Transforming urban mobility: key findings and recommendations

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Transforming urban mobility is the focus of DTU International Energy Report 2019. Urban areas are home to more than 50% of the world’s population and are the site of most of its built assets and economic activities. As more than two billion people are added to the global population in the coming decades and as urban populations continue to grow (70% by 2050), the question arises: how can people and the goods they require be moved more efficiently and effectively than they are today?

The existing transport system faces significant challenges. Traffic congestion, noise, air pollution and traffic accidents impose tremendous human and economic costs on society. Also, transport accounts for more than half of global oil demand, making it a key contributor to climate change. In many places, access to affordable and convenient transport is far from equitable.

Cities will require mobility solutions that are sustainable, affordable, secure, inclusive and integrated with customer-centric infrastructure and services. This transformation rests on the intertwined pillars of mobility and energy, both of which will require radical changes to a low-carbon economy able to cope with increasing populations and economic growth.

This transformation will require a holistic, systemic approach, one that acts in the intersection between technology, infrastructure, multi-modal mobility and behavioral changes and that seeks to achieve significant GHG emissions reductions, reduced energy consumption and less congestion, the ultimate objective being to create livable and sustainable cities. Research and innovation are playing a major role by developing portfolios of low-carbon, cost-efficient, high-performance technological and non-technological solutions at different scales and time-frames (short-, medium- and long-term).

Transforming urban mobility and getting transport on track to keep the global increase in average temperatures well below 2°C will require a broad set of measures, like those analysed in the International Energy Agency’s (IEA) Sustainable Development Scenario (SDS). This comprehensive strategy can be broken down into three distinct areas:

- Avoid/reduce travel activity
- Shift to more efficient modes of transport
- Improve transport technology, fuel efficiency and infrastructure

Avoid/reduce refers to the need to improve the overall efficiency of the transport system and thereby the need to travel.

New economic and technological trends are influencing land-use patterns and people’s lifestyles. Digitalization, on-demand mobility and flexible and cleaner energy production can increase the chances of higher density development and a more balanced mix of land uses (residential, commercial, production, schools, parks), potentially reducing the demand for unsustainable modes of travel. This is not a straightforward path for mega-cities in emerging economies such as Beijing, Delhi, São Paulo and Cape Town, each of which has its specific development trajectory, density and increase in motorized modes of transport. What is interesting, however, is that non-motorized transport seems to have remained stable in cities like Delhi, São Paulo and Cape Town, for underlying reasons yet to be explored. Further, car use in Beijing has peaked due to a combination of investment in public transport infrastructure, regulatory constraints and the roll-out of (shared) bicycle concepts and bike paths.

There are numerous bottlenecks within and across transport modes resulting in system-wide capacity constraints, traffic jams and increased levels of environmental impact. With new digital technologies and connectivity, it is easier for consumers to make more efficient choices when going from A to B - take the cycle or public transport or just select a slower but more energy-efficient route - and thereby influence real-time demand in time and space. Cities can enable greater public transport capacity and efficiency by having a door-to-door perspective in the overall organization, planning and operation of public transport, providing door-to-door mobility information and guidance systems and by facilitating intermodal travel chains.

If individual mobility services can be integrated with public transport systems, the overall efficiency of urban mobility systems can be enhanced, thus helping to avoid unsustainable modes and enable efficient demand management. Although smart mobility may fill the gap between the individual solution and mass transit, thereby impacting on congestion, air pollution, road safety, noise and costs, recent studies show that this is not always done in a resource-efficient way. For example, car-sharing subscribers may reduce the individual vehicle mileage but increase their own weekly mileage.

With regard to freight, logistics and delivery services, digitalization and smart mobility services enable unnecessary vehicle movements to be avoided by optimizing deliveries, consolidating goods flows and moving towards smaller and lighter freight vehicles. Truck platooning are also relevant for urban freight transport, using semi-automated technology to coordinate traffic flow, infrastructure and the flow of goods to and from the warehouses and terminals. On the downside, the deployment of new technologies and vehicles will require costly new investments by operators and urban consolidation centers, while the additional handling needed will increase the unit costs of the last mile.

Shift means improving trip efficiency by means of a modal shift from the most energy-consuming transport mode towards more environmentally friendly modes.

