
Challenges of Sustainable Urban Mobility Integration

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Abstract

This position paper addresses the field of cities, mobility, and climate change. We claim that the challenge is no longer just only individual interfaces for individual cars or mobility providers, but rather an overhaul of overall mobility systems and approaches, and of integrated interfaces to these new complex systems, with a focus on sustainability and emission reduction.

There are a number of open questions around this. The exact approach to deal with them is not yet clear, except that we will have to meet this mobility-related, and also societal change. We provide background and example to present our open questions and challenges.

Author Keywords

Future Mobility; Integrated Mobility; Modal Change; Sustainability; Green Energy Transition; Emission Reduction; Smart Cities; Complex Systems; eMaaS

CCS Concepts

•Human-centered computing → Ubiquitous and mobile computing systems and tools; •Information systems → Information systems applications;

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Introduction

The mobility and transport sector has a strong impact of up to 20% on GHG (greenhouse gas) emissions. It is clear that this sector will have to transform to address climate change and reach the 1.5° Paris goals, and fast. To do this, net emissions will have to be reduced down to zero as part of a radical transformation of mobility and all other sectors. This means not only a change in individual vehicles, technologies, and systems, but a complete overhaul of the mobility and transport system and the way that our mobility needs are addressed.

From an HCI perspective, this would for example concern not only individual private cars, but for example more integrated modes of shared mobility, seamless integration of mobility modes, and the ability to use different types and makes of vehicles. Will a user be able to take their preferred environment and interaction mode with their car to other cars, will they be able to have an integrated trip planning on whatever device or vehicle they are in, and will they be able to understand and reduce their emission impact from their mobility needs? Previous work has already looked at climate challenges for individual vehicles, e.g., [6]. In this position paper, we want to also include a broader systemic view and its HCI implications with questions such as, How will these individual choices be connected to larger mobility systems, from mobility service offers up to changed individual contributions to urban and transport planning?

We understand smart city as a deep collaboration of citizens and technology, however, in many scenarios, we do not yet know exactly how this collaboration will look like. In addition, we aim to consider in our work the large variety of actors, stakeholders, and service providers that we can co-create solutions with. We will go through some in the remainder of this paper.

A discussion of general applications and user stories around smart mobility in smart cities is given in [1].

We can identify 5 main areas of change towards zero emission mobility:

- efficiency improvements of the different transport modes and vehicles
- transition towards use (and ability to use) renewable energy sources
- systemic changes towards reducing mobility needs
- systemic changes towards changes in mobility systems and offers
- behavioural change towards more energy-aware and energy-efficient choices and mobility patterns

Project example on integrated mobility

We base our contributions on ongoing work around sustainable smart cities and in particular one project. +Cityx-Change is an EU H2020 SCC1 Lighthouse Project in the Smart Cities and Communities scheme. It develops the technological, social, regulatory, and financial foundations for the Green Energy Transition; with a focus on Positive Energy Blocks (PEBs) [2].

Its contributions towards mobility are twofold. First, it aims to develop an integrated eMobility-as-a-Service (eMaaS) approach that supports a modal shift towards more sustainable personal transport options (shared EVs, eBuses, eBikes, bikes, walking) and a seamless integration of these modes for trip planning and travel. Second, it works towards integrating the mobility energy needs into the buildings or districts where the mobility needs arise, so that local renewables can satisfy local or locally-induced mobility needs. It will also make EVs a first level member of the energy system [8]. Further, it links these with cities' strategies and poli-

Strategy and policy examples

National and European strategies focus strongly on fleet emission reductions and the green energy transition. As an example, Norway has stronger ambitions: the Urban Environment Agreement from 2016 for Trondheim states a 'zero growth goal'; all further growth in personal transport shall be covered by public transportation, cycling, or walking. Actions in Trondheim include an update of the city's bus system: five electric bus routes with 40 electric buses, and a Bus Rapid Transport system with 3 routes; upgrades of cycle paths; and an updated transportation strategy. Already 13.5% of vehicles are chargeable^a and charging infrastructure is developing fast. The National Transport Plan has set the goal to phase out ICEs by 2025 in favour of zero local emission vehicles for all new cars, urban buses, and light commercial vehicles.

