UNITED

Engineering Knowledge Transfer Units to Increase
Student´s Employability and Regional Development

Sustainable urban mobility planning (SUMP)

Torsten Merkens M.Eng.
(ECSM | Aachen University of Applied Sciences)

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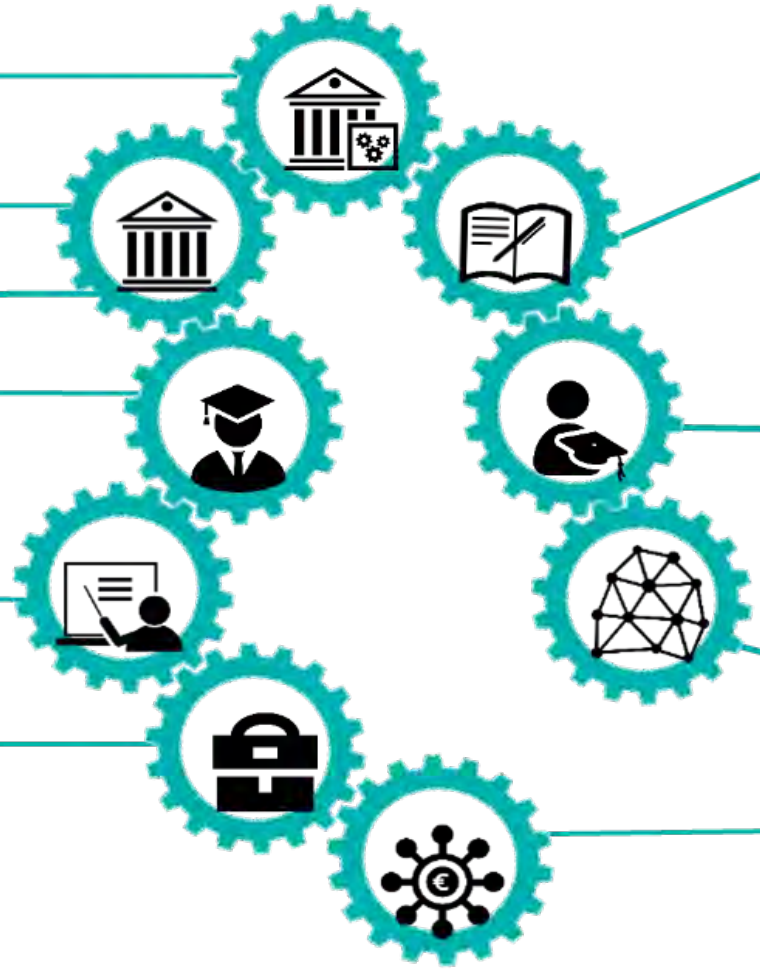
FH Aachen | University of Applied Scienes

University status in 1971, mainly from traditional engineering schools

10 Faculties

9 in-house and three affiliated institutes

1,150 Employees, i.a.
- 250 Professors
- 900 Lectures, Research & Administration



52 Bachelor's and 25 Master's degree programmes (thereof 9 Bachelor dual study programmes)

14,178 Students (WS 2017/2018)

Member of the European University Association (EUA)

And HAWtech

Third-party Funds: ~17 m € (2017)

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ECSM | European Center for Sustainable Mobility

Founded in the year 2013

Involved Faculties and Institutes:

- Civil Engineering
- Electrical Engineering and Information Technology
- Aerospace Engineering
- Mechanical Engineering and Mechatronics
- Design
- Energy Technology (Solar Institute Jülich)

Research Focuses:

- Integrated Mobility Planning
- Energy and Mobility
- Digitalisation of Mobility
- Vehicles and Infrastructure of road transport
- Vehicles and Infrastructure of rail transport

External Fundings (2013-today):
~6.5 Mio. €

Fields of Activity:

- Research
- Consultation
- Project Development

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www.ecsm.fh-aachen.de or via QR:

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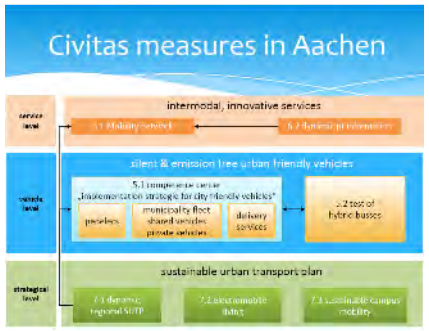
Research in Sustainable Mobility
at ECSM (extract of projects)

UNITED

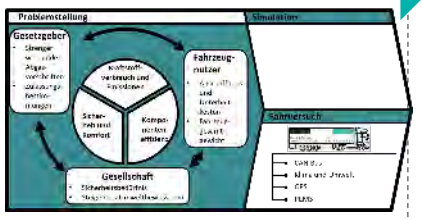
ec2go

CIVITAS DYN@MO



PPV is born

ANFAHRT



SVEN is born

Business & Mobility Models

COSTART

COSTART

SHAREUREGIO

SHAREuregio

SkyCab

Foundation of ECSM

2010 2012 2014 2016 2018 2019

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  2. Urban Mobility Index
  3. Classification of Cities
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Introduction

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Social, technical, urban challenges

Electric power and heat
- Switching to renewable energies
- Continuous supply of electricity
- Storage and distribution
- Clearing

Urban Development
- Structural change in jobs, landscape, (re-)urbanization
- Land usage: Demand by private and commercial transport
- Increase traffic safety
- Spatial disparities

Climate and health protection
- Reduction of CO2 and NOX
- Noise reduction
- Increase traffic safety

Transport & mobility planning
- Multi Modality
- Expansion of sharing mobility
- Improvement of transport organization and billing
- "Value change" by users?
- Problems in short-range/urban mobility

Infrastructure
- Long planning and implementation periods
- High maintenance effort
- What is needed (more efficient planning)?
- Connected/smart infrastructure

Technical innovations
- "Fuel change"?
- Electro Mobility
- Autonomous driving
- Connected cars / car-to-x

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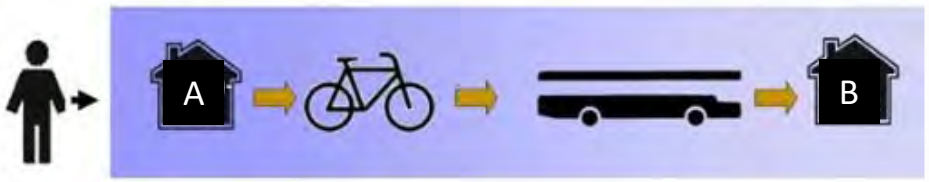
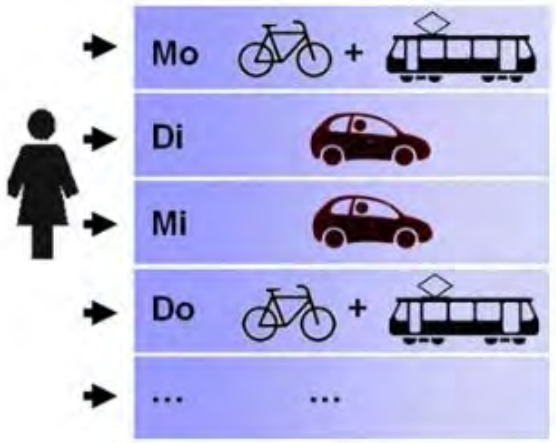
Worldwide trends

- Continuous urban sprawl.
- Sharp decrease in new car buyers between 18 and 29 years old.
- Worldwide > 90 % on the days private cars are unused.
- Inter- and multi modal mobility.



Source: Von der Ruhren et al. (2003)

Multi modality: In the future, the aspects "Organization/billing of multi modal mobility“ will be increasingly important for the users.



Source: Von der Ruhren et al. (2003)

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Four disruptive trends

Autonomous

Connected Services

Shared Mobility

Electrification

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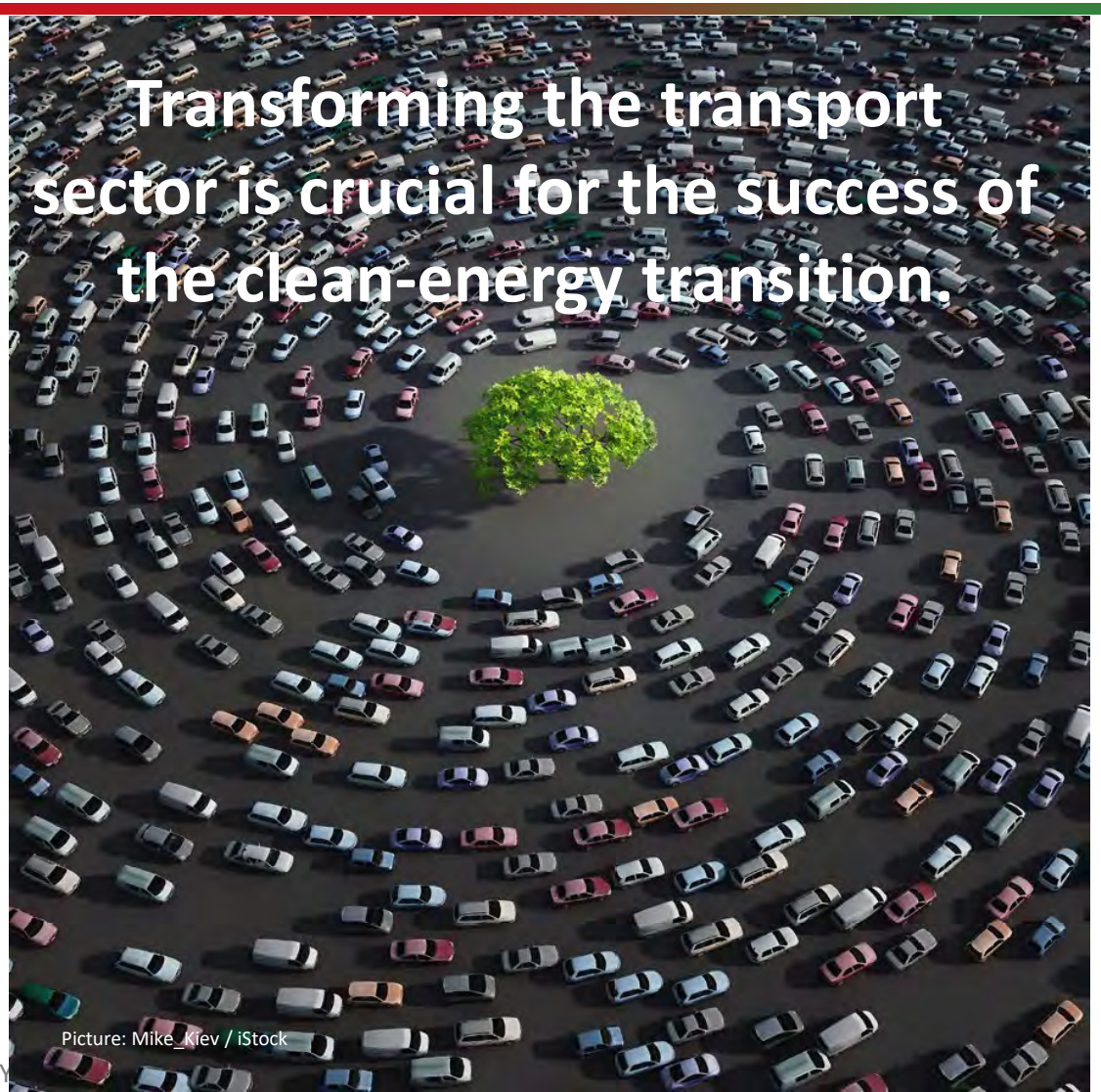
Transport transformation and clean-energy transition



Picture: Mike_Kiev / iStock

Source: Agora Verkehrswende (2017)

