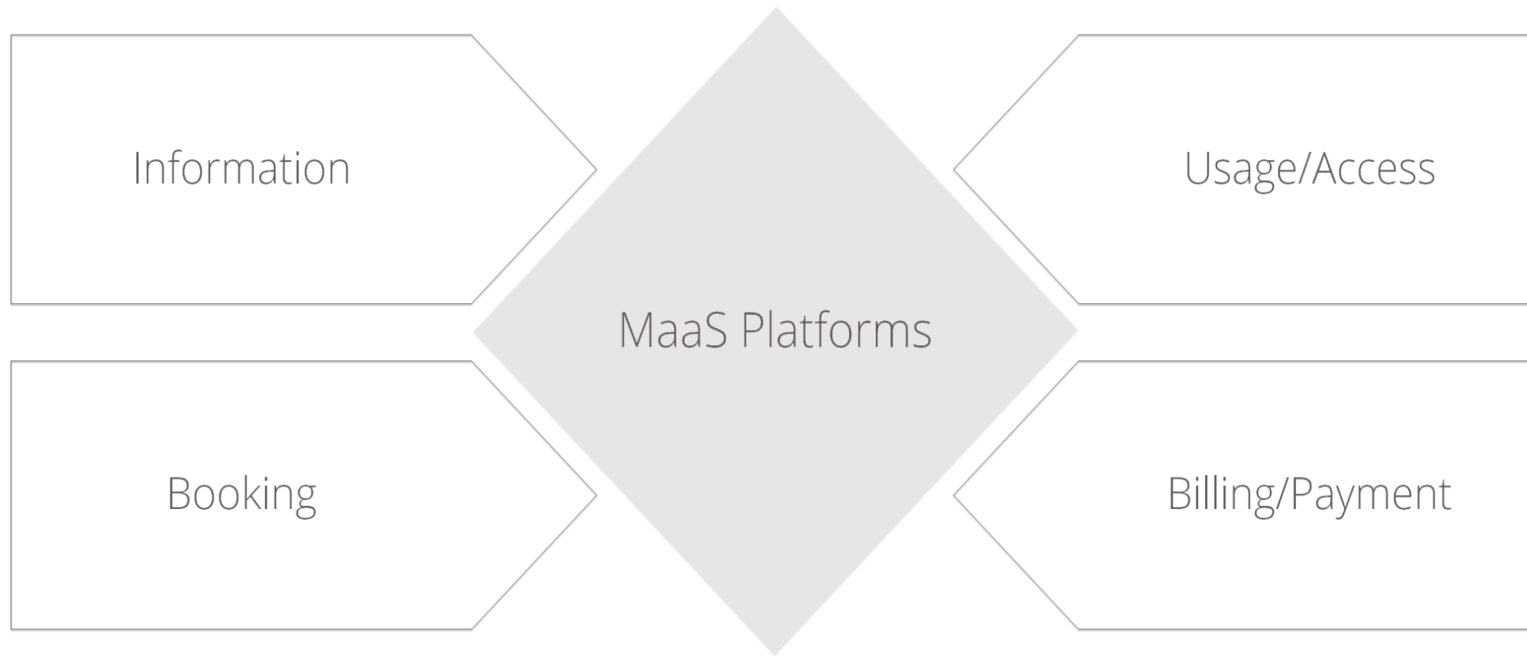
Elements of new mobility regimes: MaaS and active mobility vs. private vehicle

Concept of MaaS

- relatively simple, yet meant to be revolutionary
- bundling different transport means, public and private
- one easy-to-use package for customer
- service is provided to customer via mobile applications
- not just an app but a shift towards consuming mobility as a service
- therefore breaks traditional paradigms of owning a car, or buying trips from A to B



Definition of a MaaS system: Element of a new mobility regime



“Mobility as a Service (MaaS) - a system, in which a comprehensive **range of mobility services** are provided to customers by **mobility operators.**” Heikkilä 2014

“MaaS is a mobility distribution model where the transportation needs of individuals are satisfied by **a service provider** over a **single interface.**” Hietanen, 2014

Desired impacts of MaaS

Stakeholder

Increased cooperation of authorities / companies

Environment

Sustainable transport with „greener“ vehicles

Transport system

Improved efficiency

Increased use of public transport

Decrease in number of private cars

Urban planning and infrastructure

Innovative transport hubs (e.g. stations, terminals)

More efficient use of transport infrastructure (incl. Maintenance and improved quality)

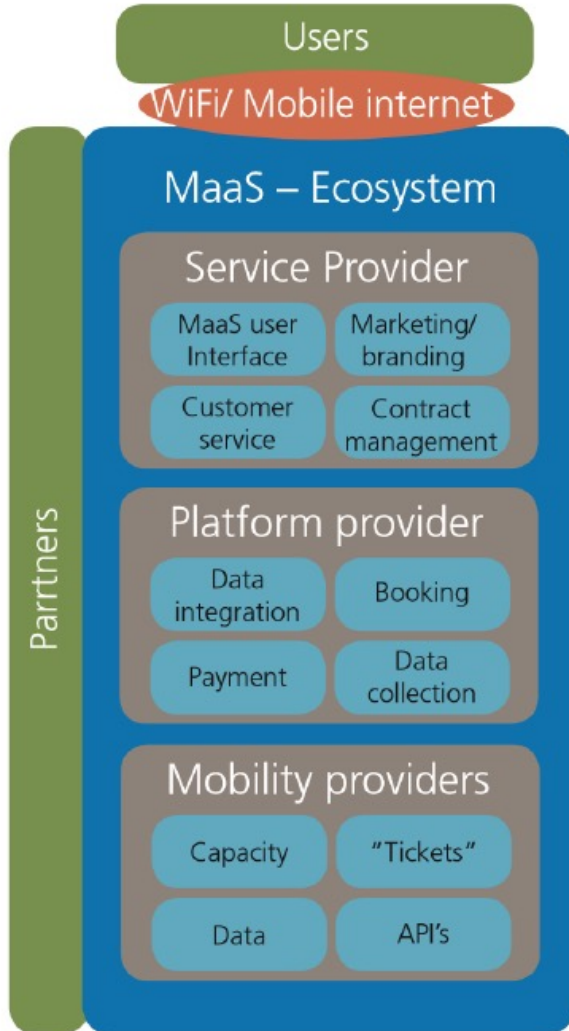
Reduced need for parking spaces and transport infrastructure in general

Technology and economy

Leading market and leading supplier for new technologies

New business model (sharing economy)

MaaS Ecosystems as example for socio-technical transition: Necessity of cooperation of many stakeholders

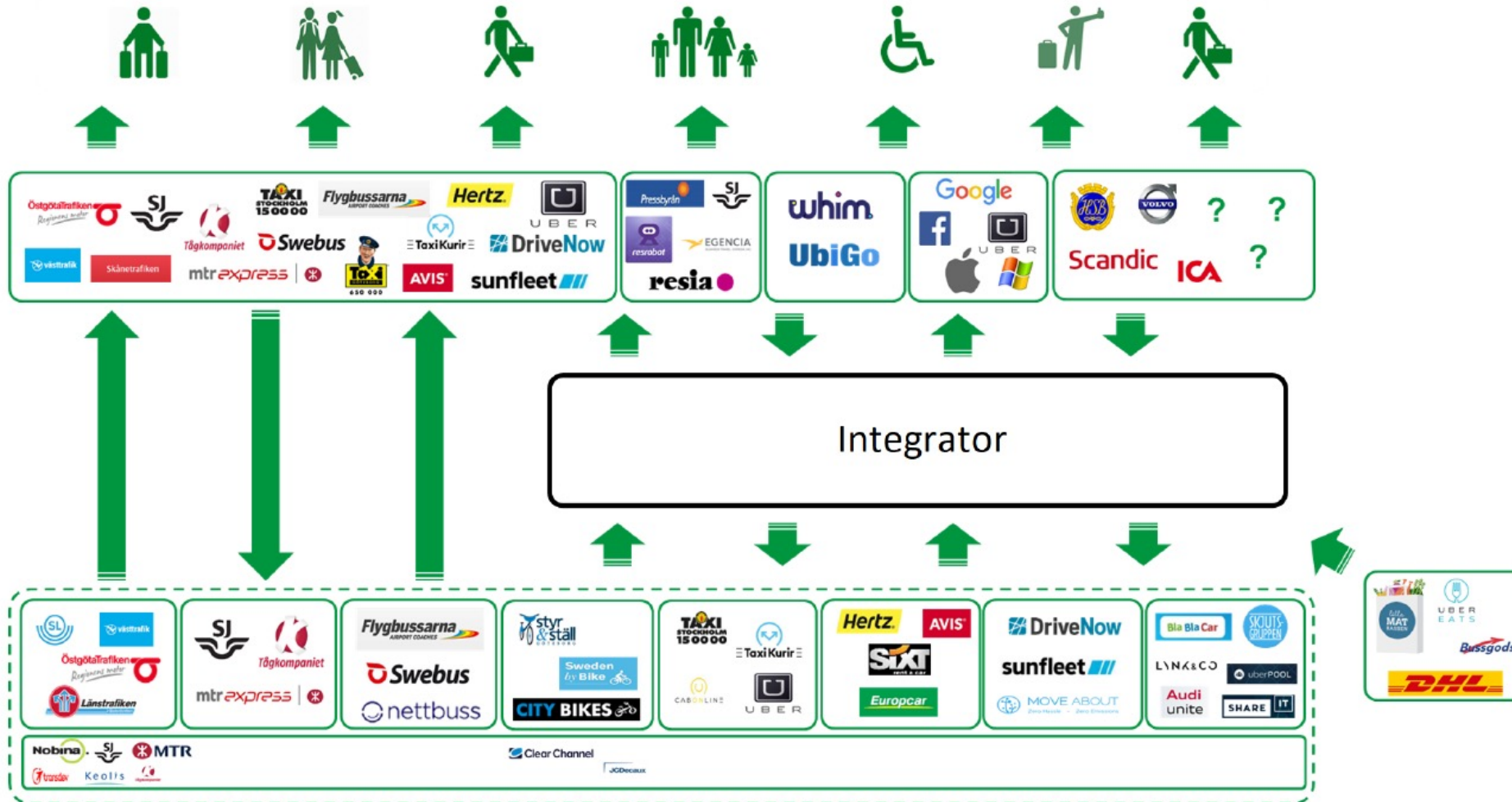


The MaaS ecosystem
(Lund, 2014)