^a<https://elbil.no/elbilstatistikk/elbilbestand/>

cies and with national and European regulation. All these are supporting the acceleration of the electrification of the mobility system, electrifying road transport making up to 13% of European energy use.¹

eMaas platforms should support a combination of transport options for personal mobility through all modes that are available, ideally shared and public transportation and other providers and systems. Apart from the backend integration [3], the user interaction sees a few challenges. A suitable overview of the available options and of the ability to combine available modes is the first step. A truly seamless interface across different providers, modes, and vehicles/devices is hard, also in light of regulations that disable certain integrations, for example of common payments.

Also, an indicator is needed that shows the 'greenness' of a chosen option, and should do this in a way that is most engaging and informative. This may even integrate into other apps users are already using to track environmental friendly behaviour. Further, the focus on the range of EVs will become relevant. Combined with the use of batteries in the energy grid, whether for private or shared cars, is an as-yet unsolved question of viable interface design and possible associated energy behaviour that is still being understood. The current prototype [8] built by an industry partner is focusing mainly on backend functionality, the user interface is under development, but some challenges raised here are out of scope for that project.

Once car batteries can become connected to smart grids through V2G (Vehicle-to-Grid) two-way charging/discharging, car owners and car fleets can become buffers in the energy

grid and owners can become prosumers. This will need a combination of prediction models of mobility patterns on the backends, and user interfaces for car users to understand how their car is used and how they may influence their car's interaction with the grid. For example, by setting limits on how much they are willing to share battery capacity with their neighbours, as well as setting limits on how much charge they need available on average or for the next day. For a wide adoption, such systems will have to be running mainly automatically, but with easy ways to adapt them to individual needs. This can bring similar challenges as for example automation in smart homes.

Multiple angles of change

We focus here on the main impacts of personal mobility, and on short distance needs through private vehicles, shared mobility, or mass transportation, with less focus on long distance rail, ships, or air travel. Simply replacing private conventional ICE (internal combustion engine) vehicles with EVs or even autonomous electric vehicles will not be enough. While EVs are able to use renewable sources, they would not change the mobility systems on their own.

Autonomous vehicles can provide some impacts for changes in the mobility system. They could both change how the car as a space or device is used, and offer more options for easier sharing of vehicles, less vehicle ownership, and new models for mobility. For example, they could switch between different users on their own, making sequential sharing more location-independent. Autonomous small feeder buses are already being trialled to connect low density residential areas to the wider public transport system and to mobility hubs, so that private cars become less of a necessity. Leisure or work time can be spent in the car. But will this become more like a more comfortable bus cabin, or turn into a personalised living room? Which of these will

¹ Final energy consumption in Europe by mode of transport, European Environment Agency, <https://www.eea.europa.eu/data-and-maps/indicators/transport-final-energy-consumption-by-mode/assessment-10>

make it easier to reduce car ownership? What other use cases are opened up?

Such examples show that there is a technical basis for a more dynamic and demand-driven mobility service. Its integration and the user interfaces and user experiences to make this change palatable and useable will be a large success factor.

Open Questions and Challenges

There are a number of other factors that may influence energy awareness and reduction, both individual and systemic/regulatory:

- How do we make the individual *and* systemic changes and impacts tangible for the users of integrated mobility systems?
- How can gamification and self-tracking support [5]? How to support personal driving style and awareness [4]? How may these be connected to other personal apps or directly into mobility systems or vehicles?
- For combination of multiple trips, what is a suitable way to integrating charging time and location into route and time planning? What are reductions possible through ride sharing [7]?
- How to empower users/citizens/passengers to meaningfully contribute to transport planning and urban planning in their cities? How to change urban layout to reduce mobility needs without impact to quality of life? How to do the same for rural regions?
- How to ensure autonomous driving can be used as a game changer and not just a 1-to-1 replacement of conventional private cars?
- What is the short- and long-term impact of Covid-19? How will this influence the acceptance of shared (micro-)mobility or of public transport? What is needed

to not fall back on old modes?

- What is the dependency on work schedules? If working from home becomes more normalised, will this reduce the need for private cars?
- How to deal with rebound effects, to ensure efficiency gains are not used in additional emissions elsewhere?

We do not have all the answers yet, but hope the workshop will bring new discussions and insights.

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