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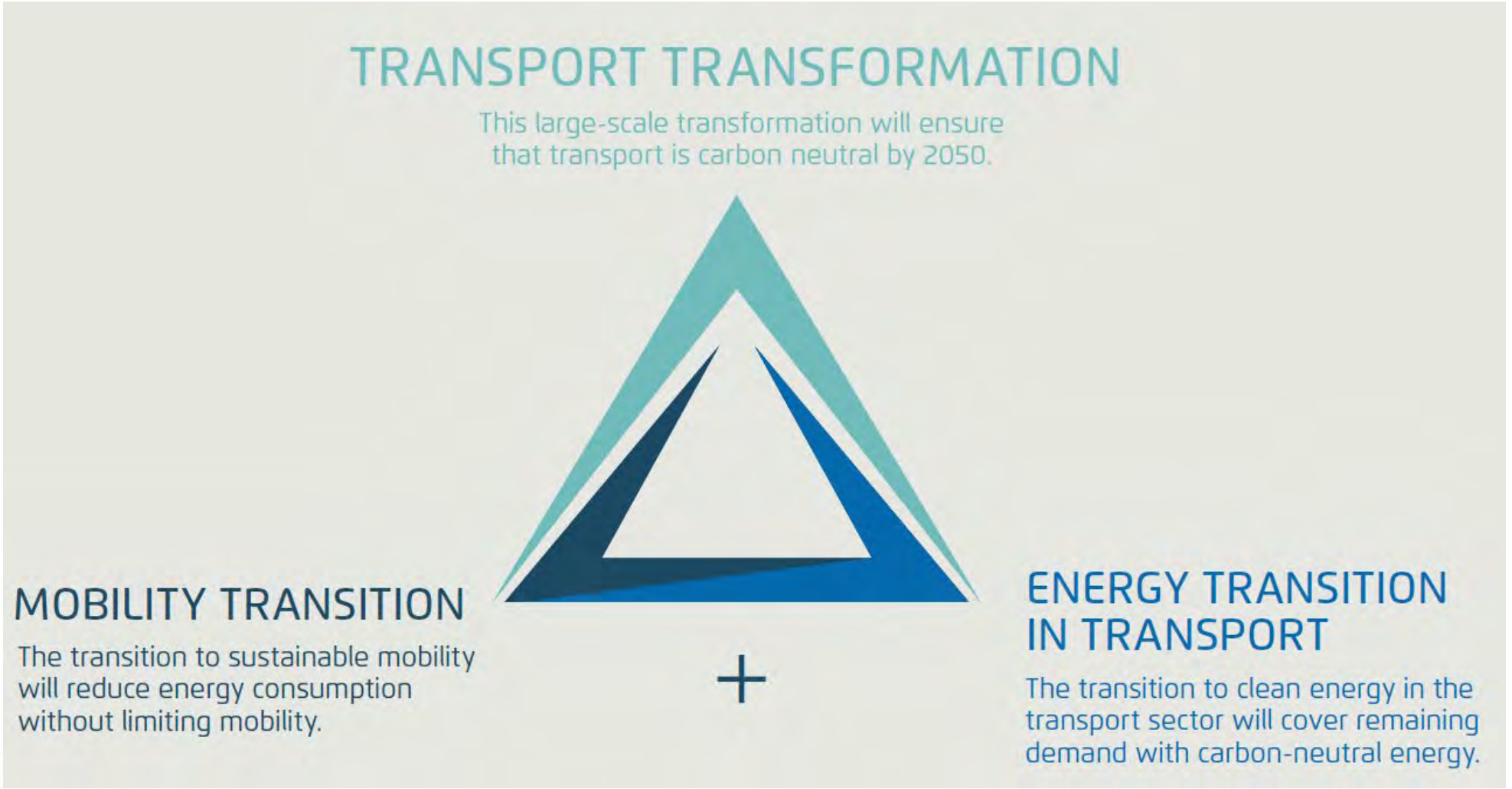
The geometry of transport transformation



Source: Agora Verkehrswende (2017)

Insights into the Transport transformation

12 Insights into the Transport transformation (I):

1. Transforming transport requires **decarbonisation** and **sustainable mobility**.
2. **Efficiency** is the guiding principle of the transport transformation.
3. **In cities**, the mobility transition has **already begun**.
4. **Rural areas** also benefit from the mobility transition
5. **Driverless vehicles** are ideal for shared use.
6. **Electrification** is key to an energy transition in transport.

Source: Agora Verkehrswende (2017)

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Insights into the Transport transformation

12 Insights into the Transport transformation (II):

7. **Carbon-neutral fuels** can supplement wind and solar energy.
8. The freight sector needs an improved **rail system** and **climate-neutral roads**.
9. Power supply and transport benefit from **sector coupling**.
10. Rethinking the development and financing of **transport infrastructure**.
11. The transport transformation can **strengthen the industrial sector**.
12. The transport transformation will be driven by its **benefits to society**.

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Source: Agora Verkehrswende (2017)

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Innovations

- Technical development of **new drives** in private and public transport (e.g. electric drives).
- Technical **development in cars** like assistance systems.
- Improving the **networking and digitalization** of different transport systems.
- Implementation of more **sharing mobility options.**
- Driverless, **autonomous** / automated vehicles.
- **"Intelligent" Infrastructure** (Bike, Bus Rapid Transport, Increase safety).
- **Mobility management** (e.g., in-house MM, expansion of vehicle sharing offers).
- **Traffic management** (city toll, environmental zones, intelligent traffic lights control).
- Optimization of **logistics and fleet management**.
- **Social networks** (commuter portal) and **guidance system** (navigation, real-time information for PT, parking guidance systems).
- Business development / **new mobility services**.

Electro mobility

Electro mobility is not the "panacea" for the current challenges of urban mobility, but offers good options in a multimodal context!

- Only when using "green/renewable" electricity, electro mobility contributes to climate protection.
- In areas with high population/demand density, public transport, cycling (especially e-bikes) and walking should still be the first choice of transport mode.
- Multi modality and sharing mobility options (with electric vehicles) support a sustainable choice of transport mode.
- Electro mobility from renewable energies needs an intense expansion of charging infrastructure.

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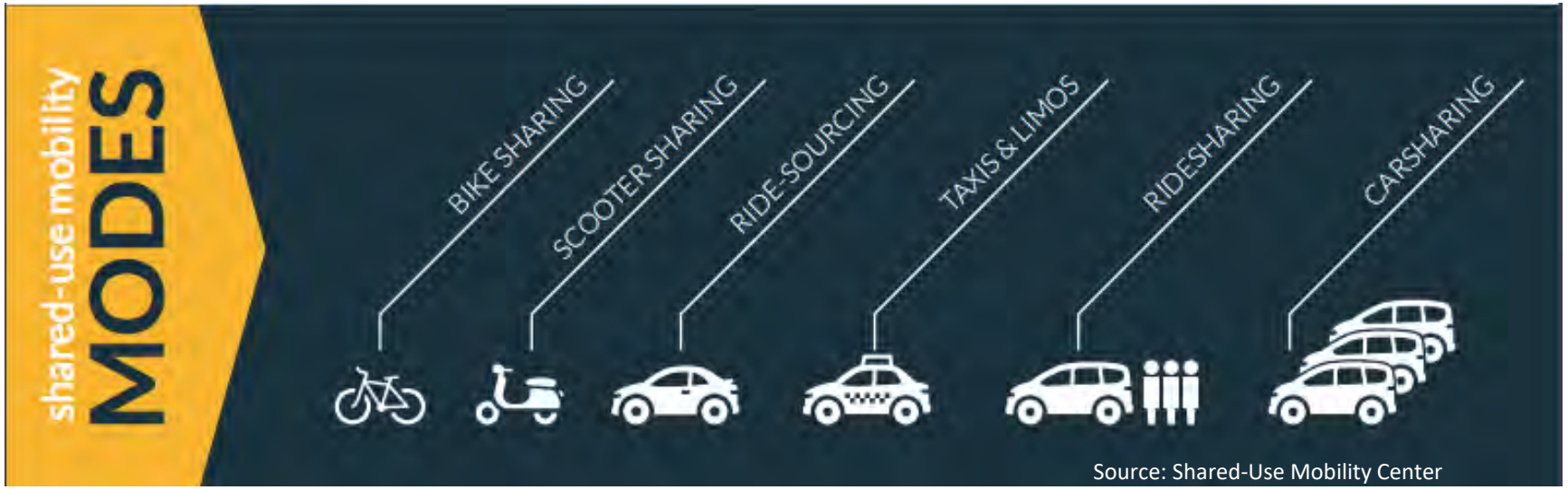
Sharing mobility options / New mobility services



Carsharing

DB Flinkster, stadtmobil, zipcar, CAR2GO, DriveNow

Ridesharing

BlaBlaCar, CleverShuttle, waze CARPOOL

E-Hailing

UBER, DiDi, lyft, Gett

Mobility as a service

moovel, Qixxit, Leipzig mobil, mobility broker

Source: Spulber et al. (2017)

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Strategies

- Implementation of integrated mobility, transport and land development planning at the regional level.
  - Defining "goals, processes and priorities", increasing consistency and speed.
  - For short-range/urban mobility: Making compromises is not (always) the solution.
  - We should make (again) more concepts in freight transport and commercial transport .
- Simplifying the usability / combinability of different transport systems is very important.
- Innovations offer many opportunities that must transport planners and decision makers actively use.
- More fields of action for municipalities: Promotion of PT, expansion of charging infrastructure, promote mobility management (e.g. for companies), promotion of electro mobility e.g. subsidy the purchase, implement digitalisation into parking space management and urban guidance systems

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Measures: Strengthening short-range/urban mobility

Transport:
- Equal rights for cycling, walking, car and PT,
- Relief of urban infrastructures and urban spaces

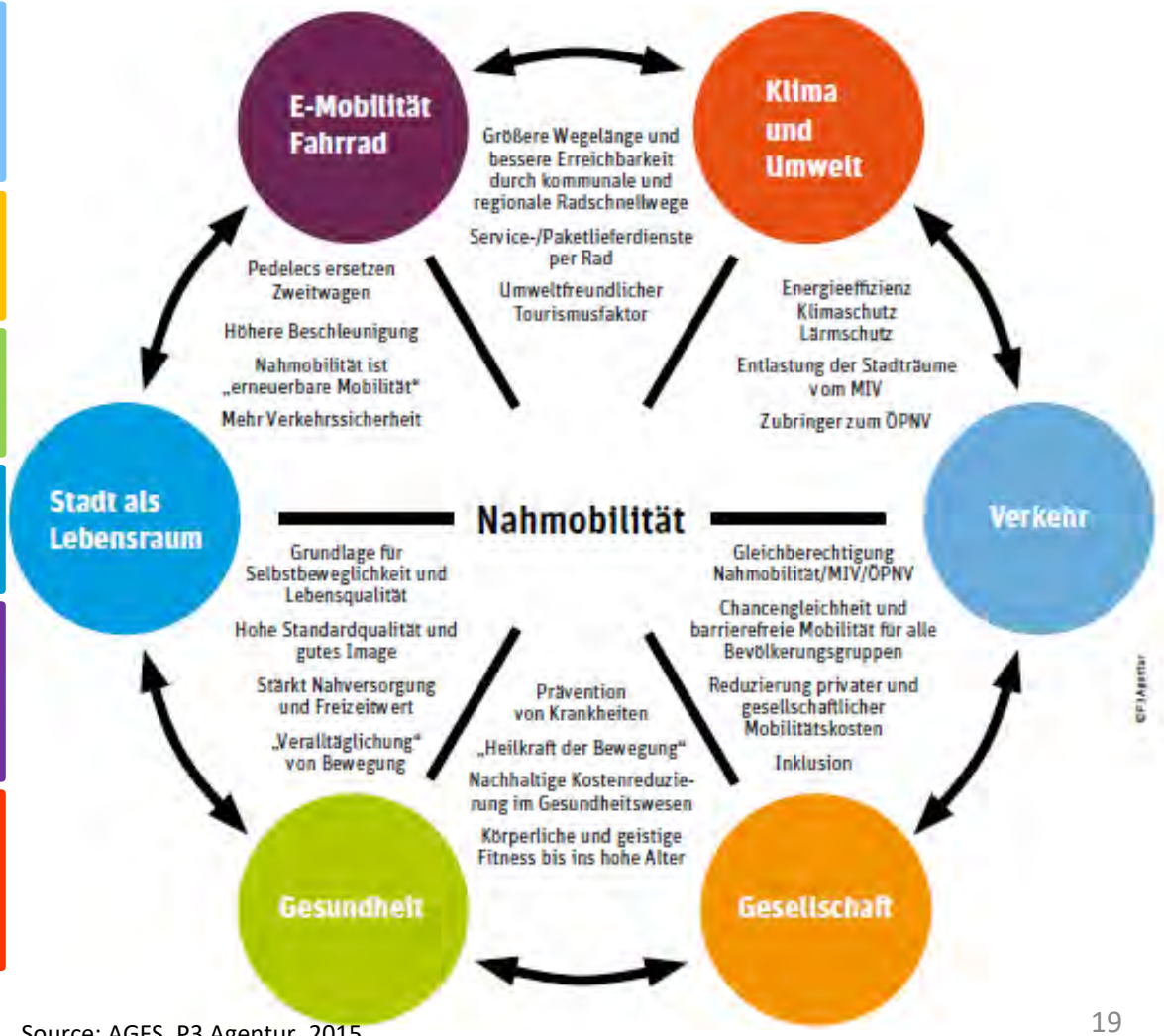
Society:
- Access to mobility (costs, reducing barriers, …)