Role of platform providers

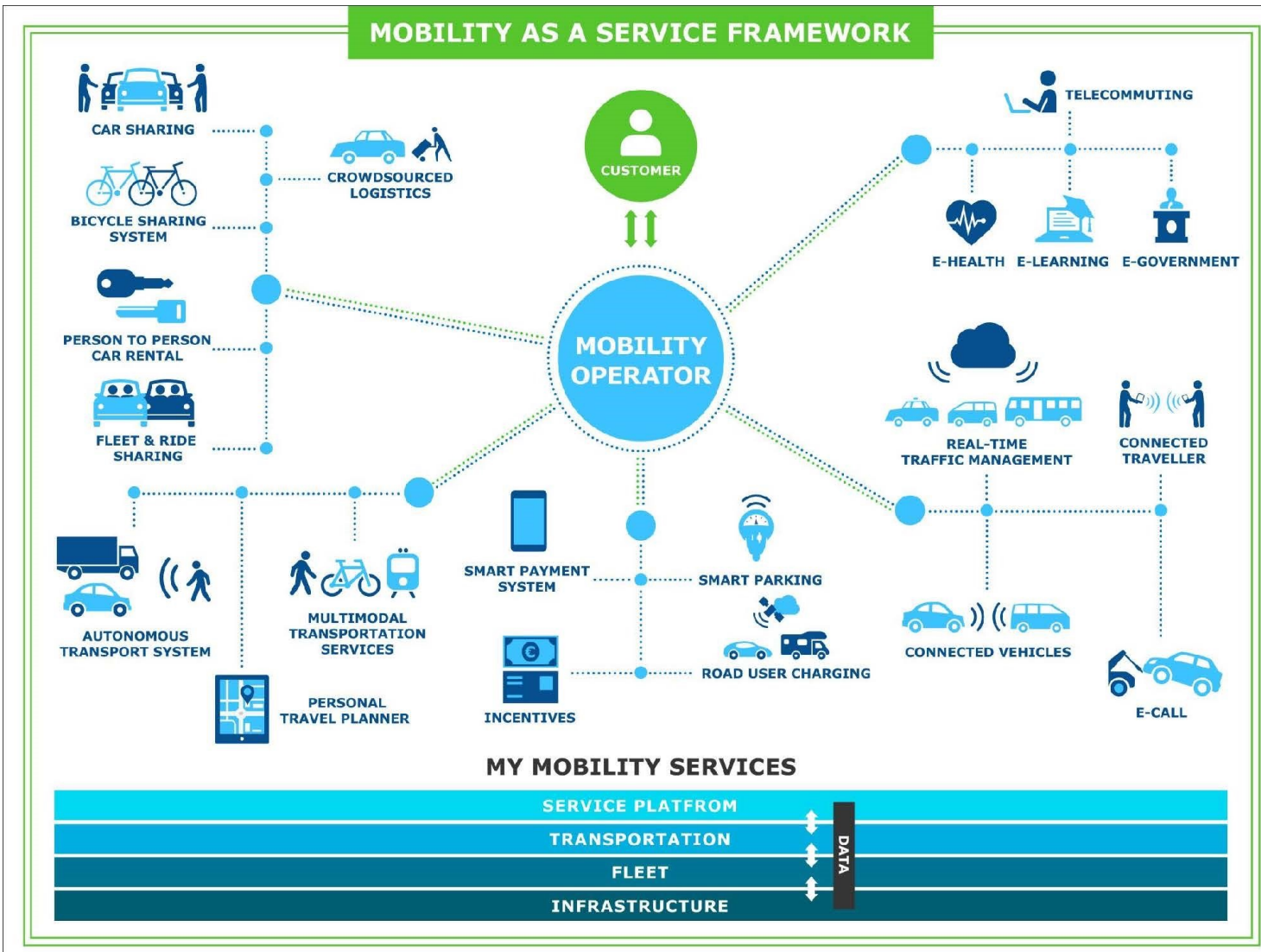
“Companies that buy mobility services (i.e. transport like public transport, taxi, car sharing, bicycle etc.) from service providers, and combine them for customer services.” (Heikkilä 2014)

MaaS actor networks



Samtraffiken (2016)

MaaS frameworks with different levels of complexity



Integration levels of MaaS services: When is a MaaS a MaaS?

1. Cooperation in terms of discounts for combined subscriptions

2. Ticketing integration

3. Payment integration

4. ICT integration

5. Institutional integration

6. Mobility packages

MAASiFiE, 2016

MaaS Service packaging: User-centred models



Whim to Go

For those who want to try Whim first or simply don't travel that much. Pay per ride, no commitment, no surcharges.

0€
per month



Whim Urban

For regular travellers who could use the flexibility of a taxi or car occasionally.

49€
per month (cancel any time)

INTRODUCTORY OFFER



Whim Unlimited

Modern alternative for owning a car. At the price of owning a car you get unlimited access to public transport, taxi or a car according to your daily need.

499€
per month (cancel any time)

INTRODUCTORY OFFER

<https://whimapp.com/>

MaaS Service packaging: Whim Pricing

	Whim To Go	Whim Urban	Whim Unlimited
Monthly payment	Free	49€	499€
Local public transport	Pay per ride	Unlimited Single Tickets	Unlimited Single Tickets
Taxi (5km radius)	Pay per ride	10€ per ride	Unlimited
Car	Pay per ride	49€ per day	Unlimited
City Bike	Not included	Unlimited (30min)	Unlimited
Cancel anytime	✓	✓	✓
Add-ons incl regional HSL >			
	Read more	Read more	Read more


MaaS in Augsburg

users

Mobility flat

swa Mobil-Flat


- Monthly subscription for public transit + bike rides + car sharing budget






MaaS

swa Mobil-App


- Aggregator app for swa services. Not including private shared services, taxi or Swaxi




Single modes


Modes	 swa	 swa Rad	 swa Carsharing	swaxi
	<ul style="list-style-type: none"> ▪ Public transit system based on bus & tram 	<ul style="list-style-type: none"> ▪ Bike sharing system based on nextbike with 500 bikes 	<ul style="list-style-type: none"> ▪ Hybrid setup of station based and free floating car sharing with more than 250 vehicles 	<ul style="list-style-type: none"> ▪ Ride pooling with carsharing vehicles ▪ Pricing based on public transit availability
Partner	<i>eos.upgrade</i>	<i>nextbike</i>	<i>cantamen</i>	<i>door2door</i>


Other providers active



Sources: swa, Wikipedia, micro map <http://bit.ly/micromapeu>



Augustin Friedel 

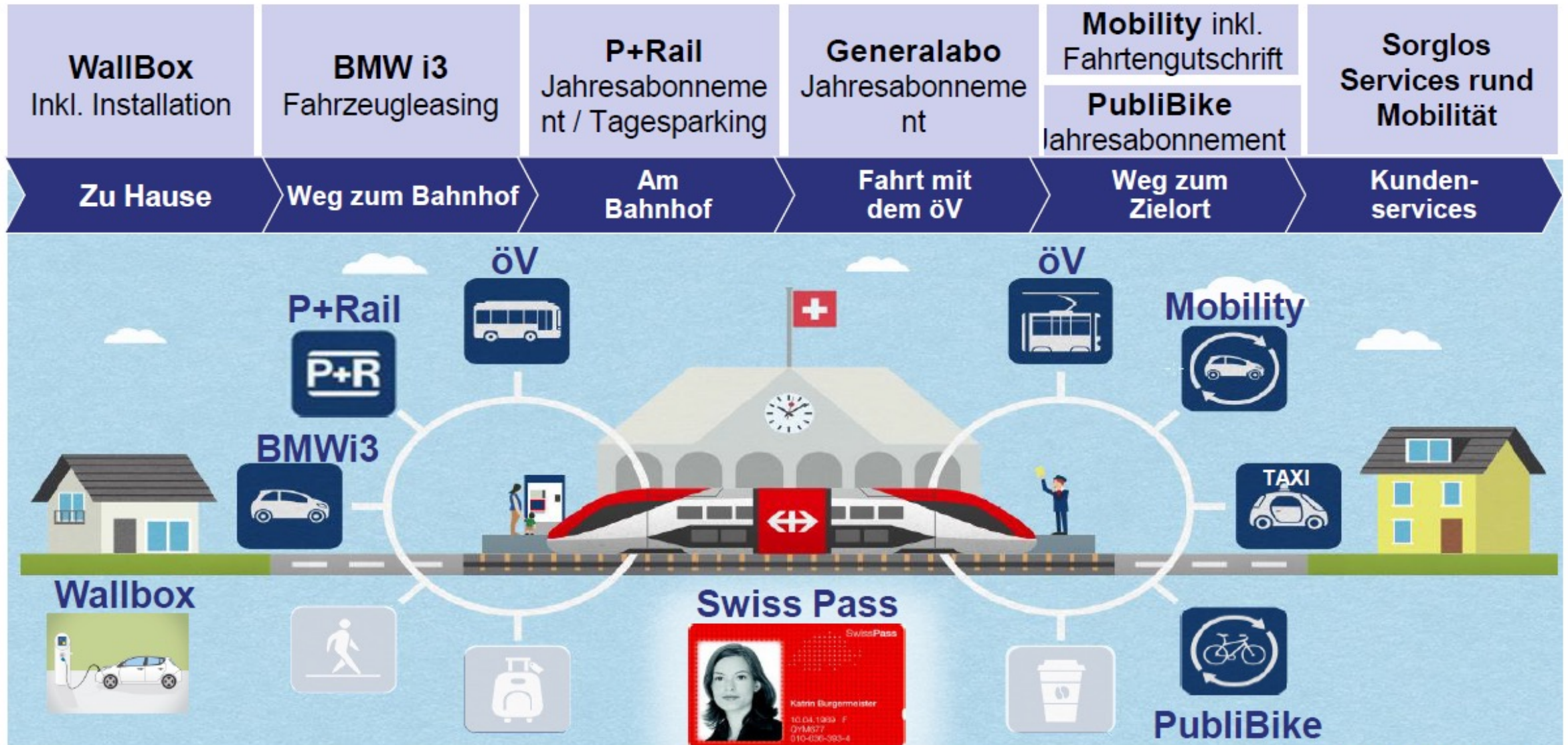


Vision as a roadblock?



