Future of Urban Mobility – Electrification, Automation, Digitalization

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Agenda

- Megatrends: A global perspective on urban mobility
- Digitalization of urban mobility: Project examples, incl. lessons learned
- Summary and outlook
We are in the urban millennium

**Population**
- **2010**
  - ~50% of the world's population lives in cities

**By 2030**
- Urban population will grow from 3.5 billion to ~4.7 billion, mainly in developing countries

**Economy**
- **2010**
  - ~50% of global GDP is produced in 600 cities; Top 100 cities with 38% of the global total

**By 2025**
- 77% of global GDP growth will be generated by middleweight cities in emerging markets

**Energy and CO2**
- Cities account for two-thirds of the world's energy consumption and up to 70% of its CO2 emissions

**Energy consumption pattern is dependent on city and industry structure**

**Urban population growth by 2030, by type/region**
- Developed: 92%
- Developing: 8%
- Latin America: 7%
- Africa: 8%
- Asia Pacific: 60%
- RoW: 7%

**Urban GDP growth by 2025, by type**
- Developed: 23%
- Developing: 77%
- Large: 12%
- Medium: 37%
- Small: 51%

**World energy consumption, by sector**

<table>
<thead>
<tr>
<th>End-use sector</th>
<th>2005 (in %)</th>
<th>2015 (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Industrial</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Residential</td>
<td>51</td>
<td>54</td>
</tr>
<tr>
<td>Transportation</td>
<td>27</td>
<td>26</td>
</tr>
</tbody>
</table>

Example:
Urban development of Jakarta and Delhi 1975-2010

<table>
<thead>
<tr>
<th></th>
<th>Jakarta 2010</th>
<th>Delhi 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>4.8 million</td>
<td>4.4 million</td>
</tr>
<tr>
<td>1990</td>
<td>8.2 million</td>
<td>9.7 million</td>
</tr>
<tr>
<td>2000</td>
<td>8.4 million</td>
<td>15.7 million</td>
</tr>
<tr>
<td>2010</td>
<td>9.2 million</td>
<td>22.2 million</td>
</tr>
</tbody>
</table>
Urban mobility is No. 1 priority of city decision makers, with strong overall growth until 2050

**Fundamental requirements**
- Efficient transportation of people and goods
- Reliable and efficient supply of energy
- Low emissions, water usage and waste
- Comfort, quality of life and security

**Demand growth in urban mobility, by mode**

<table>
<thead>
<tr>
<th>Mode</th>
<th>OECD</th>
<th>2010</th>
<th>2050 Base</th>
<th>2050 High Shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual traffic</td>
<td>x1.1</td>
<td>0.3</td>
<td>2.8</td>
<td>10.2</td>
</tr>
<tr>
<td>Public transport</td>
<td>x1.2</td>
<td>50</td>
<td>46</td>
<td>36.6</td>
</tr>
<tr>
<td>Non-motorized mobility</td>
<td>x2.3</td>
<td>2.3</td>
<td>8.4</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Key trends**
- **Significant overall demand growth** until 2050 (x2.2) mainly non-OECD driven
- **Highest growth**: India (x3.7), Africa (x3.3), China (x2.8)
- **Base Scenario**:
  - Strong growth of individual traffic (x2.7), only modest growth (x1.4) of public transp.
  - Very high risk of gridlock: Congestion, energy/emissions
- **High Shift Scenario**:
  - Disproportional increase of public transport (x2.7), in both OECD and Non-OECD cities
  - Non-linear development, upsurge from 2020 onwards

* Sources: ITDP/UC Davies 2014: A global high shift scenario, Siemens analysis
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Clear trend towards public transport, with a high degree of electrification and automation

Drivers
- Demand growth
- Mobility cost
- City-relevant policies
- Technological development

Modal Shift
- Clear market share wins for public transport in urban areas
  - Overall significant increase of public transport share by 10.9 basis points
  - Modal shift as key lever to cope with capacity and energy demand growth

OECD/Non-OECD
- Further modal shift in OECD countries and slight increase in Non-OECD countries
  - OECD: Significant growth (24% to 45%) of public transport modal share
  - Non-OECD: Slight increase of public transport with strong absolute growth

Public Transport
- Bus Rapid Transit and Urban Rail (Metro, LRT, Com. Rail) with highest growth rates
  - BRT, Metro, Commuter Rail and LRT are outpacing the urban bus and minibus modes
  - Strong BRT growth, with significant potential for electrification and automation

Development of urban modal split
- Public Transport
- Individual traffic
- Non-motorized

Urban modal split OECD/Non-OECD
- Public Transport
- Individual traffic
- Non-motorized

"Top 4" PT modes with highest growth rates
- BRT, Metro, Com. Rail and LRT
- Growth rates for OECD and Non-OECD countries

Sources: ITDP/UC Davies 2014: A global high shift scenario; Analysis based on "trillion pkm travelled"
Besides shift to public transport with a growing share of urban rail, efficiency and innovation in individual traffic will be key.