Health:
- Moving keeps healthy, prevention of diseases

City as a living space:
- Quality of life (Safety, activity, …)

E-Mobility and Cycling:
- Sustainable Mobility,
- Longer travel distances, better access

Climate and Environment:
- Energy efficiency, renewable fuels, reduction of pollutant and noise emission



Source: AGFS, P3 Agentur, 2015

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Traditional transport planning vs. SUMP

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Traditional transport planning vs. SUMP

Traditional Transport Planning		Sustainable Urban Mobility Planning
Focus on traffic	→	Focus on **people**

https://www.bild.de/regional/muenchen/muenchen-aktuell/verkehr-ueber-20-kilometer-stau-auf-inntalautobahn-62772816.bild.html

https://www.spiegel.de/fotostrecke/gesperrte-autobahn-60-kilometer-alltagskultur-fotostrecke-57271-2.html

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Traditional transport planning vs. SUMP

Primary objectives: Traffic flow capacity and speed	→	Primary objectives: **Accessibility** and **quality of life**, including social equity, health and environmental quality, and economic viability

https://www.ptvgroup.com/en/solutions/products/ptv-vissim/areas-of-application/traffic-flow-simulation/

https://3minutesstop.alstom.com/infographie/how-can-train-accessibility-be-improved/

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Traditional transport planning vs. SUMP

Mode-focussed	→	**Integrated development of all transport modes** and shift towards sustainable mobility

https://www.focus.de/gesundheit/news/gefaehrliche-stickoxide-kommt-das-verbot-was-diesel-abgase-so-besonders-riskant-fuer-ihre-gesundheit-macht_id_8507943.html

DO THE RIGHT MIX

https://www.eltis.org/file/do-right-mix-logo

https://www.zukunft-mobilitaet.net/161399/konzepte/mobilitaetstation-verknuepfung-artikelserie-oepnv-staedtebau/

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Traditional transport planning vs. SUMP

Infrastructure as the main topic	→	**Combination** of infrastructure, market, regulation, information and promotion

https://blog.gbs.com/trends-markt/de-cix-betreiber-des-weltweit-groessten-internetknotens-wird-20

https://www.intelligenttransport.com/transport-articles/73506/smart-mobility-smart-cities/

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Traditional transport planning vs. SUMP

Sectoral planning document	→	Planning document **consistent with related policy areas**

https://www.kip.net/hessen/floersheim

https://www.eppgroup.eu/newsroom/publications/eu-transport-policy

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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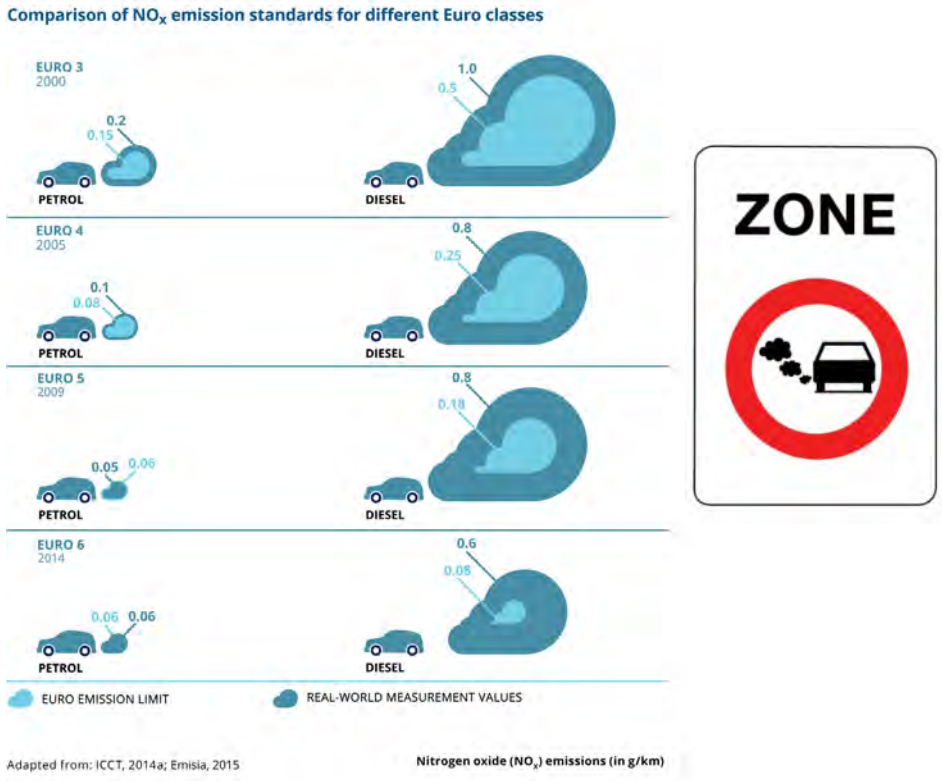
Traditional transport planning vs. SUMP

Short and medium-term delivery plan	→	Short and medium-term delivery plan embedded in a **long-term vision and strategy**



https://www.roboticsbusinessreview.com/unmanned/consumer-acceptance-of-self-driving-cars-soars-study-says/

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Traditional transport planning vs. SUMP

Covering an administrative area	→	Covering a **functional urban area** based on travel-to-work flows

https://www.timeanddate.com/holidays/us/administrative-professionals-day

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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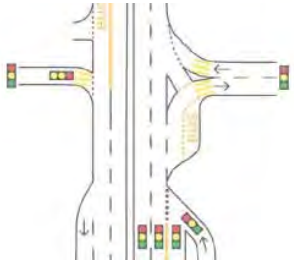
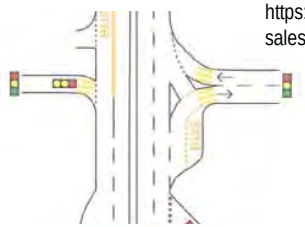
Traditional transport planning vs. SUMP

Domain of traffic engineers	→	**Interdisciplinary** planning teams
Planning by experts	→	Planning with the **involvement of stakeholders and citizens** using a transparent and participatory approach



http://www.buchhoferag.ch/index.php/referenzen/linkreferenzenporta/verkehr

https://www.salesforce.com/ca/blog/2018/01/shake-up-sales-team-meeting-agenda.html



http://www.schoeneaussichtenffm.de/bewahrung_umwelt

https://www.zv-vrt.de/oepnv-konzept

https://www.elemize.com/benefits-of-digitalization-in-the-power-industry/

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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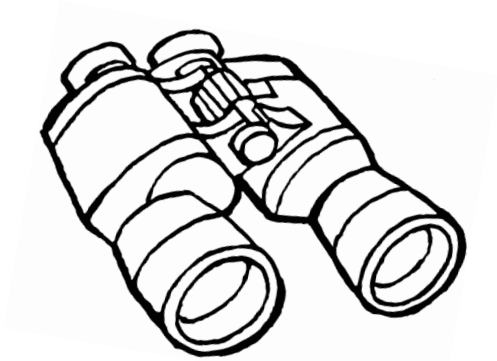
Traditional transport planning vs. SUMP

Limited impact assessment	→	Systematic **evaluation** of impacts to facilitate **learning** and improvement

1 x

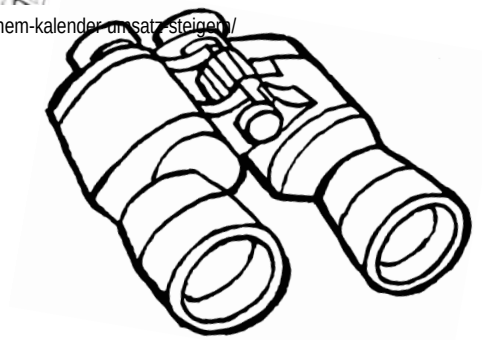


https://kiddicolour.com/de/malvorlage/fernglas/

later

https://www.scm-blog.de/2015/11/wir-lernen-das/

https://www.sachs-media.com/mit-einem-kalender-umsatz-steigern/



https://kiddicolour.com/de/malvorlage/fernglas/

https://www.scm-blog.de/2015/11/wir-lernen-das/

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Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

What is a SUMP?

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Definition

A Sustainable Urban Mobility Plan is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Policy context

Sustainable Urban Mobility Planning is Europe's de facto urban transport planning concept. The policy that facilitated its establishment has been systematically developed by **European policy makers** since 2005. Its most important milestone was the publication of the Urban Mobility Package at the end of 2013, where the European Commission defined in an **Annex** the concept of sustainable Urban Mobility Plans. At the same time, the first version of the **Guidelines** was released. The Urban Mobility Package advocates "a step-change in the approach to urban mobility…to ensure that Europe's urban areas develop along a more sustainable path and that EU goals for a competitive and resource efficient European transport system are met." It sketches out the guiding principles of the planning process and the topics to be addressed in a Sustainable Urban Mobility Plan.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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The objectives

What turns a plan into a “sustainable” mobility plan?

A Sustainable Urban Mobility Plan aims to create an urban transport system by addressing – as a minimum – the following objectives:

- Ensure all citizens are offered transport options that **enable access** to key destinations and services;
- Improve **safety and security**;
- Reduce **air and noise pollution**, greenhouse gas emissions and energy consumption;
- Improve the **efficiency and cost-effectiveness** of the transportation of persons and goods;
- Contribute to enhancing the **attractiveness and quality of the urban environment and urban design** for the benefits of citizens, the economy and society as a whole.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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The scope

The policies and measures defined in a Sustainable Urban Mobility Plan cover all modes and forms of transport in the entire urban agglomeration, including public and private, passenger and freight, motorized and non-motorized, moving and parking.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

1 Plan for sustainable mobility in the "functional urban area"

Cities are connected with their surroundings by daily flows of people and goods, meaning the geographical scope of a SUMP needs to be based on this "functional urban area". Depending on the local context, this might be a city and its surrounding peri-urban area, an entire polycentric region, or another constellation of municipalities. Planning on the basis of actual flows of people and goods is an important criterion to make a plan relevant and comprehensive, even if municipal boundaries may follow a different logic and make this difficult to achieve.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

2 Cooperate across institutional boundaries

The development and implementation of a Sustainable Urban Mobility Plan needs to be based on a high level of cooperation, coordination and consultation across different levels of government and between institutions (and their departments) in the planning area.

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Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

What is a SUMP – the 8 principles

3 Involve citizens and stakeholders

A Sustainable Urban Mobility Plan focuses on meeting the mobility needs of people in the functional urban area, both residents and visitors, as well as institutions and companies based there. It follows a transparent and participatory approach, actively involving citizens and other stakeholders throughout the plan's development and implementation.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

4 Assess current and future performance

A Sustainable Urban Mobility Plan builds on a thorough assessment of the current and future performance of the transport system in the functional urban area. It provides a comprehensive review of the existing situation and establishes a baseline against which progress can be measured. To do this, the Sustainable Urban Mobility Planning process identifies objectives and ambitious but realistic targets which are consistent with the established vision, and then defines performance indicators for each of these.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

5 Define a long-term vision and a clear implementation plan

A Sustainable Urban Mobility Plan is based on a long-term vision for transport and mobility development for the entire functional urban area and covers all modes and forms of transport: public and private; passenger and freight; motorised and non-motorised; and moving and stationary. It also includes infrastructure and services. A SUMP contains a plan for the short-term implementation of objectives and targets through measure packages. It includes an implementation timetable and budget as well as a clear allocation of responsibilities and outline of the resources required.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

6 Develop all transport modes in an integrated manner

A Sustainable Urban Mobility Plan fosters balanced and integrated development of all relevant transport modes while prioritising sustainable mobility solutions. The SUMP puts forward an integrated set of measures to improve quality, security, safety, accessibility, and cost effectiveness of the overall mobility system. A SUMP includes infrastructure, technical, regulatory, promotional and financial measures.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

7 Arrange for monitoring and evaluation

The implementation of a Sustainable Urban Mobility Plan must be monitored closely. Progress towards the objectives of the plan and meeting the targets are assessed regularly based on the chosen performance indicators. Appropriate action is required to ensure timely access to the relevant data and statistics. Ongoing monitoring and evaluation of the implementation of measures can suggest revisions of targets and, where necessary, corrective action in implementation.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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What is a SUMP – the 8 principles

8 Assure quality

A Sustainable Urban Mobility Plan is a key document for the development of an urban area. Having mechanisms in place to ensure a SUMP's general professional quality and to validate its compliance with the requirements of the Sustainable Urban Mobility Plan concept (i.e. this document) is an effort worth taking. Assurance of data quality and risk management during implementation require specific attention.