Why do sth. now?
Lets wait for autonomous vehicles or lets do the planning for autonomous vehicles and leapfrog the MaaS approach?

SBB Green class



1 Kundenvertrag – 1 Rechnung – 1 Ansprechpartner

Sorglos

WallBox

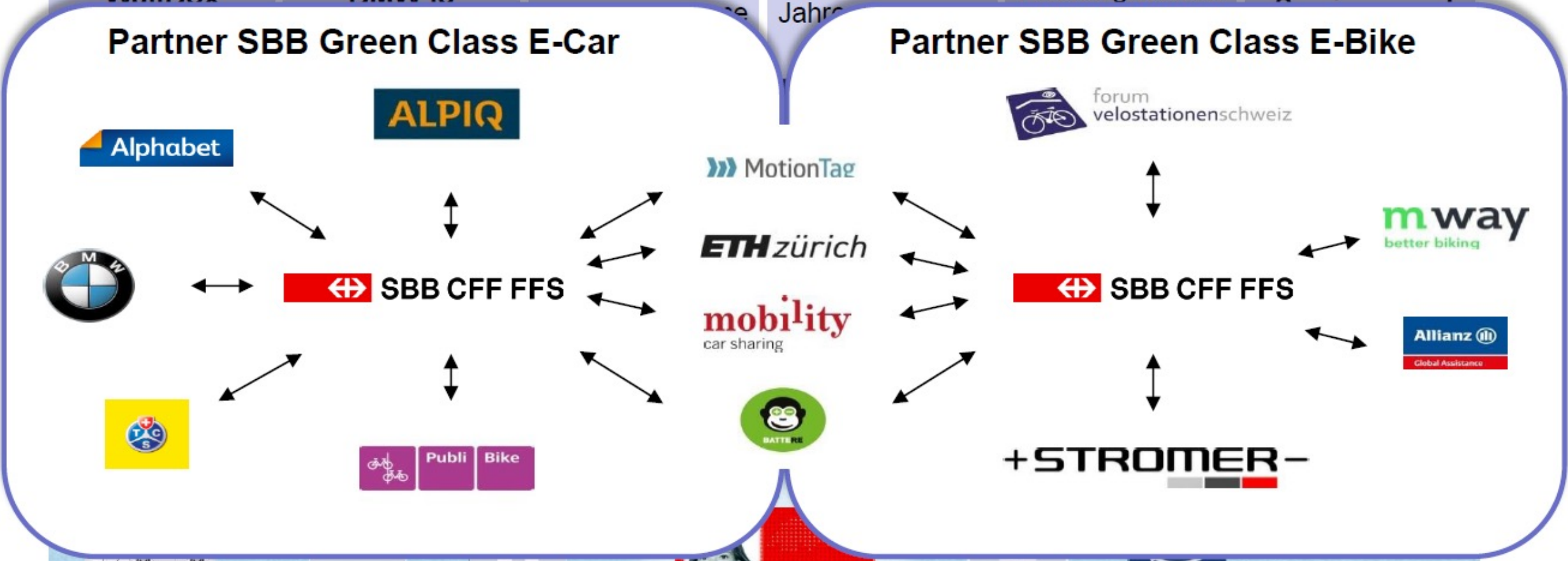
BIMV 1.5

Jahre

Partnerengagements

Partner SBB Green Class E-Car

Partner SBB Green Class E-Bike



SBB Green class: Pilot projects to introduce MaaS in Switzerland



SBB Green Class E-Car (BMW i3)

→ Forschungspreis CHF 12'200 (1. Kl.)

- 2'500 Bewerber
- 138 zahlende Pilotkunden
- Hohe Kundenzufriedenheit (8.3 v. 10 Pkt.)
- Erneuerungsrate Mobilitätskombi rund 70%
- Erfassen täglich ihre Mobilitätsdaten für Forschungsprojekt mit ETH Zürich

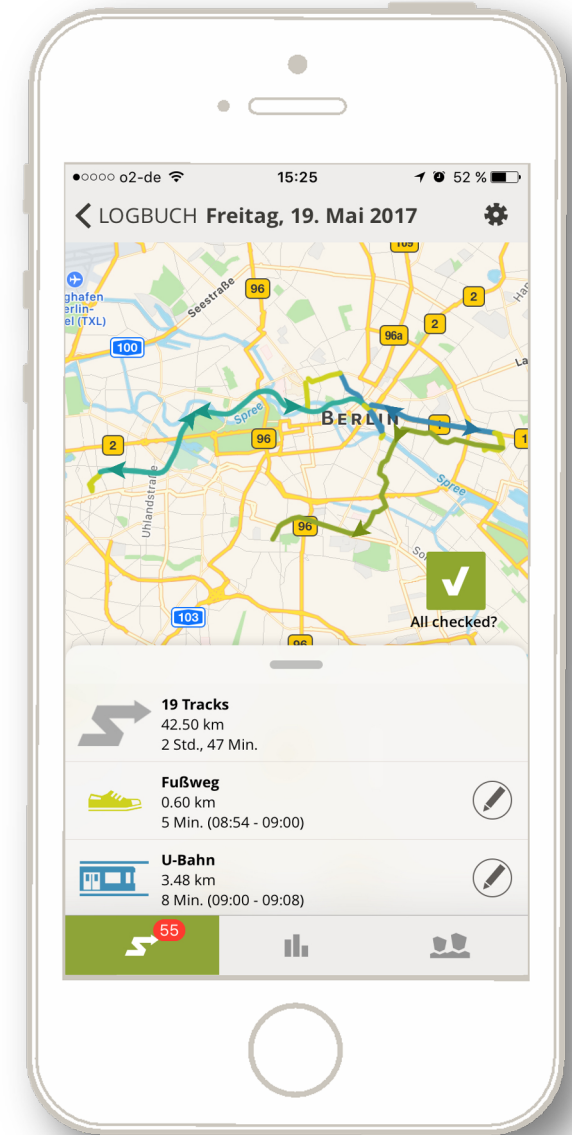


SBB Green Class E-Bike (STROMER)

→ Pilotpreis CHF 9'880 (1. Kl.) / CHF 6'750 (2. Kl.)

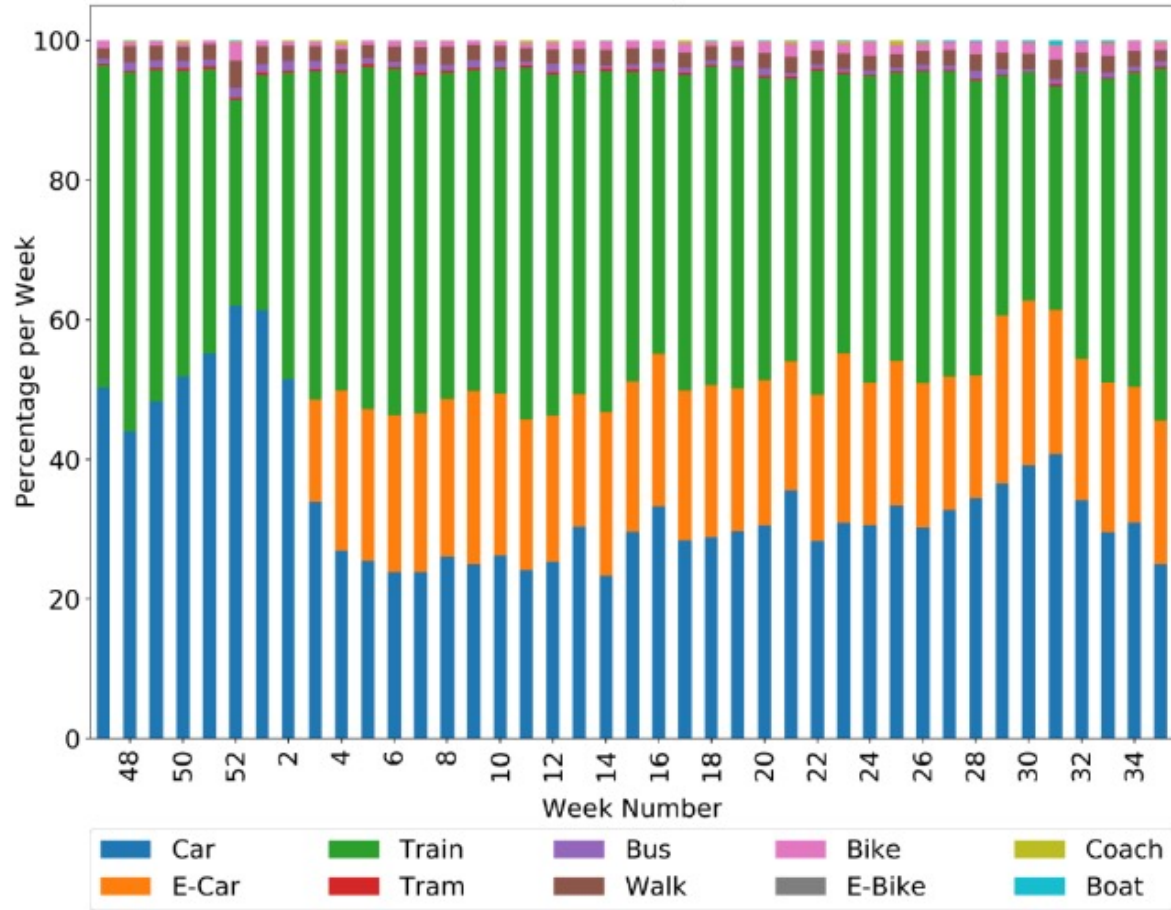
- 53 zahlende Pilotkunden
- Erfassen täglich ihre Mobilitätsdaten für Forschungsprojekt mit ETH Zürich
- Läuft noch bis im Herbst 2018