A reduction in personal-use and single-occupancy vehicles requires adequate options for public transport, other shared forms of transport, cycling and walking. Cities around the world are trying to increase the share of active transport modes, but they are having to face the challenge that this shift is influenced by many factors. Cycling is considered an everyday mode of transport for all age groups and genders in Copenhagen and Amsterdam, while walking is popular in some East European cities. Walkability and bikeability are closely related to accessibility, environmental qualities, safe sidewalks and bike paths for pedestrians and cyclists.

Future mobility is expected to be autonomous, connected, electric and shared and to contribute to the efficiency and safety of transport systems. Smart mobility solutions impacts congestion, air pollution, road safety, noise, interoperability and costs, but not always in a resource efficient way. Whether car-sharing is more eco-efficient than individual car ownership is a matter of whether it increases total person transports. Car-sharing in combination with autonomous driving may result in a rebound effect due to possible increases in the number of potential users and the ease and convenience of the system. Smart mobility solutions should be part of a much broader urban mobility revolution that puts alternative modes of transport to the forefront. Substantial gains in energy consumption and emissions can be achieved through significant demand shifts and integration of the entire smart mobility eco-system where stronger public-private partnerships may foster multi-modal transport solutions, increase the efficiency of goods transport and shift greater volumes of passenger traffic toward public transport or other shared modes.

Improve focuses on vehicle and fuel efficiency, as well as on better infrastructure.

Transport electrification can substantially contribute to breaking transport’s dependence on oil and to decreasing CO₂ drastically, as well as emissions of air pollutants. The increasingly decentralized generation of electric power will provide cleaner electricity to propel electric drivetrains and electric vehicles (EVs) and vessels, while electric vehicles will be able to provide storage services to the grid, favoring the further penetration of renewables. Urban living labs such as EnergyLab Nordhavn and Frederiksberg Forsyning, working in close cooperation with university labs, have demonstrated that EVs can effectively provide frequency control to support more renewables entering the power system and even 100% EV penetration, with only limited additional load at peak times.
Recommendations:

- **Opt for a mission-driven RD&D approach to transforming and decarbonizing urban mobility.**
  These problem-specific challenges of how to avoid, shift and improve transport can only be solved by working together across all technical, natural science and social science disciplines, as well as across institutions and national borders, as the interconnectedness of DTU research demonstrates. By definition research does not recognize boundaries, and as Pasteur’s quadrant illustrates, it is possible to conduct research that contributes to both the quest for understanding and considerations of use. Such integrated energy and transport solutions are not a question of picking technological winners but of enabling decision-makers to facilitate, create and shape markets so that the best, most eco-efficient and most socially acceptable options are chosen. The prospect of smart mobility is raising ethical challenges and cybersecurity concerns, which also need to be addressed by researchers and practitioners alike.

- **Facilitate urban living labs in cities around the world.**
  Urban living labs provide an ideal opportunity to test different aspects of integrated energy and mobility solutions, including by allowing regulatory exemptions from the existing legal framework in a sandbox setting. They allow the impact for both technologies and frameworks to be evaluated before rolling out regulatory schemes for the whole country. Across the world, urban living labs are providing a great opportunity for in-depth policy learning, and they can be fed back into decision-making for urban planning, new regulatory frameworks and business models.

- **Step up policy support and innovation to reduce the costs of alternative fuels.**
  While future urban mobility may to a large extent be electrified, other parts of the transport sector, such as aviation, shipping and heavy duty vehicles, will rely on competitive, low-carbon, sustainable fuels. Producing such fuels of non-fossil origin will be an important stepping stone to reducing energy intensities in order to decarbonize the whole transport sector. Such green or alternative fuels include synthetic fuels, hydrogen and advanced biofuels, fuel blends and engine optimization. In order to compare the different technologies and mobility options, life cycle assessments (LCA) of different transport solutions compare the eco-efficiency of products, services and the whole system, thus enabling decision-makers to make informed decisions and choices. For example the economic benefits of a fuel efficient vehicle may be more attractive relative to other transport modes such as public transport.

- **Engage actively in matching the supply and demand of skills relevant for future mobility solutions.**
  Insights, together with educational shifts, re- and upskilling, are needed to manage the radical transformation of urban transport sectors that is required. Education needs to race ahead of technology, not vice versa.

- **Strengthen partnerships: engines of change.**
  Transformations of urban mobility are made by and for people, making cities more liveable and sustainable. They will need to be co-created by multiple stakeholders by means of dialogue, participatory processes and accountable, engaged and committed partnerships.