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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The benefits

- Improving "**Quality of Life**"
- Saving costs – creating **economic benefits**
- Contributing to **better health and environment**
- Making mobility **seamless** and **improving access**
- Making more **effective use of limited resources**
- Winning **public support**
- Preparing **better plans**
- Fulfilling **legal obligations** effectively
- Using **synergies**, increasing relevance
- Moving towards a **new mobility culture**
- …

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Planning Cycle

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“Planning Cycle”

The 12 Steps of Sustainable Urban Mobility Planning – A decision maker’s overview

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Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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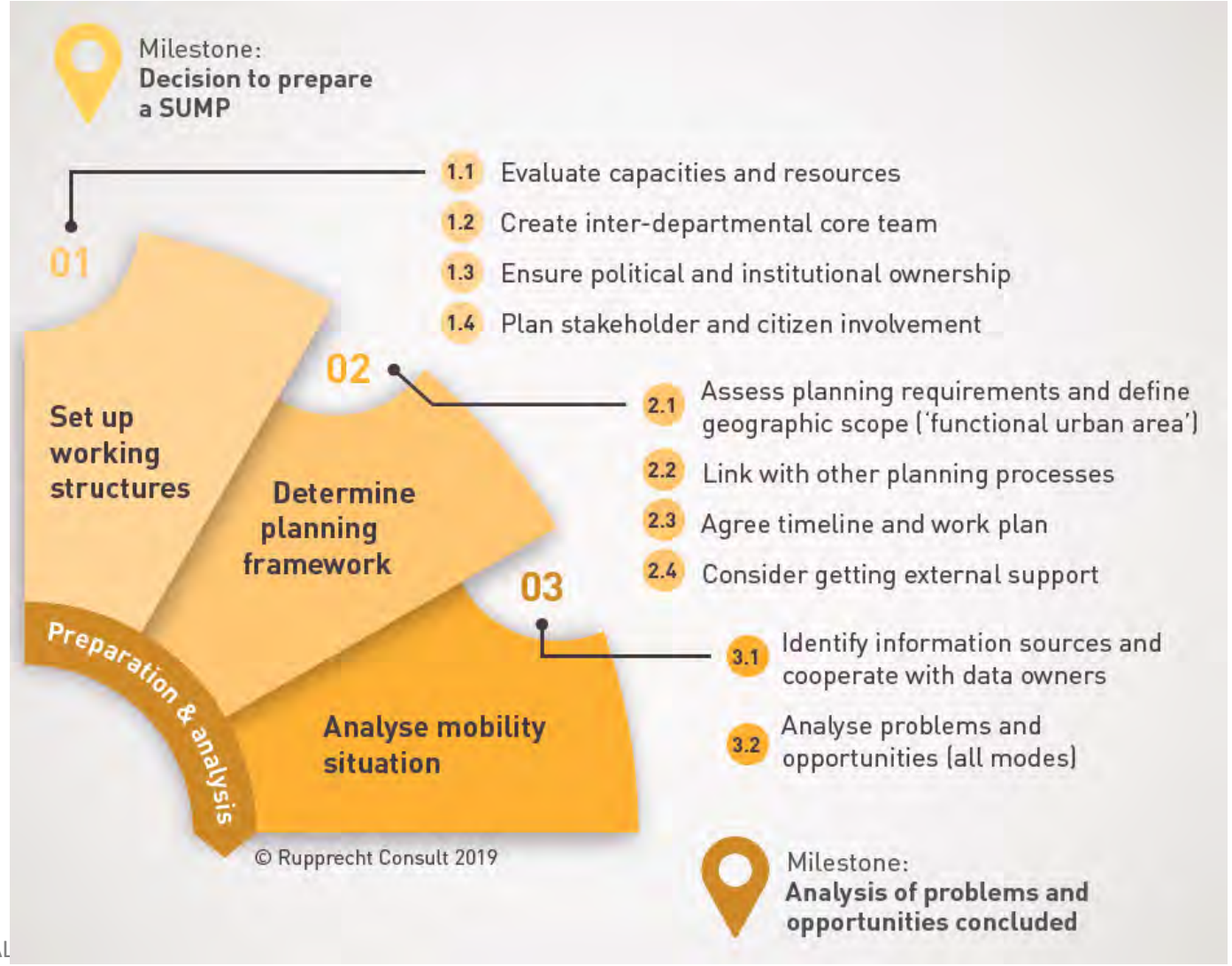
“Planning Cycle” – Phase 1: Preparation & analysis



Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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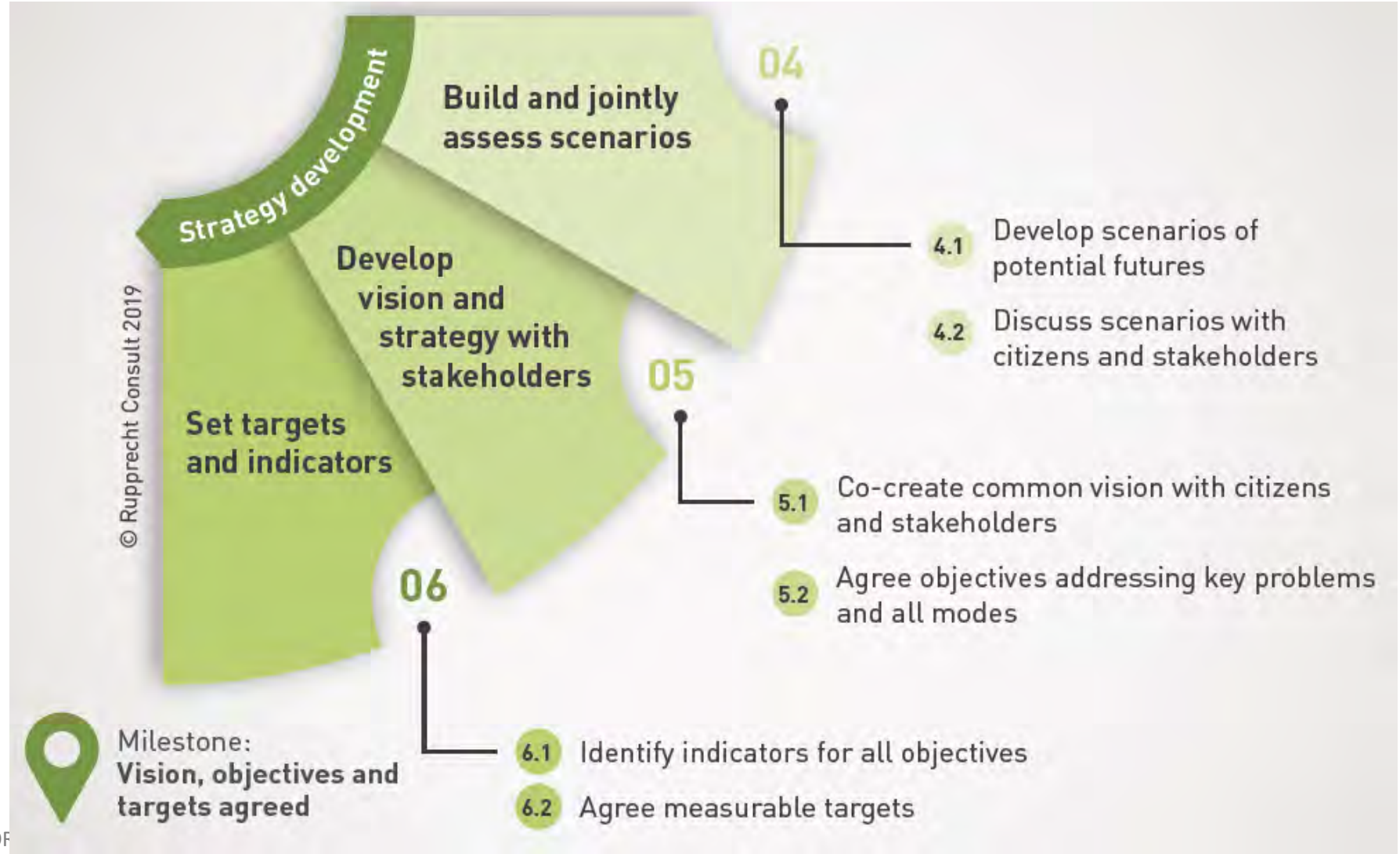
“Planning Cycle” – Phase 1: Strategy developement



Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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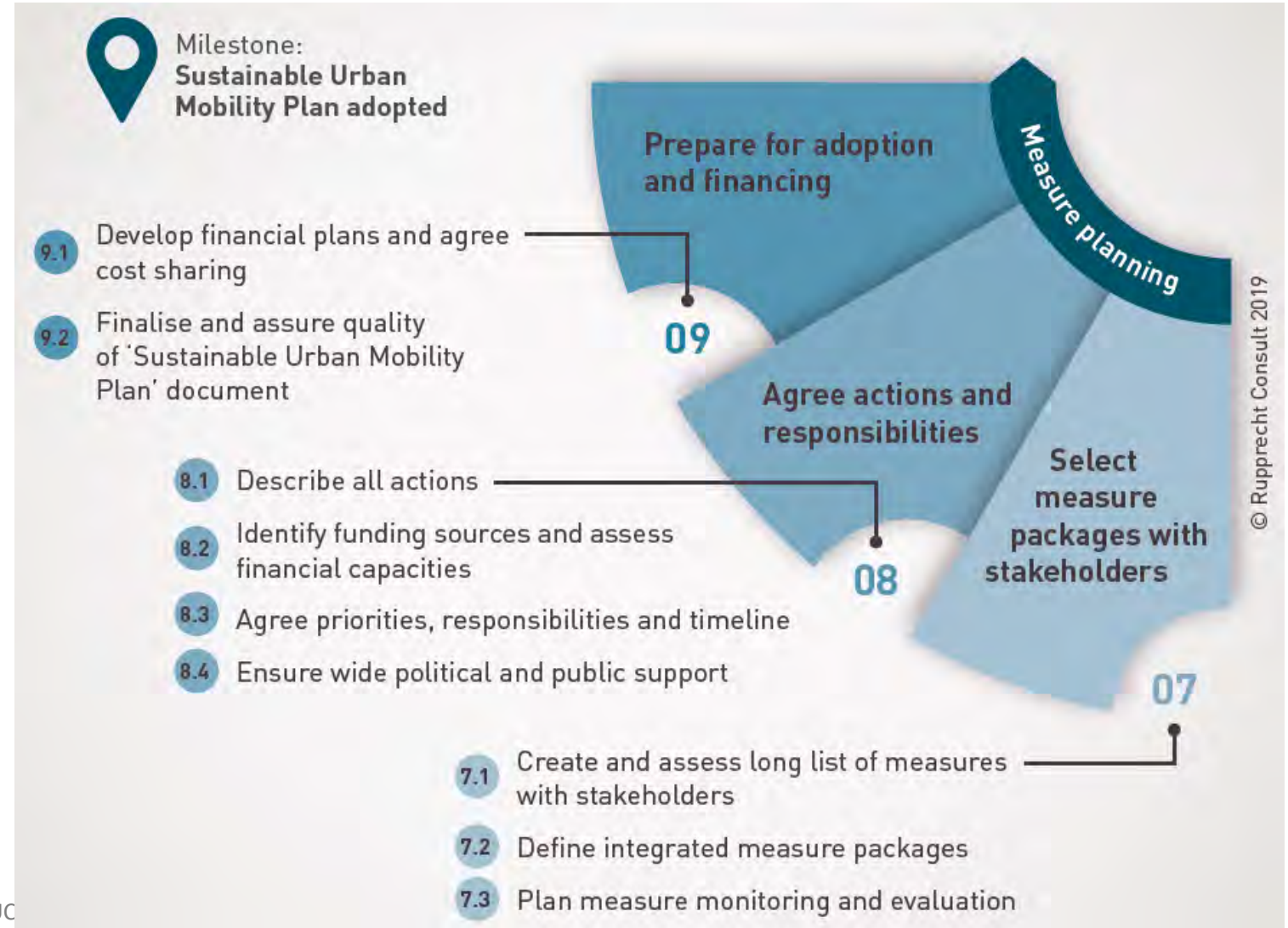
“Planning Cycle” – Phase 3: Measure planning



Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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“Planning Cycle” – Phase 4: Implementation & evaluation

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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2. Agora Verkehrswende (2017): Transforming Transport to Ensure Tomorrow's Mobility