Tracking users travel behavior to evaluate and develop the product

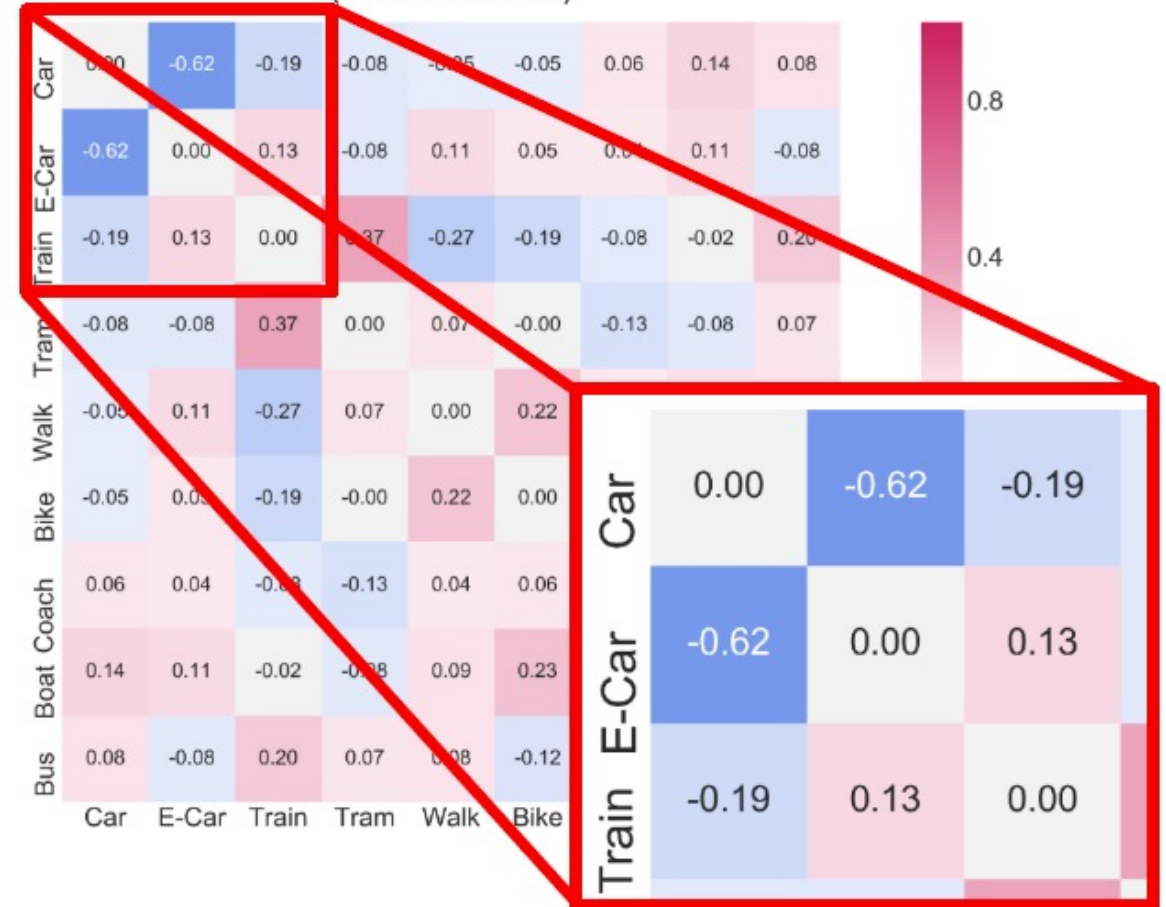


Increasing E-Car usage correlates with decreasing ICE vehicle usage

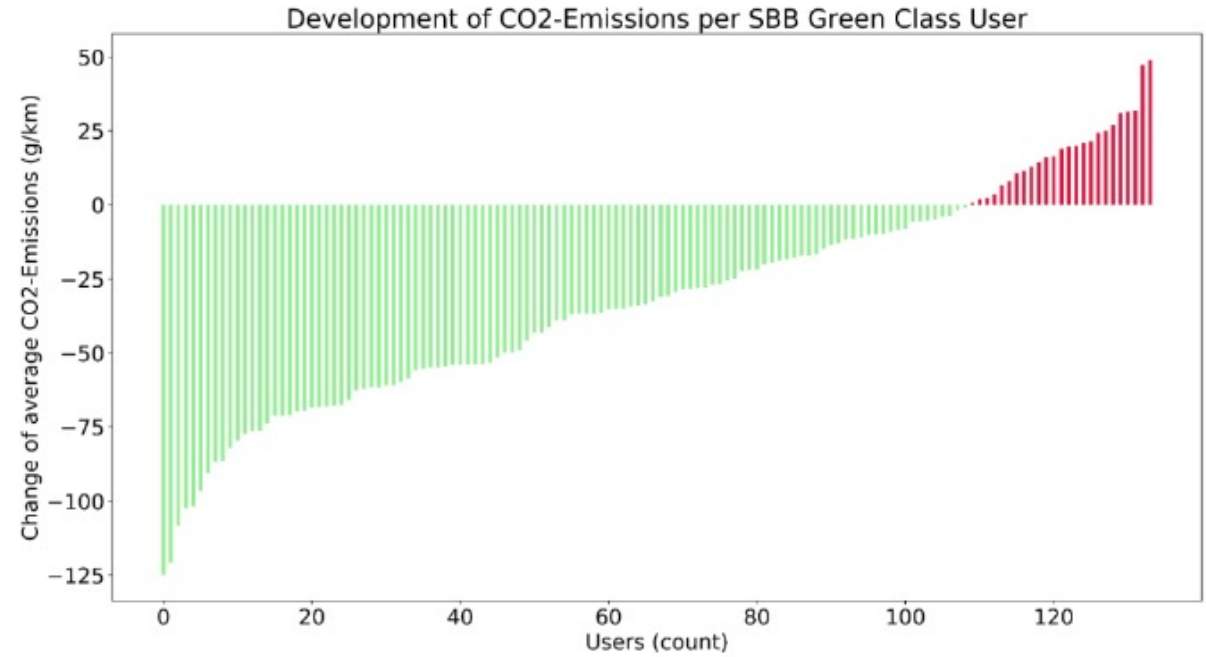
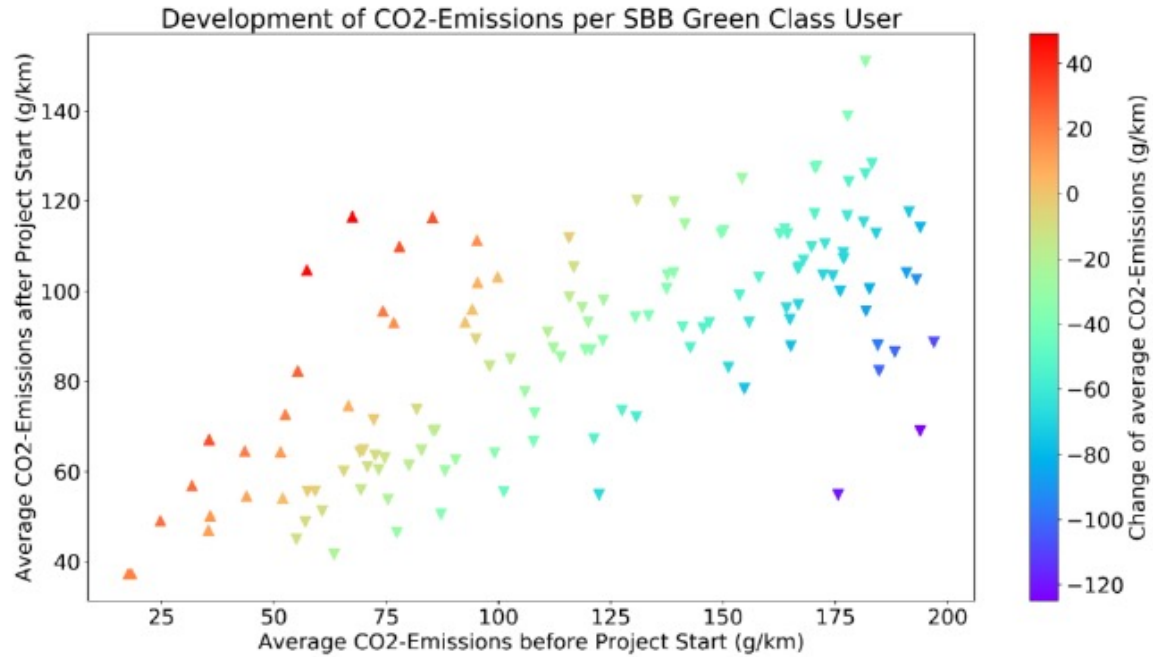
Normalized Modal Split of All Users