Drivers
- Demand growth
- Mobility cost
- City-relevant policies
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Rail-bound systems
Urban Rail (Metro, LRT, Commuter Rail) is winning market share against bus systems
- Bus/BRT still as leading public transport mode, but urban rail is winning market share
- Comparable development path in all Non-OECD countries/regions, but for Africa

Individual Traffic
High efficiency improvements needed to manage absolute growth in individual traffic
- Individual vehicle efficiency (incl. alternative fuels/drive systems)
- Efficient management of road network/intelligent traffic systems

Alternative fuels/drives
Urban area as focal point for new fuels/drive systems, particularly electromobility
- From mainly conventional fuels to a more diversified energy system for urban mobility
- Urban areas as well suited environment for electric mobility (and natural gas)

Sources: ITDP/UC Davies 2014: A global high shift scenario; Analysis based on "trillion pkm travelled"; IEA 2012: Energy Technology Perspectives

Development of urban bus/urban rail split

Battery costs through 2020

New sales of cars & light duty vehicles/year
Typical development path of urban mobility, based on an increasing degree of electrification, automation and digitalization

**Basic "Brick&steel" Mobility**
- Road and rail tracks
- Public transport systems
- Mobility hubs

**Semi-) Auto-mated Mobility**
- Operational control systems for road and rail traffic
- Rail automation with focus on safety and security

**Intelligent Mobility**
- Fully automated train control system
- Urban traffic management center
- Personalizes services and information
- Environmental friendly fuels and drives

**Fully integrated, intelligent mobility**
- Integrated platforms and solutions
- End-user centricity, on-demand services
- Real-time, smart data based optimization and incident handling across modes
- Integration of mobility with energy and building systems to smart city solutions
Example Stockholm: An European lighthouse of sustainable and smart urban mobility

- Small, but very well integrated public transport network: Only 7% of commuters using private vehicles
- High density of city combined with excellent walking and cycling lanes: 68% of people cycle or walk to work
- Very effective connection of suburbs and peripheral areas: 75% of rush-hour travels into city center by public transport
- "Real-time Information" for travelers with regard to arrival times for buses and trains
- Income from city tolling/tax re-invested into new mobility technologies: Use of cars reduced by 20%
- Continuous "green" innovations: e.g. adaptive traffic management, buses with alternative/electric fuels (50% by 2011, 100% by 2015), eCar policies
Siemens Mobility: Addressing the future of urban mobility with an integrated portfolio and consulting & solution design competencies

Consulting & innov. solution design

- Smart and sustainable city/mobility studies, e.g. for London, Singapore, Vienna, Helsinki, Shanghai
- Business and technology advisory, including strategic design and piloting of innovative mobility technologies/ solutions with key clients and partners

Integrated technology solution portfolio

- Electrification: Rail-bound urban transport, electrification solutions for rail and eBus systems (electric/hybrid), eCar technologies
- Automation: Automation of urban and interurban rail-based transport systems, intelligent road traffic systems
- Digitalization: Software and IT solutions for managing rail and road transport, Business analytics and data-driven service optimization, embedded software/systems for electrification and automation

Consult → Design → Build → Operate → Maintain
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Digitalization as key value driver for operator and end user, based on integration into overall system approach: Rhein-Ruhr-Express

- **Best asset utilization**
  - Digitally enhanced electrification and automation components
    - Tailor made train setup based on optimized lifecycle costs (train, service and energy)

- **Guaranteed availability**
  - Digital services
    - Smart data analytics for vehicle service
    - Preventive up to predictive maintenance
    - Bogie remote diagnosis

- **Enhanced passenger experience**
  - Vertical software/IT solutions
    - Internet on board (WiFi)
    - Passenger Information System
    - Security for passengers (CCTV)
It's about end-to-end mobility of people and good, not of vehicles:
Intermodal Mobility Platform Berlin

- Public urban transport
- Individual Mobility
  - eCars and eBikes
  - Car Sharing solutions
- Additional services
  - Access to parking
  - Other public services

- Intermodal urban mobility platform
  - One customer interface with single sign-on
  - Smart phone or smart card based
  - Real-time Info, reservation, ticketing, billing across all modes/offers

- Value drivers
  - Easy to deal with
  - Additional value-add for all players
Proximity-based, personalized and real-time information will become key success factors: Passenger flow solution Dubai (metro, tram, bus)

Backend
- Maps ID to place
- Provides content and services
- Analyses streams

Beacon
- Sends a unique ID

Smartphone of the passenger
- Traveller: Relevant, context-related information, when needed
- Operator: Automated real-time passenger data
- Shops/retail: Personalized, Location based offerings
From separate to multi-functional and integrated smart mobility/city solutions: Smart parking solution Berlin

- **Smart Parking** system based on overhead radar sensor detection and integration into end-user and operator mobility platform
- **From separate** (sensor, communication, power) to **multi-purpose sensor networks**:
  - Smart lighting, parking,
  - Traffic control, security
  - Emissions
  - WIFI, etc.
Demand management and new business models, enabled by real time information and smart analytics: Fast lane Tel Aviv

- Length 13 km, around 6,000 cars per day
- System calculates the toll dynamically according to the traffic situation
- Guaranteed speed of 70 km/h on fast lane
- Co-financing of free shuttle buses to the city center; toll free for vehicles >3 passengers
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Summary and outlook

**Urban Mobility as Nr. 1 priority** for sustainable urban development and competitiveness, with significant, specific challenges in developed and developing countries.

**Electrification, automation and digitalization** as key technological improvement levers to develop from Mobility 2.0/3.0 towards Mobility 4.0.

**Digitalization with strong potentials** both for efficiency and revenue improvements in the mobility industry - but need for combining the physical and virtual worlds to realize value-add.

**Key success factors:** Effective digitalization eco-system, addressing all digitalization levers, integrated IT platforms, vertical process expertise, adaption of innovation processes and new business models, management of data security issues.

**Development path for mobility industry:** Build upon existing strength (domain expertise, system and operations know-how) while both endogenously learning and exogenously integrating good-practices from the new economy (end-user/process focus, speed, new business models).