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Engineering Knowledge Transfer Units to Increase Student´s Employability and Regional Development

Sustainable urban mobility planning (SUMP)

Torsten Merkens M.Eng.
(ECSM | Aachen University of Applied Sciences)

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Table of Content

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Mobility Cultures

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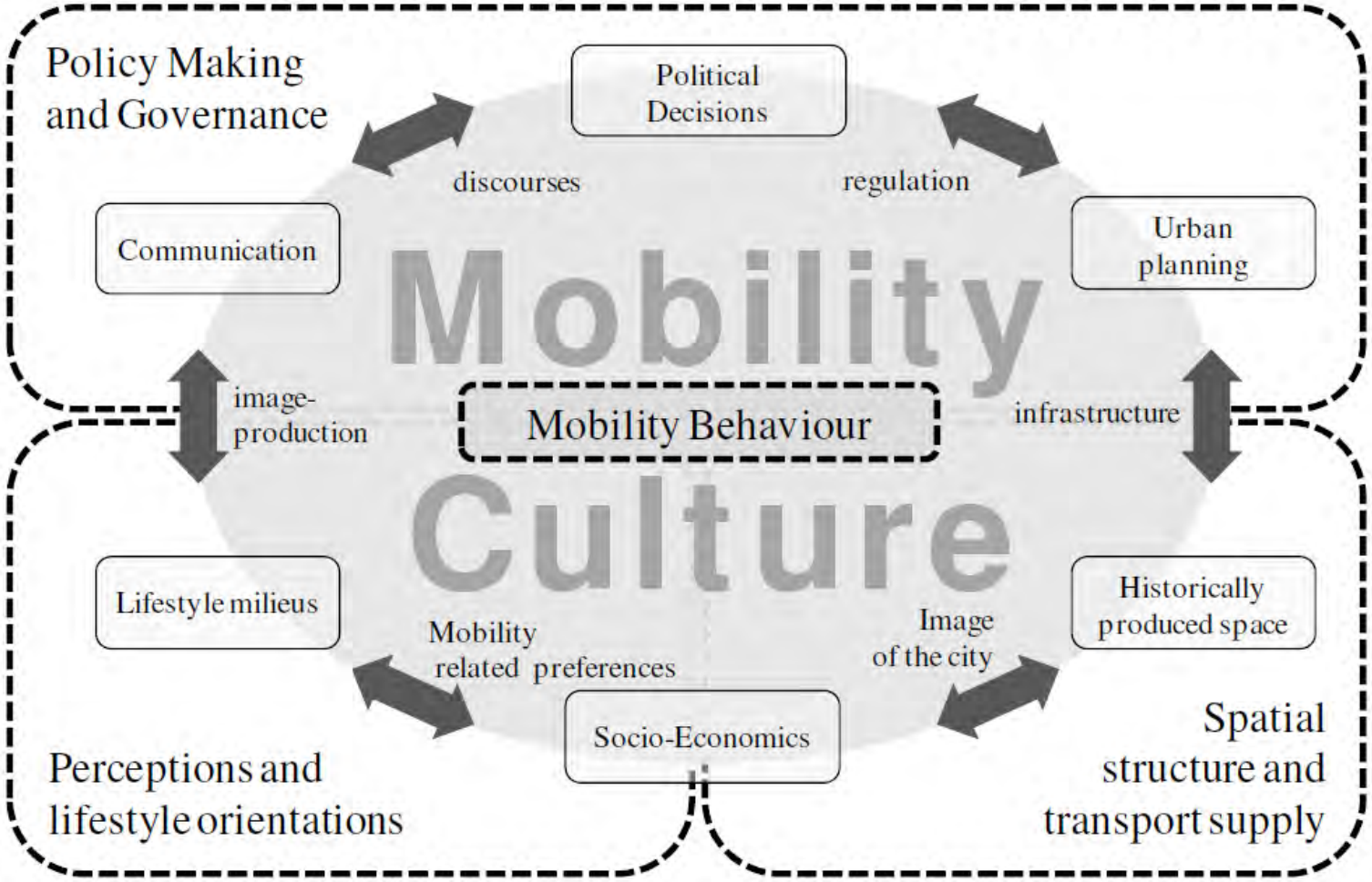
Workshop Session

Four key dimensions of mobility culture have been identified



Source: Wulfhorst, G. et. al., 2013

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Mobility Cultures: The four dimensions

(1) Spatial structure and transport supply:

Key aspects of this dimension include the characteristics, opportunities and constraints provided by the fundamental geographical space and its topography, economic and demographic framing conditions, corresponding urban densities and the transport infrastructure. Transport networks and service qualities for pedestrians, cyclists, private vehicles and public transportation **characterize the quality of transport supply**.

(2) Policy-making and governance:

This second dimension of mobility culture covers the societal framework of official and unofficial plans and programs. This includes (a) the general political context; (b) the specific political discourse on the level of the urban policy arena; (c) the involvement of different stakeholders; (d) their quality of governance; (e) participation mechanisms; and (f) the decision-making processes. These aspects of mobility culture **strongly influence the local transport system and city structure**, and herewith the conditions for everyday mobility behavior.

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Source: Wulfhorst, G. et. al., 2013

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Mobility Cultures: The four dimensions

(3) Perceptions and lifestyle orientations:

The third dimension of mobility culture directly relates to the **user level**. It covers the perceptions, values and preferences of the travelers. These are heavily influenced by the specific cultural background, ethnics, gender and race but also by the socio-economic situation, status, social norms and motivations. First, such context conditions are influential on individual travel options and on how individuals perceive these options. Second, these conditions can also be influential on the collective level because they shape local milieu conditions of different neighborhoods with distinct lifestyle orientations and mobility styles.

(4) Mobility behavior:

The fourth dimension of mobility culture finally encompasses the **realized mobility behavior**. This concerns the individual social practice regarding long-term as well as everyday mobility decisions. Long-term decisions include the choice of workplace and residential locations (influencing urban settlement patterns) and car ownership (influencing motorization trends). Every-day mobility decisions include choices about activity engagement, trip chaining, destinations and travel distances, mode of travel, departure time etc.

Source: Wulfhorst, G. et. al., 2013

Mobility Cultures

The methodological approach has been set up on three different levels:

- **Quantitative factor analysis** of megacity clusters based on desk research (UITP Millennium City Database)
- **Post-Doc fellowship program** (8 Post-Docs for in-depth analysis of the following eight megacities Sao Paolo, Johannesburg, Atlanta, San Francisco, Shanghai, Ahmadabad, Berlin and London)
- **Expert workshops and common discussion** to intensify their individual research interests within the group by regular colloquia and in two major expert workshops with internal scientific supervisors and external international guests

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Source: Wulfhorst, G. et. al., 2013

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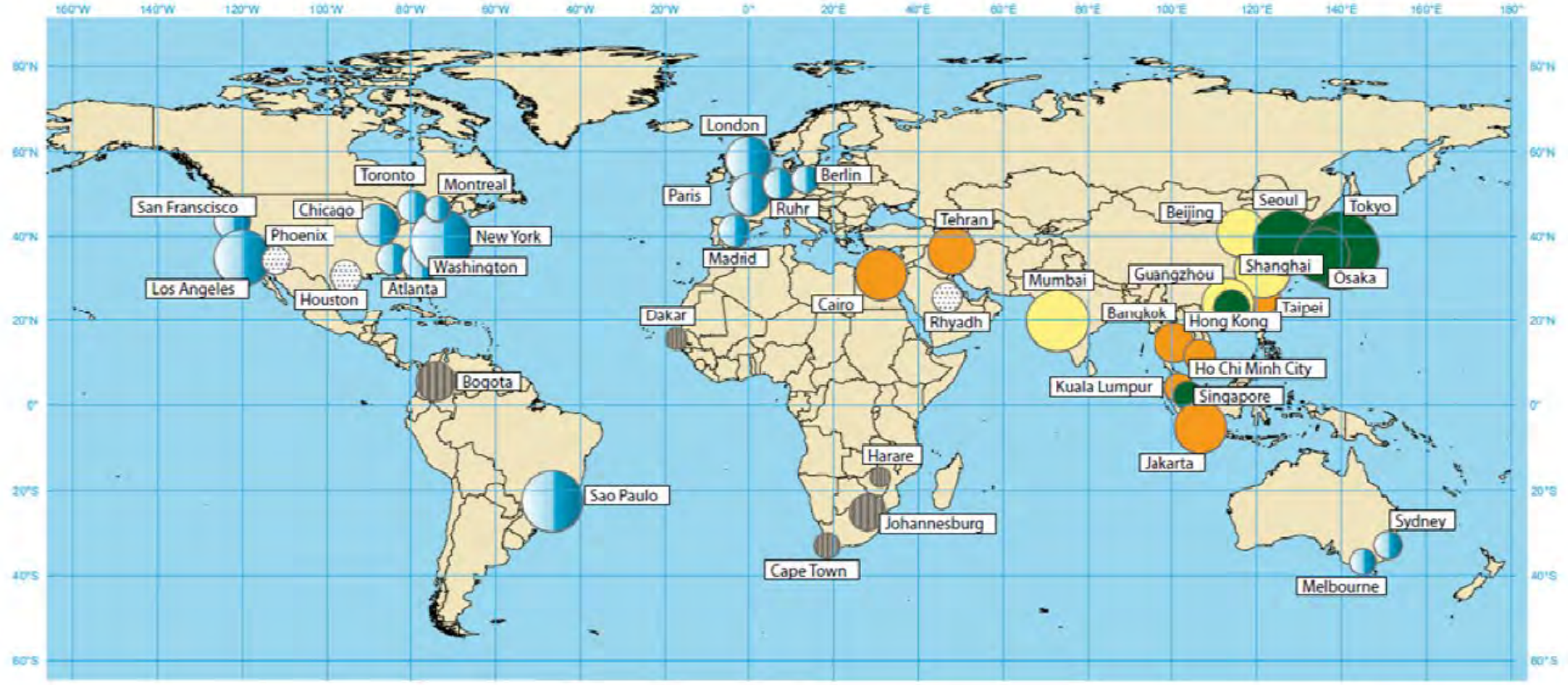
Mobility Cultures: Megacity-clusters



Source: Wulfhorst, G. et. al., 2013

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Mobility Cultures: The 6 clusters

(I) Hybrid Cities

Cities in this cluster display a specific character, being best described as of a 'hybrid' nature. This means, on the one hand, that these cities have a consolidated, dense urban core, extending to the inner suburban areas, with good infrastructure and significant usage of public transport and non-motorized modes. On the other hand, it signifies that these urban centers are surrounded by a vast and sprawling suburban area, with much poorer public transport and opportunities for walking and cycling.

(II) Auto Cities

Auto cities can be described as sprawling, relatively wealthy and completely car-dependent, with tiny roles for public transport and non-motorized modes. Their infrastructure is dominated by freeways and they have few quality public transport alternatives.

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Source: Wulfhorst, G. et. al., 2013

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Mobility Cultures: The 6 clusters

(III) Transit Cities

The main characteristics of a Transit City lie in its strong public transport (or transit) profile, in conjunction with the minor role that private cars play in its mobility culture. While car ownership is low or moderate at the utmost, and the availability of public transport is high, their public transport modal share puts them near the top of the list. Thus, car kilometers per capita travelled, energy use and particularly emissions are all low or very low.

(IV) Non-motorized Cities

Non-motorized cities can be described as those where walking and bicycling (and other mechanized but non-motorized modes) dominate the modal split for all trips. These cities have high public transport use as well, with very low car use and their urban densities are amongst the highest in the world.

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Source: Wulfhorst, G. et. al., 2013

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Mobility Cultures: The 6 clusters

(V) Paratransit Cities

In Paratransit Cities, relative poverty and a high level of informality in the practicalities of day-to-day life causes chaotic transport conditions and leads to a very high number of transport deaths. Much of the transport system of these cities consists of a semi-organized entrepreneurial response to the general ineffectiveness of government planning and transport infrastructure development (with some notable exceptions, such as Bogotá's Trans-Milenio bus rapid transit system). Car ownership and transit system development in such cities are generally rather low, due mainly to poverty.

(VI) Traffic saturated Cities

This group of cities is characterized by urban regions with intense – in some cases legendary – traffic congestion, Bangkok being an obvious example. These cities rank high in urban density but generally low in wealth. The cities also have a fundamental mismatch between the degree of development of their transport infrastructure – for both private and public transport – and the existing demand for transport. Motorization is relatively high.