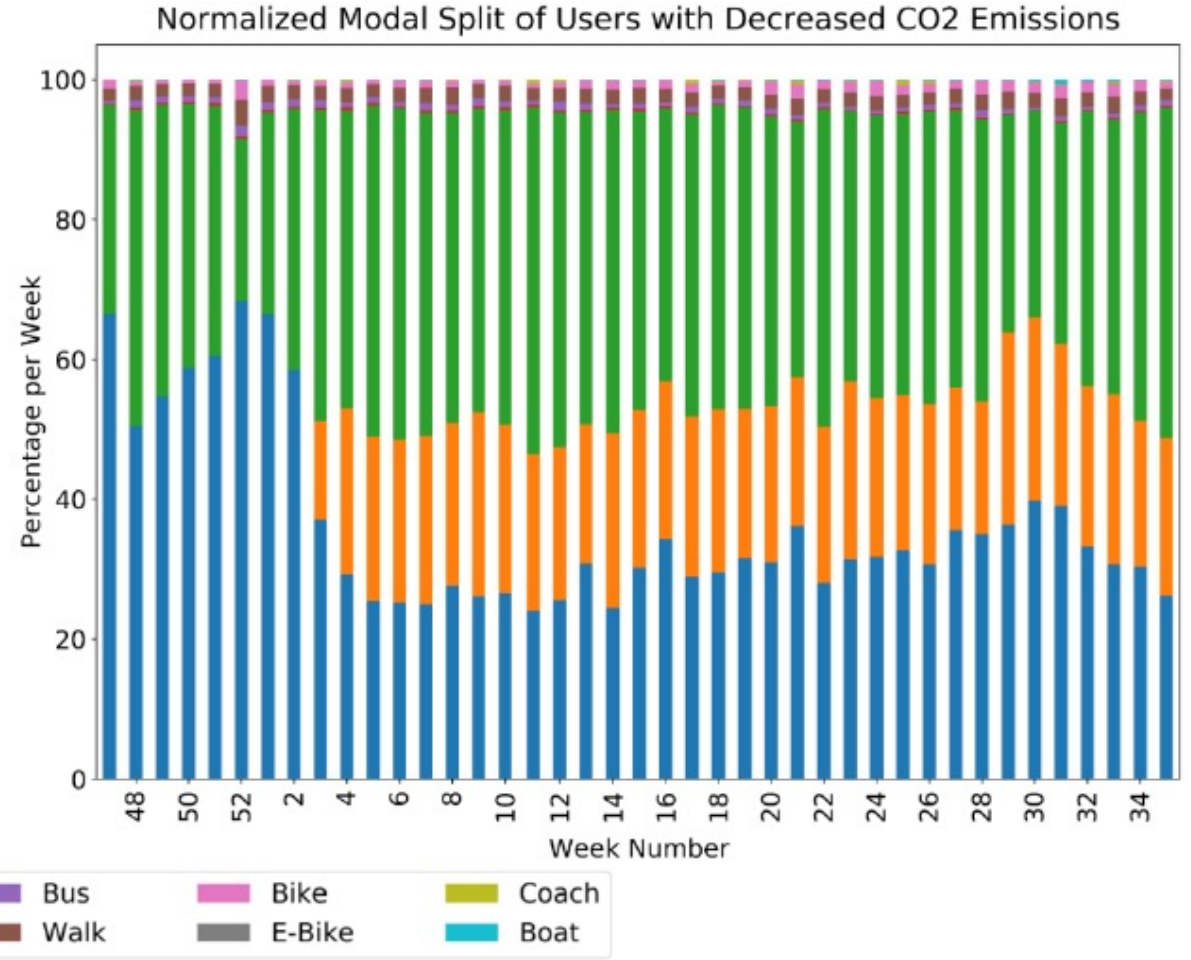
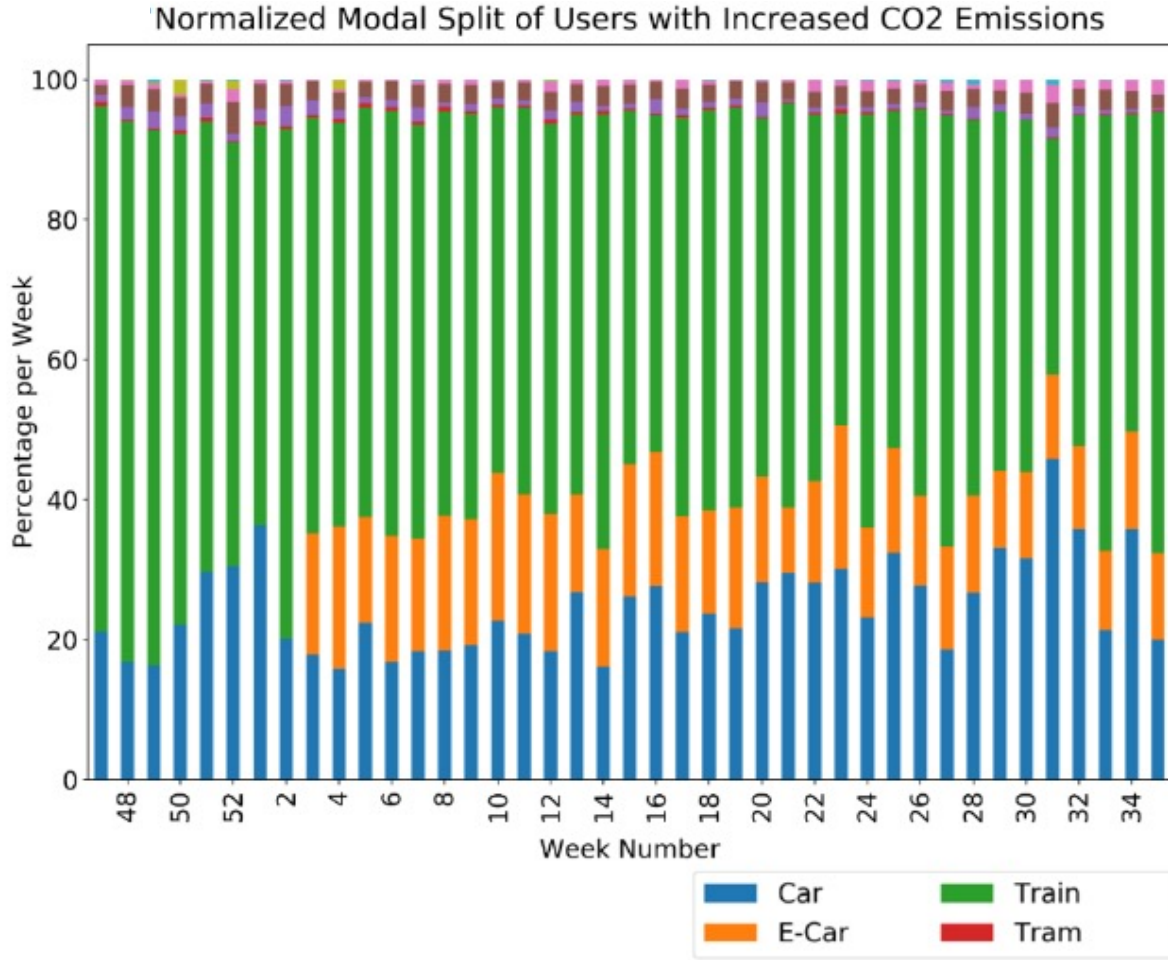
Partial Correlation Matrix of All Users
(Distances in km)



Most of the SBB Green class users decreased CO2-emissions



CO2-Emissions: People with increasing CO2 emission are highly mobile rail users



SBB Green class



SBB Green Class Premium

- ✓ GA 1. Klasse
- ✓ BMW i3 **Neuwagen**, konfigurierbar
- ✓ Parkieren am Bahnhof **Plus**

Ergänzende Mobilität:

- ✓ Carsharing
- ✓ Bikesharing **Plus**
- ✓ **Taxi**

Sorglos unterwegs:

- ✓ Einfach unterwegs laden
- ✓ Immer versichert
- ✓ Sicher mit Sommer- & Winterreifen
- ✓ Inklusive Autobahn-Vignette
- ✓ Fahren mit erneuerbaren Energien

[Mehr Details zu den Leistungen](#)

Vertragsdauer & Einführungspreis Premium:

36 Monate *	CHF 1180.- / Mt.
24 Monate	CHF 1250.- / Mt.
12 Monate	CHF 1310.- / Mt.

* Heimladestation bei 36 Monatsvertrag mit 600 Franken Rabatt.

Jetzt bewerben →

SBB Green Class Comfort

- ✓ GA 2. Klasse
- ✓ BMW i3
- ✓ Parkieren am Bahnhof

Ergänzende Mobilität:

- ✓ Carsharing
- ✓ Bikesharing

Sorglos unterwegs:

- ✓ Einfach unterwegs laden
- ✓ Immer versichert
- ✓ Sicher mit Sommer- & Winterreifen
- ✓ Inklusive Autobahn-Vignette
- ✓ Fahren mit erneuerbaren Energien

[Mehr Details zu den Leistungen](#)

Vertragsdauer & Einführungspreis Comfort:

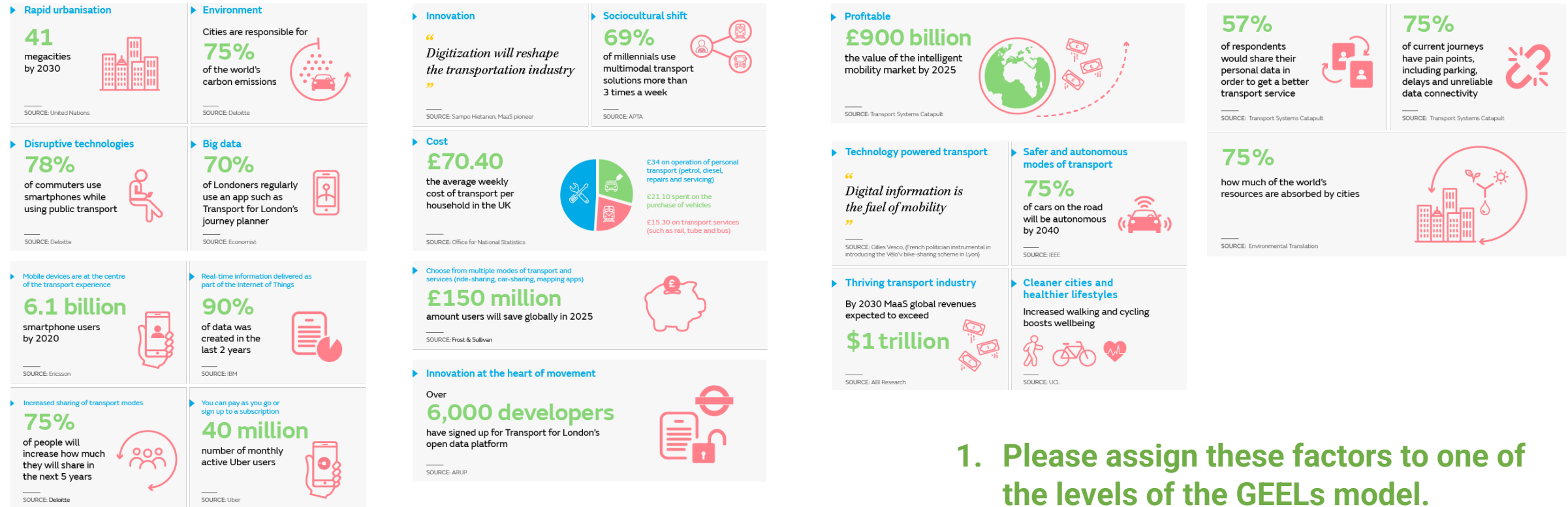
36 Monate *	CHF 910.- / Mt.
24 Monate	CHF 980.- / Mt.
12 Monate	CHF 1040.- / Mt.

* Heimladestation bei 36 Monatsvertrag mit 600 Franken Rabatt.

Jetzt bewerben →

MaaS is an old idea but why is it emerging now?

Transition on landscape, regime and niche level



To which level can these factors be assigned?

1. Please assign these factors to one of the levels of the GEELs model.
2. Please think about four factors that could be additionally taken into account and assign these to the GEELs model as well.

[8]

Innovationen in der VUCA-Welt

Von der Ideenfindung bis zur Umsetzung neuer
mobilitätsbezogener Dienstleistungen

- ICT as a major driver for but also opponent of sustainability
- Due to scaling effects, the impact can be large (in both directions)
- Sustainability as a Systems Thinking activity
 - Potentially high costs vs. few guidelines
- Systems vs. Software Requirements Engineering
 - Need to look at wider socio-economic system

Four major trends changing the automotive industry

CONNECTED

C



AUTONOMOUS

A



SHARED & SERVICES

S

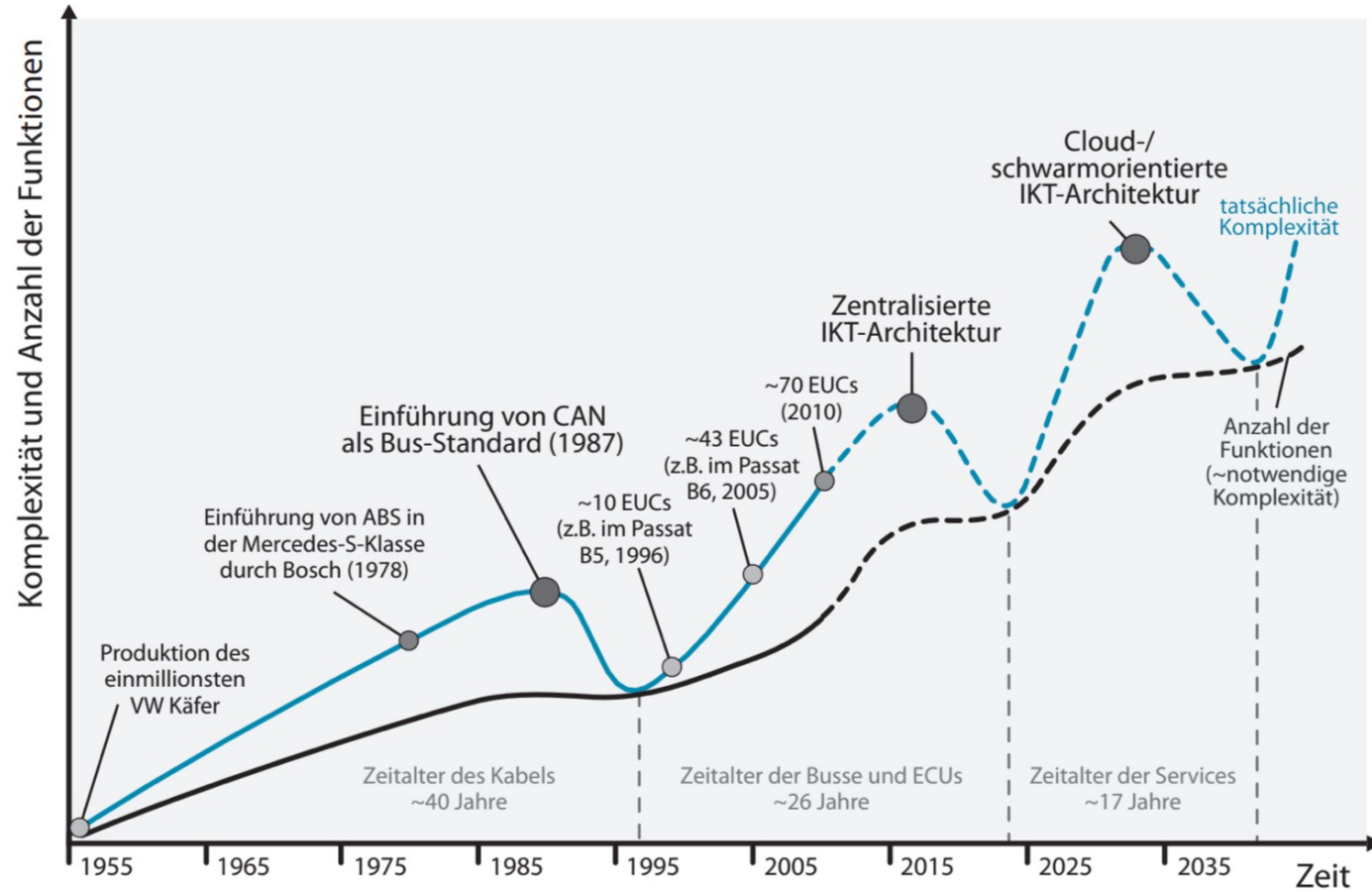


ELECTRIC

E



Software in the car is growing fast



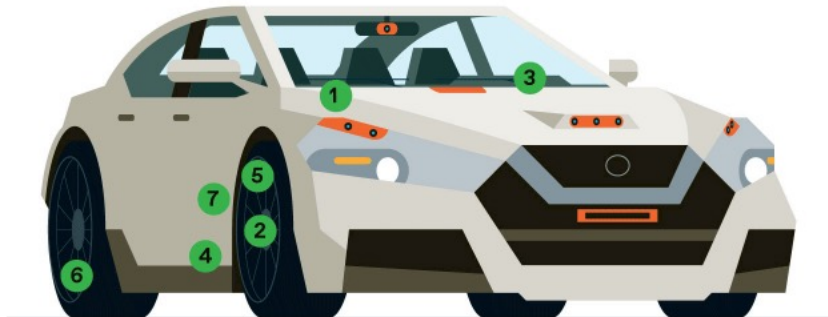
Bernard et al.: Mehr Software (im) Wagen: Informations- und Kommunikationstechnik (IKT) als Motor der Elektromobilität der Zukunft, 2011

Software in the car is becoming more important

The car is a computer on wheels

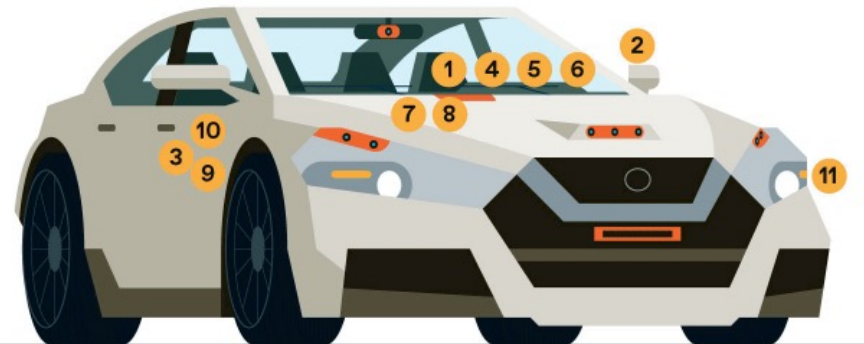
Chassis

- | | |
|--|--|
| <p>1 INERTIAL SENSOR CLUSTER
Sensors for vehicle stability control; can be combined with airbag ECU.</p> <p>2 ELECTRONIC STABILITY CONTROL
Vehicle Stability Control, Antilock Brakes, Traction Control.</p> <p>3 ELECTRIC POWER STEERING
Front, rear (optional).</p> | <p>4 ADAPTIVE DAMPING
Ride comfort control.</p> <p>5 ACTIVE ROLL CONTROL
Roll control.</p> <p>6 TIRE PRESSURE MONITORING SYSTEM
Can be combined with Keyless Entry system.</p> <p>7 TORQUE VECTORING CONTROL
Control of differential(s).</p> |
|--|--|



Body

- | | |
|---|---|
| <p>1 INSTRUMENT CLUSTER
Driver information.</p> <p>2 BODY CONTROL MODULE
Basic body (windows, lights, seats, wipers, etc.).</p> <p>3 DOOR MODULE
Local switch inputs to Body Control Module (windows, mirrors, seats).</p> <p>4 CENTER CONSOLE SWITCH PANEL
Local switch inputs to Body Control Module (defrosting, heated seats, etc.)</p> <p>5 STEERING COLUMN CONTROLS
Local switch inputs to Body Control Module (Turn signals, lights, wipers).</p> | <p>6 STEERING WHEEL CONTROLS
Local switch inputs to Body Control Module (Entertainment, Communications).</p> <p>7 SMART FUSE BOX
Power distribution and management (e.g. key-off load control).</p> <p>8 CLIMATE CONTROL
Control of cabin temperature, humidity.</p> <p>9 ANTI-THEFT SECURITY SYSTEM
Control of vehicle security systems.</p> <p>10 KEYLESS ENTRY SYSTEM
Can be combined with Tire Pressure Monitoring System.</p> <p>11 ADAPTIVE LIGHTING CONTROL
Control the brightness of individual headlight LEDs.</p> |
|---|---|

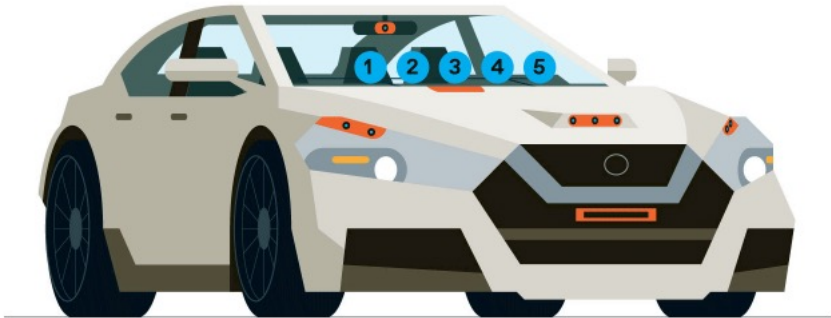


Software in the car is becoming more important

The car is a computer on wheels

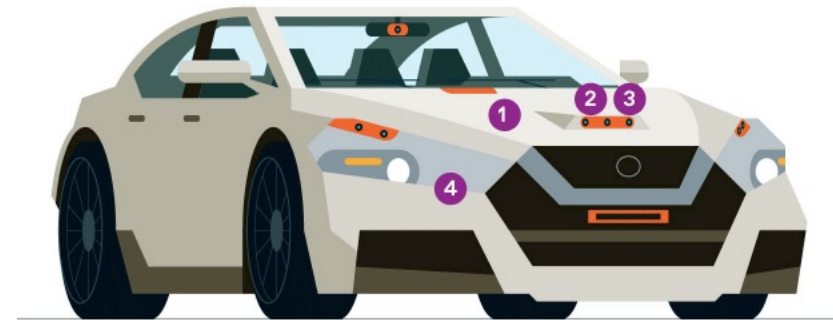
Infotainment

- 1 NAVIGATION
Route Guidance.
- 2 TELEMATICS
Vehicle data connectivity.
- 3 ENTERTAINMENT SYSTEM
Plays music and videos,
option for active noise
cancellation.
- 4 HMI DISPLAY
Touch input, and visual
output to driver.
- 5 PHONE INTERFACE
Bluetooth connectivity
to infotainment system.