=> e.g. Kuala Lumpur

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Source: Wulfhorst, G. et. al., 2013

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Urban Mobility Index 3.0

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Urban Mobility Index 3.0 – Summary (I)

The authors of the third edition of Arthur D. Little Urban Mobility Index worked on seven geographical areas across six continents, with 100 cities scrutinized. These cities were assessed on the basis of 27 indicators split into three even groups – maturity, innovativeness and performance of mobility systems – measured by nine indicators in each.

The results of the Urban Mobility Index 3.0 show that the average score of the 100 cities surveyed was 42.3 out of a possible 100 points. This means that, worldwide, the average city has unleashed less than half of the potential of its urban mobility system, a situation that could be improved by applying best practices across all its operations.

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Source: Arthur D. Little, 2018

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Assessment criteria

Figure 48: Arthur D. Little Urban Mobility Index 3.0 assessment criteria

Maturity [max. 36 points]	Innovation [max. 24 points]	Performance [max. 40 points]

Criteria	Weight
1. Financial attractiveness of PT	4
2. Share of PT in modal split	6
3. Share of zero-emission modes	6
4. Road density	4
5. Cycle-path network density	4
6. Urban agglomeration density	4
7. Public-transport frequency	4
8. Urban mobility initiatives*	2
9. Urban logistics initiatives*	2

Source: Arthur D. Little Mobility Index
Notes : The maximum of 100 points is defined by any city i

Figure 49: Arthur D. Little Urban Mobility Index 3.0 – definition of assessment criteria

Arthur D. Little Urban Mobility Index 3.0 – Assessment criteria		
Maturity (max. 36 points)		
Criteria	Weight	Definition
1 Financial attractiveness of public transport	4	■ Ratio between the priceof a 5 km journey with private means of transport and the price of a 5 km journey with public transport within the agglomeration area ■ Private means of transport car or motorcycle, depending on what vehicle type dominates in modal split ■ Cost of journey with motorized individual transport: fuel cost only, based on fuel consumption and fuel price including taxes, average of gasoline and diesel cost taken ■ Cost of public transport journey: ticket cost for a 5 km distance trip
2 Share of public transport in modal split	6	■ Percentage of the total number of person trips which are made with public transport in the last available measurement ■ Only formal public transport is considered. Informal public transport (paratransit) is considered as a part of motorized individual transport ■ Modal split definition: trips made by residents of the urban agglomeration, both motorized and non-motorized trips; trips for all purposes; trips on both working days and weekends
3 Share of zero-emission in modal split	6	■ Percentage of the total number of person trips which are made by bicycle and walking in the last available measurement ■ For cities with emerging mobiliy systems and a very high share of non-motorized transport, the modal split data was corrected in order not to suggest a high maturity level of a mobility system

Source: Arthur D. Little, 2018

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Urban Mobility Index 3.0 – Summary (II)

The highest score was achieved by the city-state of Singapore with 59.3 points, followed by Stockholm (57.1 points), Amsterdam (56.7 points), Copenhagen (54.6 points) and Hong Kong (54.2 points). This indicates that even the highest-ranking cities have considerable potential for improvement. Only 10 cities scored more than 50 points, out of which eight are European cities and two Asian.

Twenty-six cities ranked below average, and these represent the lowest tertile of the final score data set. The vast majority of the cities with mobility systems that scored below average belong to developing countries in Africa and Asia. However, several US cities can also be found in this group, invariably because the private car makes up an unhealthy proportion of their modal split. These cities need to implement sustainable mobility models and decrease their dependence on cars. Propping up the bottom of the index with a score of 27.9 points out of a possible 100 for its mobility system was the Iraqi capital, Baghdad.

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Source: Arthur D. Little, 2018

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Which cities have been analyzed?

Figure 47: Urban Mobility Index by regions and cities

	Americas 24		Europe, Middle East & Africa 41		Asia-Pacific 35	
	US/Canada	Latin America	Europe	MEA	Asia	Pacific
"Mega-cities"– cluster of C40 Cities Climate Leadership Group 62	Boston Chicago Houston Los Angeles Montreal New York Philadelphia San Francisco Toronto Washington D.C.	Bogota Buenos Aires Caracas Curitiba Lima Mexico City Rio de Janeiro Salvador Santiago de Chile Sao Paulo	Athens Barcelona Berlin London Madrid Milan Moscow Paris Rome Warsaw	Accra Addis Ababa Amman Cape Town Cairo Dubai Johannesburg Lagos	Bangalore Bangkok Chengdu Chennai Delhi Dhaka Guangzhou Hanoi Ho Chi Minh Hong Kong Istanbul Jaipur Jakarta Karachi Kolkata Kuala Lumpur Mumbai Nanjing Seoul Shenzhen Tokyo Wuhan	Melbourne Sydney
World's largest cities determined by GDP share[1] 21	US/Canada Atlanta Dallas Miami		Europe Lisbon St. Petersburg	MEA Baghdad Kinshasa Riyadh Tehran	Asia Ankara Beijing Chongqing Hyderabad Lahore Manila Osaka Shanghai Shenyang Singapore Tianjin Xi'an	
Smaller innovator cities 17	US/Canada Portland		Europe Amsterdam Brussels Copenhagen Frankfurt Hanover Helsinki Lausanne Munich Nantes Prague Stockholm Stuttgart Tallinn Turin Vienna Zurich			

Source: Arthur D. Little Urban Mobility Index 3.0; Note: 1) not included into group 1 (C40 Megacities)

Source: Arthur D. Little, 2018

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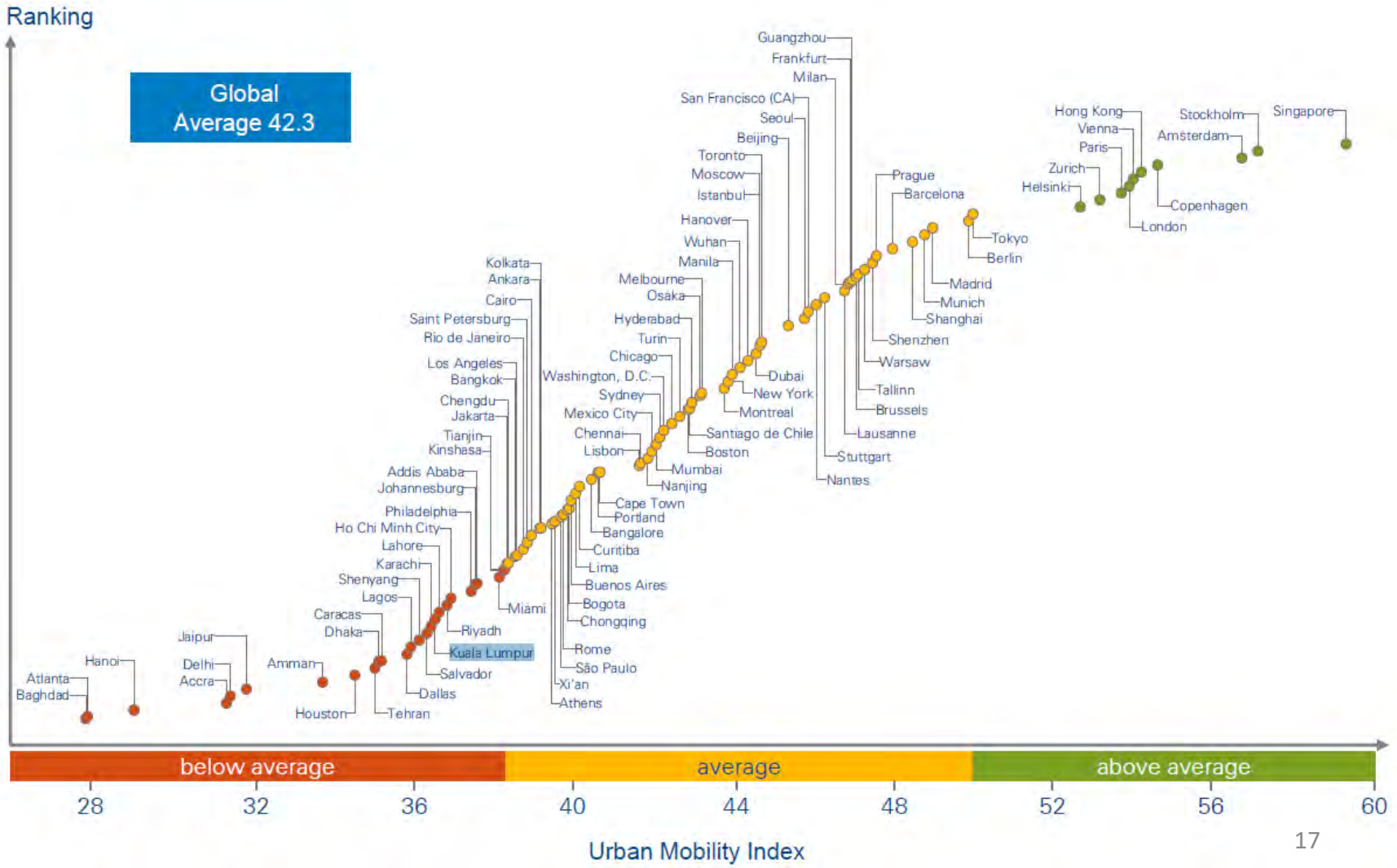
Urban Mobility Index 3.0

The Future of Urban Mobility – Towards networked, multimodal cities of 2050 – Arthur D. Little



Source: Arthur D. Little, 2018

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Insights into the analyzed cities

- The global share of **motorized individual transport has decreased** from 42 to 40 percent of the modal split, a welcome development. During the same time period, the share of **public transport increased** from 29 to 31 percent, while non-motorized transport remained stable at 29 percent.
- Average **transport-related CO2 emissions** per capita **decreased** by 3 percent – from 1,506 to 1,464 to.
- The density of **cycling networks** in the analyzed cities **increased** by 26 percent – from 756 to 955 km per 1,000 km2.
- The penetration rate of **multi modal mobility cards** increased by 27 percent – from 442 to 560 cards per 1,000 citizens.
- The penetration level of **car sharing increased** by 54 percent – from 116 to 179 shared cars per million citizens. At the same time, the penetration level of **bike sharing increased** by a factor of 10.7 – from 385 to 4,114 shared bikes per million citizens.
- The **motorization level has increased** by 5 percent, driven by dynamics in developing regions, from 380 to 398 cars per thousand citizens.

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Source: Arthur D. Little, 2018

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Classification of Cities

by M. Ollmanns

Masters thesis “Innovative mobility and transport concepts for large cities”

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Classification of Kuala Lumpur

The classification based on the analysis of:

- State of development of the countries (industrial country as well as developing and emerging nations)
- Population of the city (referring to the agglomeration area)
- Population density, car density, CO2 emissions per inhabitant, modal split

Source: Ollmanns, 2015

=> Kuala Lumpur identified as a City of Cluster 2.2:

Cluster 2.2:

Entwicklungs- & Schwellenländer, 1-10 Mio EW; 5,01-12 t CO_2/Kopf

Land	Stadt	BIP	Einwohner	EW-Dichte	Motorisierungsgrad	CO_2-Ausstoß/ Kopf	MIV	NMIV	ÖPNV	Sonstige
-	-	[US$]	[Personen]	[Pers./km²]	[Fahrzeuge/1.000 Pers.]	[t CO_2/ Kopf]	[%]	[%]	[%]	[%]
Türkei	Ankara	10.950	4.525.000	6.856	1.433	9,40	28,9	0	71,1	0
Vietnam	Hanoi	1.730	2.900.000	10.175	4.630	9,20	64,5	24,4	8	3,1
Südafrika	Kapstadt	7.560	3.975.000	4.871	974	7,60	50	2	48	0
Malaysia	Kuala Lumpur	10.400	6.800.000	3.500	759	7,57	58	21	21	0
Mexiko	Monterrey	9.940	4.525.000	9.447	4.251	6,10	41	4	55	0
China	Hong Kong	6.560	7.200.000	6.522	398	5,50	11	0	88	1
Südafrika	Johannesburg	7.560	8.750.000	3.378	1.385	5,10	36,7	31,1	30,7	1,5
Aserbaidschan	Baku	7.350	2.400.000	8.054	370	5,05	34	0	66	0

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Mobility and Transport Concepts for City of Cluster 2.2

Problem analysis:

- Often large differences within the population, e.g. their very different modal choice: poorer people prefer public transport, while cars are the primary choice among richer people.
- The high car traffic caused by the rich population leads to very high CO2 per capita (6.94 t CO2 / capita).
- The road network is well developed in these cities.
- Local PT networks have considerable gaps in supplies, which is a major problem for the poorer stratum. Therefore, for them many parts of the city can only be reached on foot or by other non-motorized transport modes.
- This leads to a significant safety gaps, because pedestrians are forced to use roads planned for vehicle use only.
- PT mainly based on roads (bus systems). Occasionally, cities in this cluster also have metro or suburban rail systems.

Source: Ollmanns, 2015

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Mobility and Transport Concepts for City of Cluster 2.2

Need for Actions / Objectives for Cities of Cluster 2.2:

- Reduce motorized private transport and make it more environmentally friendly
- Promotion of non-motorized private transport, as it has usually been less than 10% in modal split
- Make non-motorized private transport safer, also to increase its attractiveness
- Better development of public transport

Source: Ollmanns, 2015

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Mobility and Transport Concepts for City of Cluster 2.2 - Recommendations

Motorized private transport:

- Electro mobility to reduce CO2-, Nox- Emission and pollutants as well as noise emission
- Set targets for share of Electro mobility
- Electro mobility in vehicle fleets or for new mobility options like car sharing (has also substitution effect
- Get the rich people into PT vehicle: reduce speed limit or re-design of road cross-section (roadway narrowing)

Source: Ollmanns, 2015

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Mobility and Transport Concepts for City of Cluster 2.2 - Recommendations

Public transport:

- The development of PT networks are often incomplete and is considered unsafe due to numerous attacks and thefts. Hence, promoting measures are helpful to make PT a transport mode for everybody
- It is advisable to increase the security personnel/video cameras, e.g. at train stations/inside the vehicles
- Expansion of PT networks, close of supply gaps
- Increase travel time of PT Bus Rapid Transit-Network
- Improve convenience of travel

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Source: Ollmanns, 2015

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Mobility and Transport Concepts for City of Cluster 2.2 - Recommendations

Non-motorized private transport:

- Cities of cluster 2.2 have the lowest percentage of Non-motorized private transport
- Construction of new cycle paths to fill in supply gaps
- Implementation of bicycle sharing schemes (incl. Electro mobility)
- Integration of bike sharing into urban transport system (mobility alliance)

Source: Ollmanns, 2015

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Mobility and Transport Concepts for City of Cluster 2.2 - Recommendations

Urban and spatial design:

- Because of the dominance of road traffic areas, for example, dwell areas must be set up
- Extension or widening of pedestrian walkways
- A shift from individual car use to non-motorized private transport must be visible in urban and spatial design to increase the consideration for pedestrians and cyclists

Source: Ollmanns, 2015

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Imagine your city…

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Workshop Session

Imagine your city in 20 years: What would you want it to look like? A place where children can play safely? Where the air is clean? Where you can walk to do your shopping? With lots of parks and green space? Where businesses can prosper?

Source: Rupprecht Consult - Forschung & Beratung GmbH (2019)

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Imagine your city…Aachen

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Aachen Profile

- Most western major city of Germany
- 250,000 inhabitants
- Center of border triangle Germany, Belgium and the Netherlands

Source: City of Aachen (2019)

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SUMP Aachen

SUMP Aachen

Moving together in the right direction

New SUMP for Aachen

Source: City of Aachen (2019)

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1991 - 1995: First SUMP

- Objectives:
  - city friendly mobility, especially in residential streets and the inner city
  - fewer accidents
  - less car traffic

- Transport model established
- Mobility household survey
- Traffic calming/reducing travel speed in inner city quarters
- Extension of the pedestrian zones

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Source: City of Aachen (2019)

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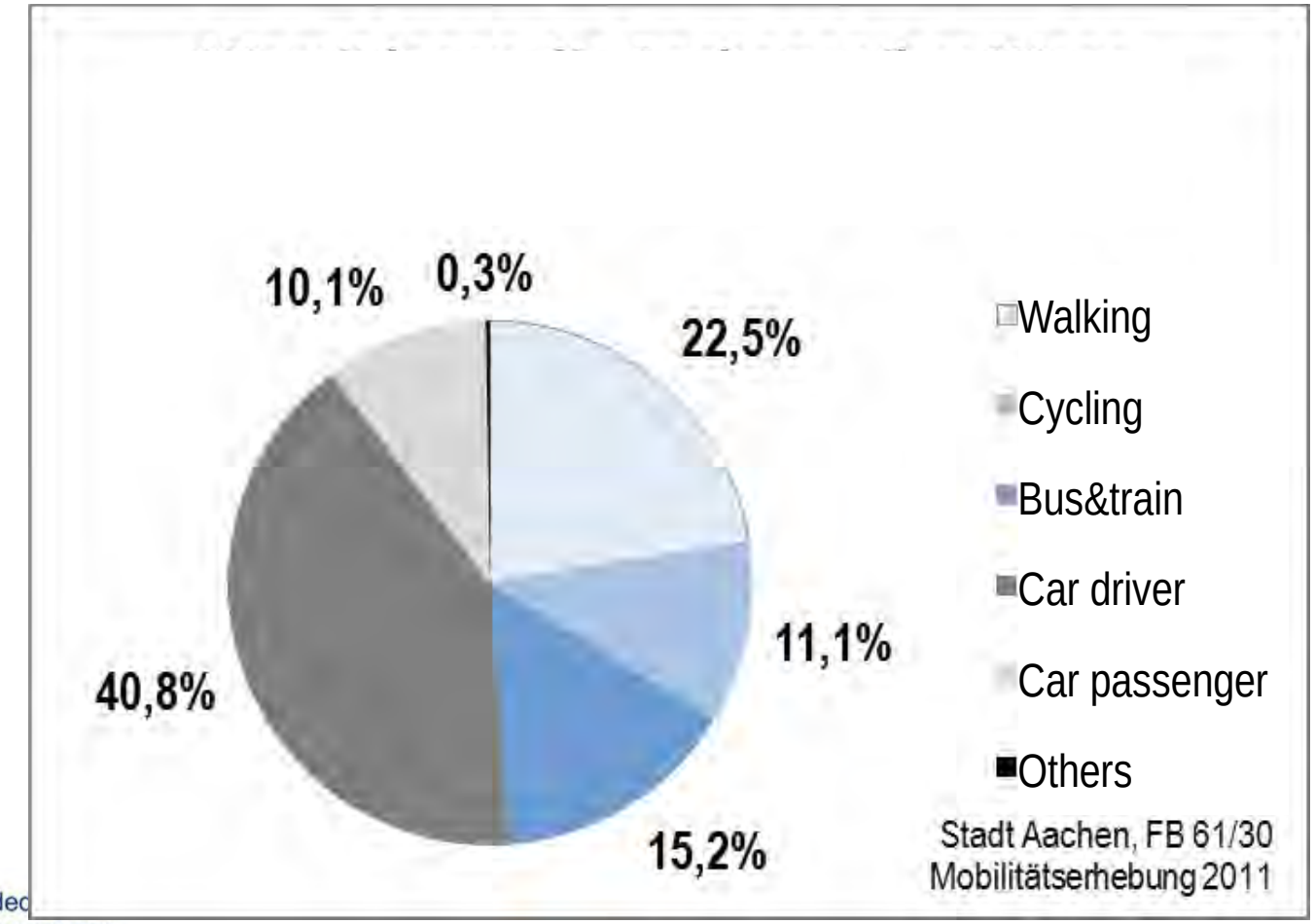
49 % sustainable modes (2011 as in 1991)
Modal Split Aachen inhabitants



1990

walking 28%
cycling 10%
PT 10%
Others 1%
Sustainable modes
49%

car 51%

Source: City of Aachen (2019)

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Objectives of the Aachen SUMP

- Road safety
- Environment friendly and social mobility
- City with short distances
- Good accessibility
- Reliable and comfortable mobility services
- Efficient und affordable mobility for city and people

Source: City of Aachen (2019)

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Aachen SUMP process permanent process established

- 2008 1st Clean Air plan
- 2009 Start of new SUMP process
- 2011 household mobility survey
- 2013 Noise reduction plan
- 2014 2nd Clean Air Plan with “environmental zone”
- 2014 “vision mobility 2050” incl. “status quo report”
- 2015 Draft version of “strategy mobility 2030”
- 2017 “#AachenMooVe” - Winner of competition “emissionfree inner city” in state North-Rhine Westfalia
- 2018 planned: decision about structure and targets of strategy 2030
- 2019ff decisions about thematic strategies

Source: City of Aachen (2019)

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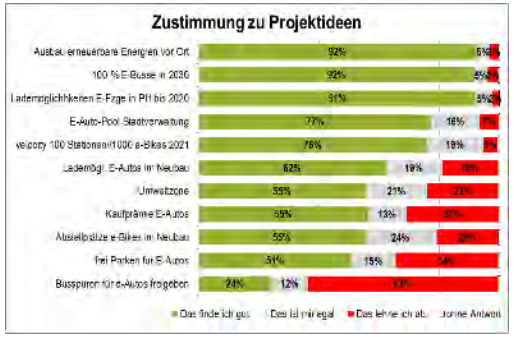
Importance of public participation

- Interactive exhibition

Online surveys



mobility forum

- facebook

internet

www.aachen.de
/vep
/clevermobil
/fahrrad …

brochures

Source: City of Aachen (2019)

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2016 technical test of “mobility alliance”

Three mobility services with one access medium

Source: AVV GmbH (2019)

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Car sharing since 1990
40 stations, 150 cars, 10 % electric, 5000 users

- 1 car sharing car replaces about 10 private cars
- For occasional car use; regular mobility with bike and/or public transport

Source: City of Aachen (2019)

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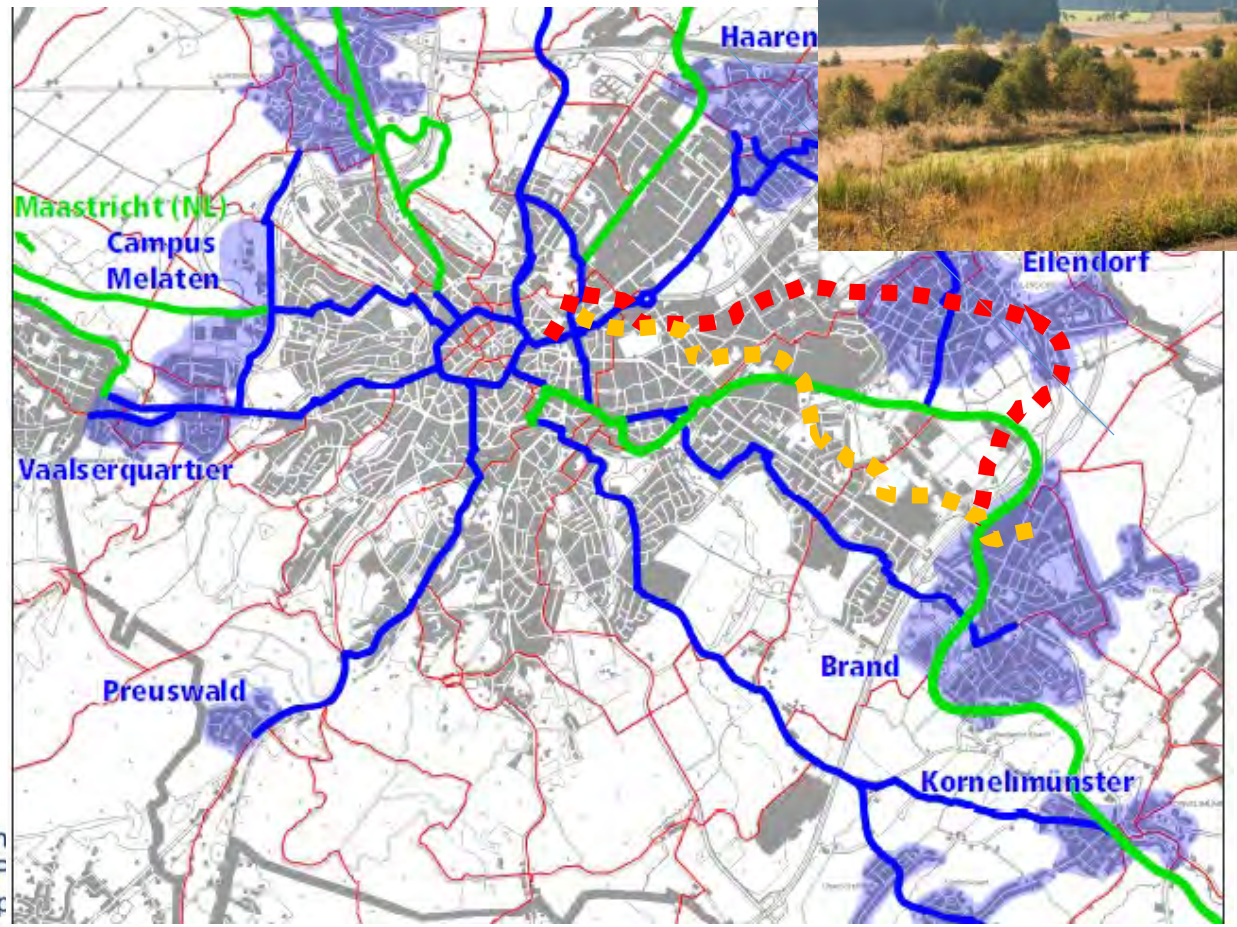
Actual lighthouse project: Priority cycling route
From every urban district to the city center