Powertrain

- 1 ENGINE MANAGEMENT
Engine ignition, emissions
control, diagnostics.
- 2 AUTOMATIC TRANSMISSION
Shifting strategies.
- 3 AUTOMATIC TRANSMISSION
SHIFTER
Driver inputs to
automatic transmission.
- 4 EV POWERTRAIN/INVERTER
Control of electric motors
(drive, regen braking).

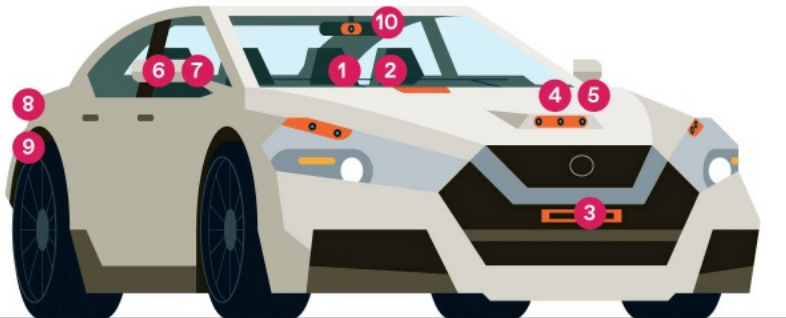


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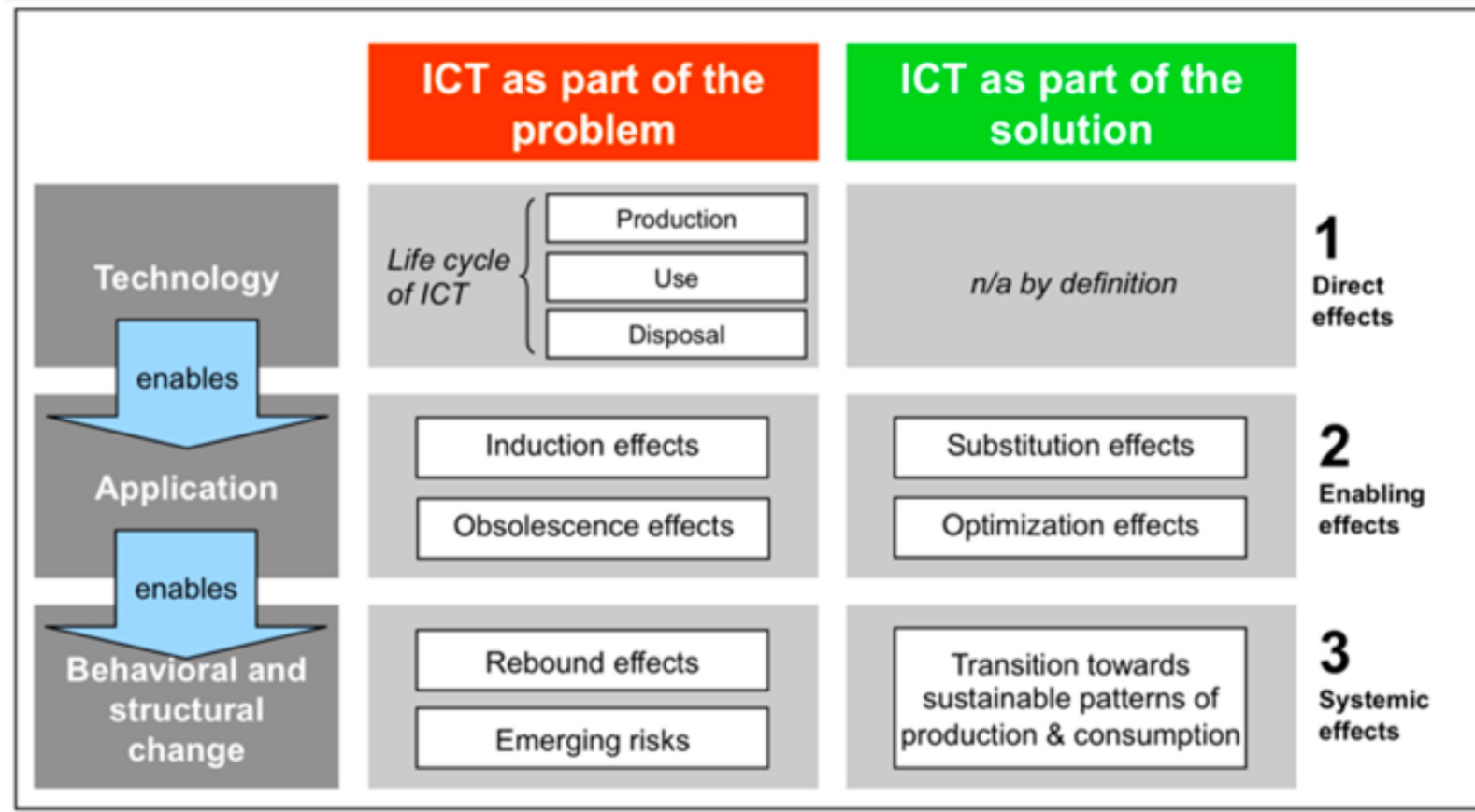
Safety

- 1 AIRBAG CONTROL**
Controls deployment of airbags.
- 2 CENTRAL ADAS/AD**
Multi-sensor fusion, automated parking, traffic jam assist, highway driving assist.
- 3 FORWARD-LOOKING RADARS**
Adaptive Cruise Control, Auto Emergency Braking.
- 4 FORWARD-LOOKING CAMERAS**
Adaptive Cruise Control, Auto Emergency Braking, Lane Keeping, Lane Departure Warning.
- 5 FRONT NIGHT VISION CAMERA**
Dedicated camera for IR spectrum.
- 6 SIDE-LOOKING RADARS**
Blind Spot Detection/ Lane Change Assist, Parking Assist.
- 7 SIDE-LOOKING CAMERAS**
Blind Spot Detection/ Lane Change Assist, Parking Assist.
- 8 REAR-FACING CAMERAS**
Reversing Assist, Parking assist (passive).
- 9 REAR ULTRASONIC SENSORS**
Reversing Assist, Parking assist (active).
- 10 INTERIOR CAMERA**
Driver Monitoring.



- How can we harness ICT for the benefit of sustainability?
- Two things are essential:
 - To stop the growth of ICT's own footprint
 - To find ways to apply ICT as an enabler in order to reduce the footprint of production and consumption by society

LES Model – Effects of / by ICT



Hilty, Lorenz M., and Bernard Aebischer. "ICT for sustainability: An emerging research field." *ICT Innovations for Sustainability*. Springer, Cham, 2015. 3-36.

Let's build an ICT system! How hard can it be?

1. Decide what to build
2. Build it
3. Test it
4. Deploy it
5. Done!

When is waterfall appropriate?

1. The requirements are known in advance.
2. The requirements have no unresolved, high risks such as due to cost, schedule, performance, safety, security, user interfaces, organizational impacts, etc.
3. The nature of the requirements will not change very much.
4. The requirements are compatible with all the key system stakeholders' expectations.
5. The architecture for implementing the requirements is well understood.
6. There is enough time to proceed sequentially.



1:32pm
July 16th 1969

BUT: We are living in a VUCA world!