- „Vennbahn“ = former railway section:
  Aachen: coal →
  Luxemburg: steel
  through „Hohes Venn“ (Belgium)
- 130 km

Priority cycling route „Brand“ (17.000 people)

Source: City of Aachen (2019)

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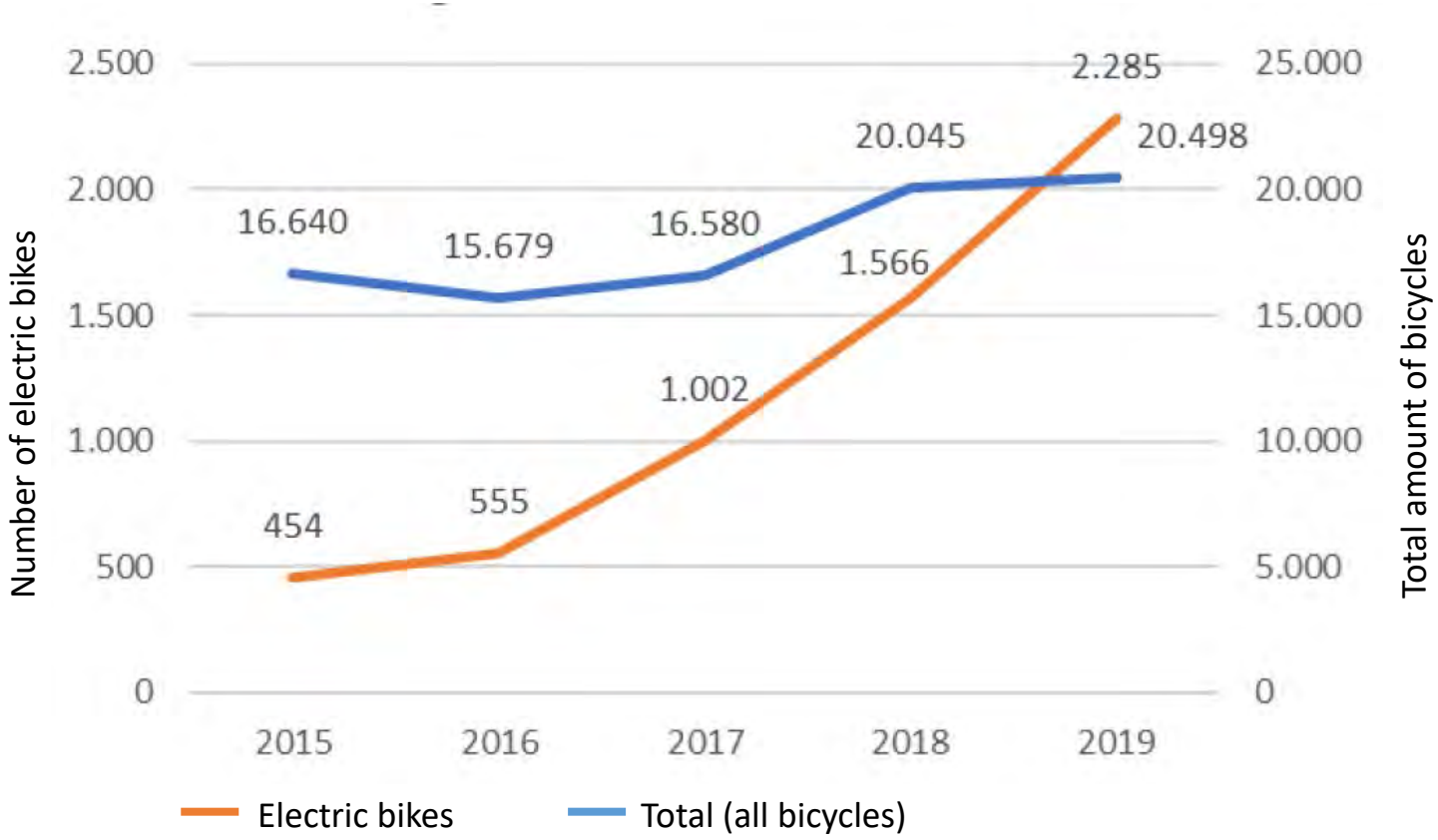
Development of cycling statistics in Aachen



Development in share	
2015	2.7 %
2016	3.5 %
2017	6.0 %
2018	7.8 %
2019	11.1 %

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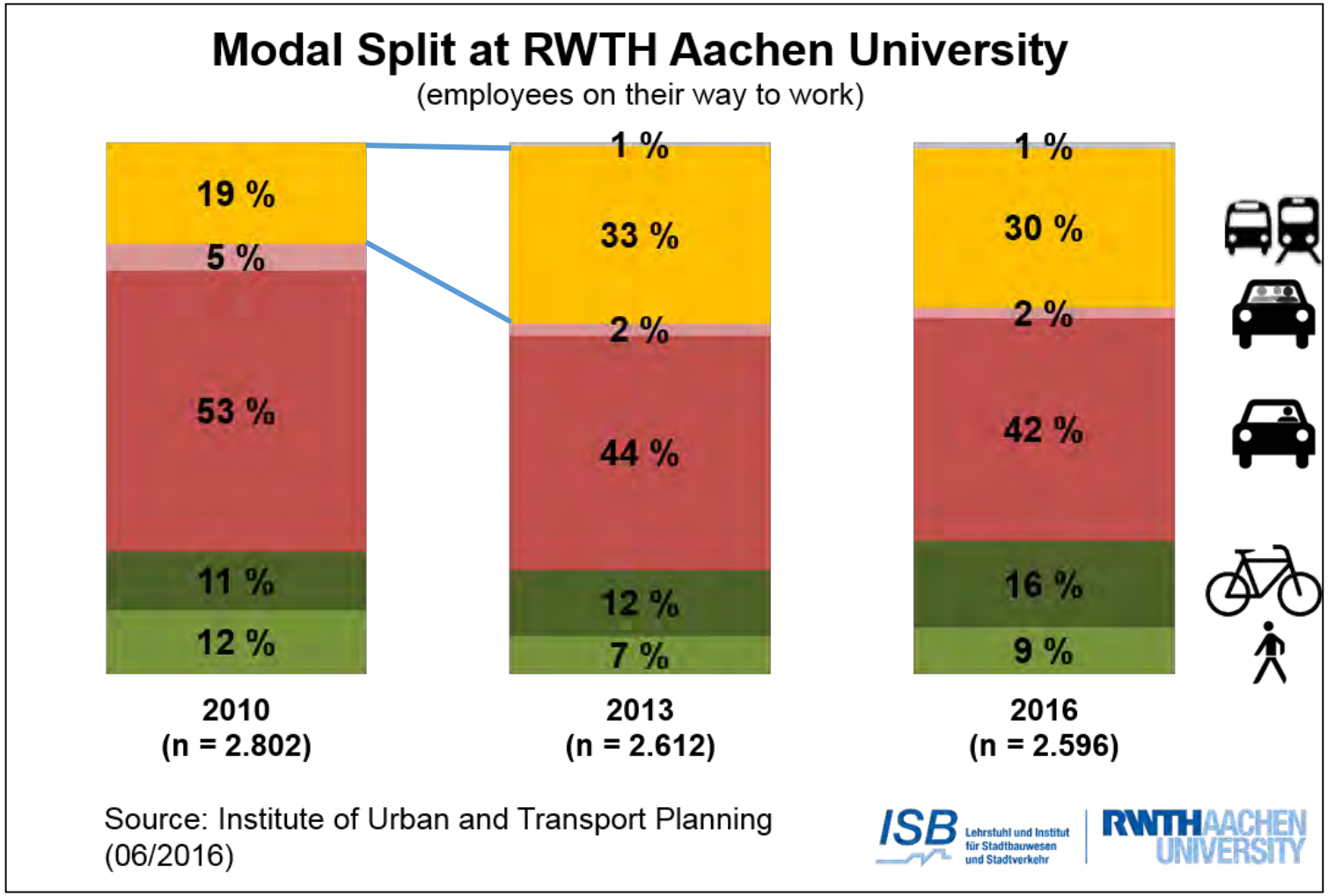
RWTH Aachen university demonstrated modal shift

Shift from car to public transport after implementation of "Jobticket" offered to approx. 9,000 employees at RWTH Aachen University



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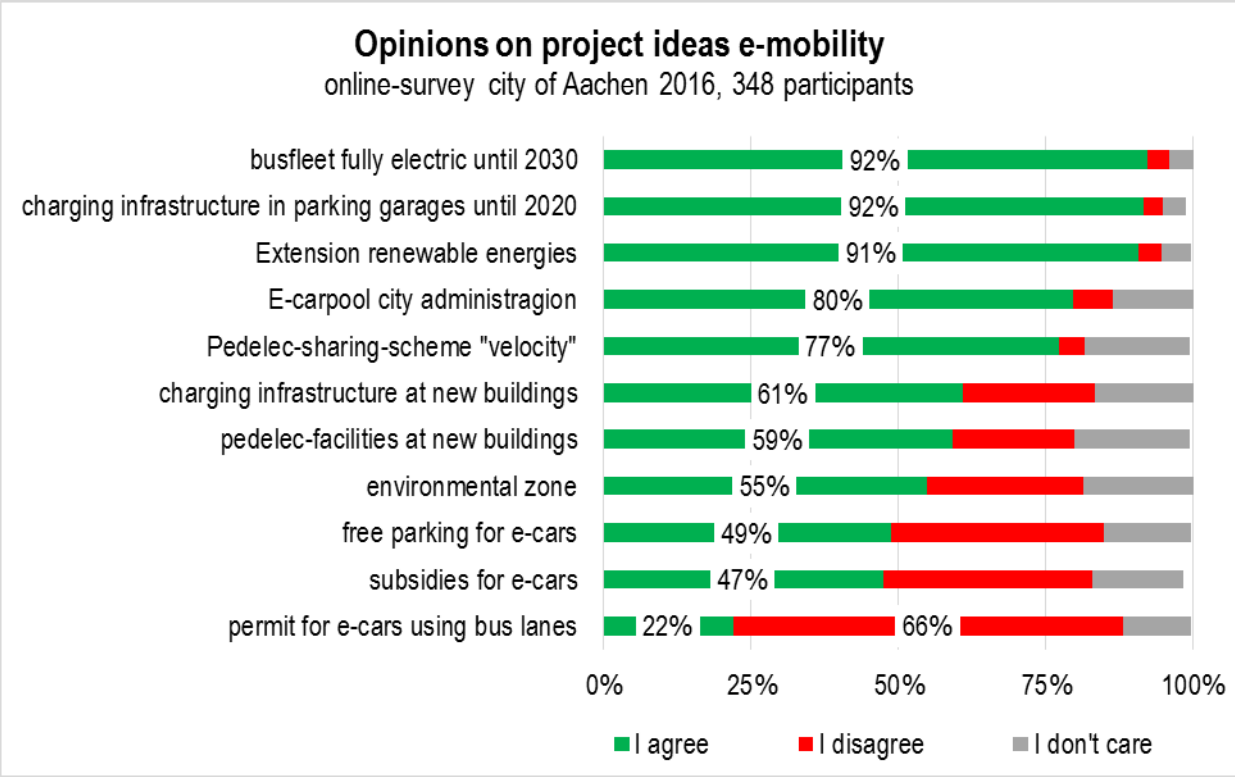
More SUMP Aachen measures

- Zero emission und autonomous mobility projects Made in Aachen
- Connected, emissions free mobility City administration as a pilot company
- Member of CIVITAS network Cities Vitality Sustainability
- Reactivation of tram system
- Vision Mobility 2050
- CIVITAS DYN@MO 2015: https://www.youtube.com/watch?v=WBkDxbBUdnw



Source: City of Aachen (2011)

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Thank you for your attention!

Discussions/Questions

More information about SUMP Learning Activities and Materials on the following homepage:
https://sumps-up.eu/learning-activities-materials/

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