Volatility, uncertainty, complexity and ambiguity

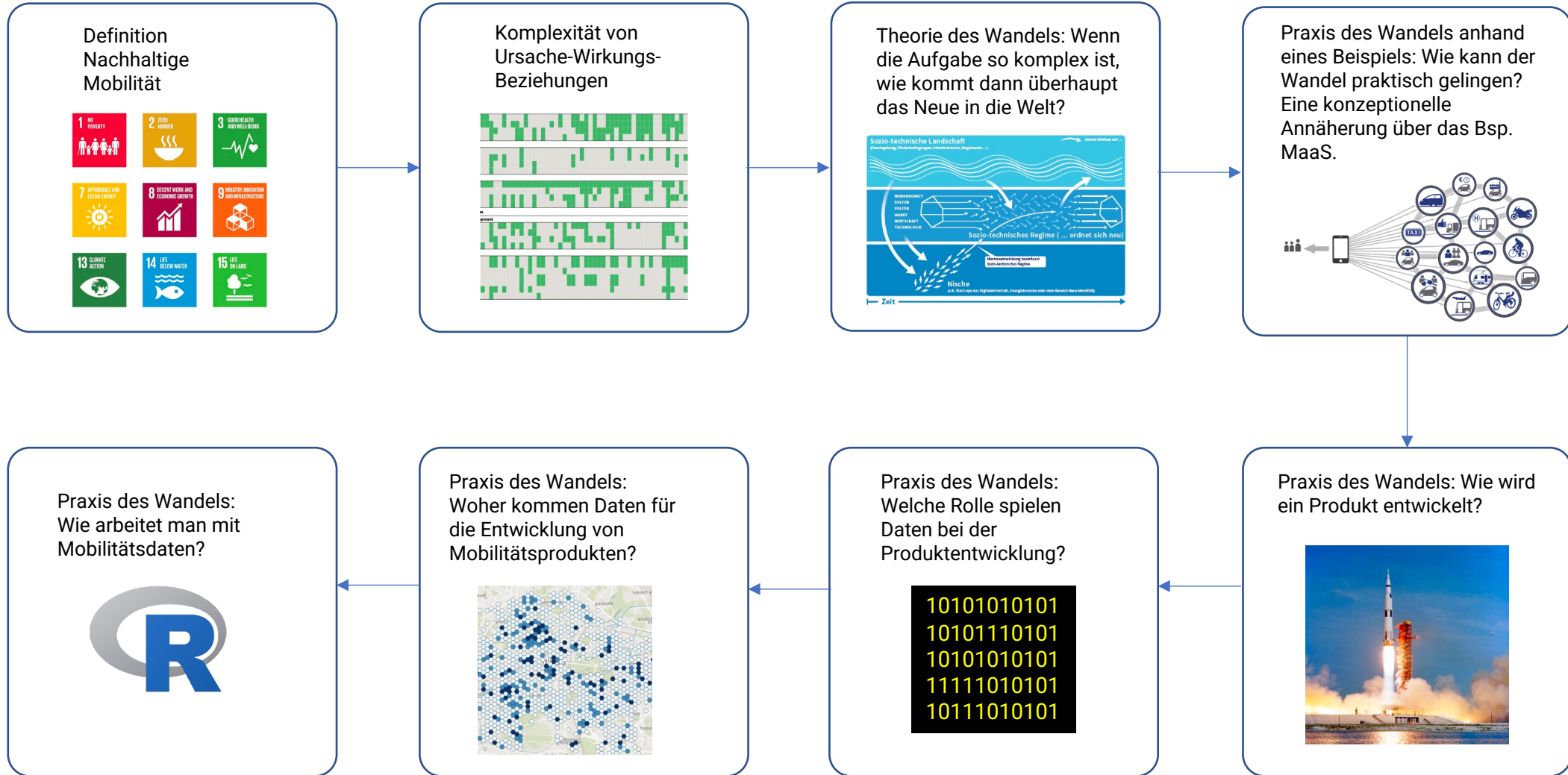
The key challenge is: change

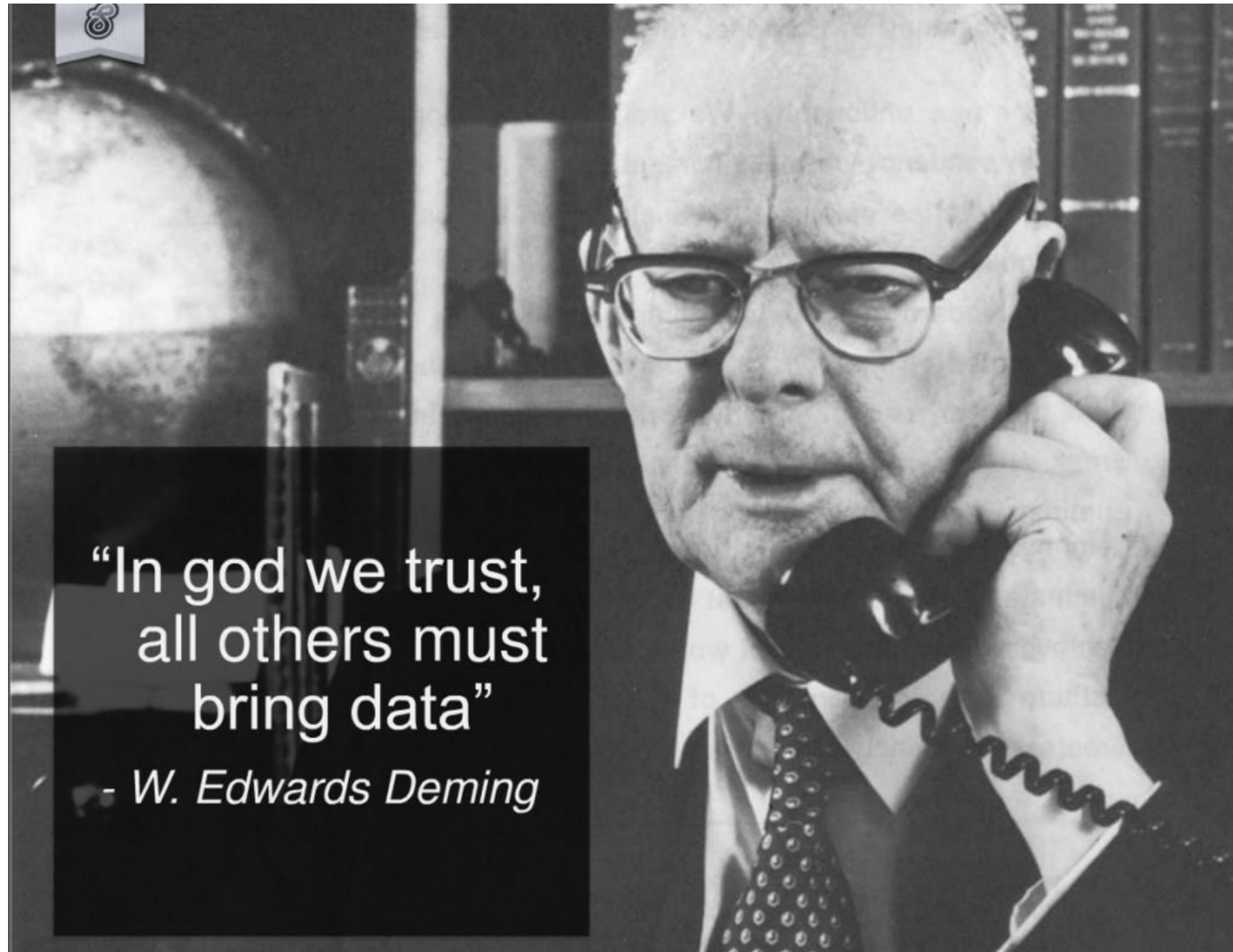
- Software seems changeable (“soft”)
- Developers prone to changes and “extra features”
- Customers often do not understand what is easy to change and what is hard
- “Good enough” vs. “optimal”

Let's build an ICT system! How hard can it be?

1. Decide what to build
 - Don't know what to build in advance
2. Build it
 - Don't know all the details how to build it
3. Test it
 - Struggling with testing and evaluation
4. Deploy it
 - Deploy, evolve, redeploy
5. Done!

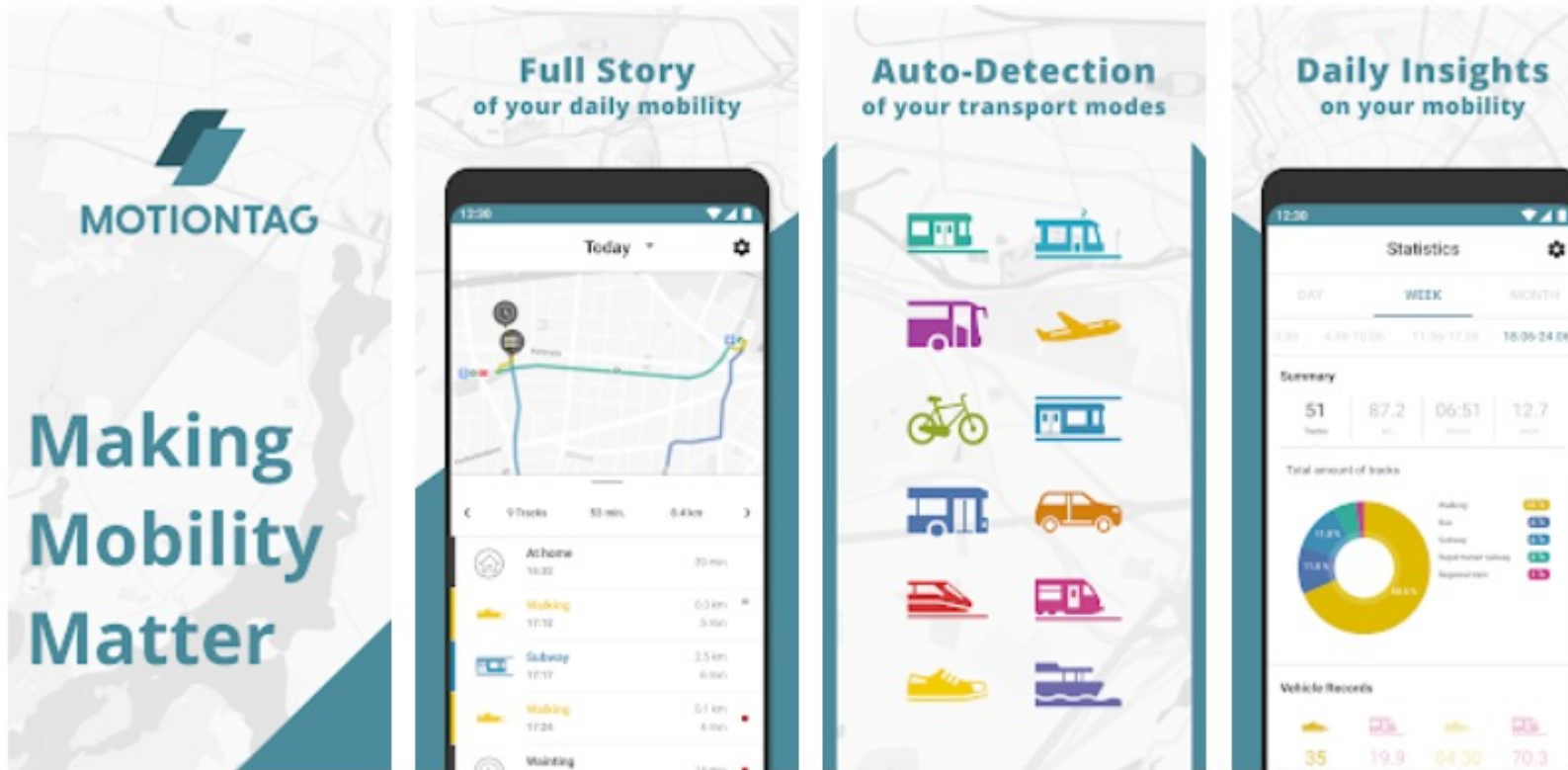
Wrap up und Ausblick





Homework 1: Data collection for next lecture

Smartphone-based GPS tracking data



Download the MOTIONTAG-App from the store.
Use it for some days.

We will use the data in the next lecture on 18.06.2021



Bereitstellung der Daten über ein Auskunftsbegehren

Mail an: florian.duffner@motion-tag.com

Betreff: Auskunftsbegehren für das Seminar „Smart Mobility Transition?“

Lieber Herr Duffner,

Ich nutze die App MOTIONTAG. Hiermit möchte ich sie bitten, die aufgezeichneten Mobilitätsdaten für den Account meine@email.de bereitzustellen. Bitte senden Sie die Daten an schoenduwe@h2-mobility.de . Die Daten sollen im Rahmen des Seminars „Smart Mobility Transition?“ an der Goethe-Universität Frankfurt/Main genutzt werden.

Vielen Dank.

Beste Grüße

...

Homework 2

Install R and RStudio



Install the language and the interpreter R.

<https://cran.rstudio.com/>



The second step is to install the IDE

<https://rstudio.com/products/rstudio/download/#download>