

Transforming household mobility practices through shared consumption: Low-carbon transport and sustainable energy solutions in urban areas. (TEMPEST)

Relevance to EnergiX

This inter-disciplinary project addresses the question of how transition in the transport sector can bring about a more efficient and sustainable use of energy. That is critical in order to reduce energy consumption, greenhouse gas emissions and overexploitation of common natural resources (Araújo 2014). Transportation is a particular important subsystem, responsible for about one third of energy consumption in Europe. In Norway, energy consumption for transport, including road, rail, air and sea transport has increased by 40 percent since 1990, and 38 percent of CO₂ emissions now come from mobile sources (Brunvoll & Monsrud, 2013). The National Transport Plan estimates a growth in passenger and freight transport in Norway of 40 and 80%, respectively, towards 2050 (Meld. St. 26 (2012-2013)).

The project will study the transformation of household mobility practices by focusing on the emergence of *shared consumption* of formerly private means of transportation, particularly the privately owned fossil-fuelled car in urban areas. Although spurred by new mobile technologies and applications this is most of all a non-technical innovation that focuses on changing travel practices (Hyard 2013; Shove & Walker 2010), new markets and new forms of cooperation and business models.

Transition to a low-carbon transport system is a key challenge in the years ahead and particularly addressed in the call. Much hope is invested in that technological transport innovations, greening of cars etc., may help to spur changes toward more sustainable transport. However, gains in energy efficiency alone are unlikely bring about the necessary restructuring of the transport system, changes in transport practices that require less energy/fuel are also required. This is particularly important in order to achieve the zero-growth target for passenger car transport in major cities.

The project will contribute to new knowledge in several ways: Firstly, by combining system-oriented innovation theories (Markard & Truffer 2008; Geels et al 2014) with theoretical approaches that address change in behaviour on individual and household level. The project applies a *novel analytical framework in order* to develop a deeper understanding of such transition processes. Secondly, based on the theoretical framework the project will generate new, empirically based insights on *conditions and key factors* that are important to enhance and stimulate transitions toward more sustainable mobility patterns. Thirdly, a better understanding of the *potential future impact* of shared mobility services makes it easier to employ policy instruments that can reduce energy demands in the transport sector.

Background and status of knowledge

The massive adoption of cars in the developed world in the past 5 years, have fundamentally changed urban landscapes and millions of people's way of life. In this short period, the automobile has evolved into a mean for private travels, sustained by a far-flung network of roads and highways designed for driving. Consequently, the "regime of automobility" dominates the current mobility system in Western countries (Geels & Kemp, 2012; Berger et al., 2014). Although the benefits of the private car for individuals and households in everyday mobility is recognised, most politicians, planners, and social scientists have acknowledged the backdrop of this development. The private car contributes to an over-consumption of oil-based fuel and energy, which makes it difficult to bring down the energy consumption and reduce CO₂ emissions from the transport sector.

However, there is also increasing empirical indications that car-based personal mobility is lessening its share of urban travel (Kent et al 2013; Dennis & Urry 2010). Several scholars point out that car use and car ownership in many Western cities may have reached its peak and, that a new generation of travellers tends to prefer other modes than private cars (Berger et al., 2014; Kuhnimhof 2012; Line 2012; Millard-Ball & Schipper). The interest for alternative mobility arrangements may be enhanced by a new and general interest for *shared or collaborative consumption* in society, which refer to an economic model that emphasises “access” or “sharing” instead of ownership (Shaheen, et al 2012). The sharing economy has become more prevalent in recent years particularly due to online connectivity and the maturing of mobile technologies and software which has made car-sharing applications more widespread (Botsman & Rogers 2010).

Shared mobility services exist in many forms. Ridesharing, such as casual carpooling, vanpooling and real-time ride sharing (e.g., Avego, Carticipate in North America or Go-More in Denmark and Norway, “Bilkollektivet” in Norway) has grown increasingly popular (Chan & Shaheen, 2011). According to Shaheen & Cohen (2007), a car sharing vehicle reduces the need for an estimated 4 to 10 percent privately owned vehicles in continental Europe, 6 to 23 vehicles in North America, and 7 to 10 vehicles in Australia. European studies indicate a reduction of 28% to 45% in vehicle kilometres travelled (VKT) due to car sharing. Such reductions in the number of vehicles and VKT would have a substantial impact on energy consumption as well as reduced emissions and pollution from car traffic.

New communication technology and online social networking behaviour have supported a rapid growth in shared mobility services in recent years. Social media is important for consumer-facing businesses and particularly for P2P sharing businesses such as personal vehicle sharing. However, mobility transition may take some time since people are still not familiar with the concept and there may be a fear of sharing among users in the early period. It is also important to be aware of that decisions related to the use of cars and other travel resources are usually made within the realm of a social group, a family or a household. Changes in household formations, relocations and employment will often influence on how household members interact with each other, and their decision about the use of cars and other transportation means. Therefore, negotiations in household is an important factor to explain everyday mobility practices (Jarvis 2003; Pooley et al 2011; Jensen et al 2015), and this we be emphasised in the project.

So far, car sharing and other shared mobility solutions is implemented in a relatively small scale in inner urban areas. A limited number of scientific studies have suggested that this may represent an important element in a transition towards a low-energy urban transportation system (Nenseth et al 2012; Kent et al 2013). However, there is a need for more comprehensive, long-term studies to develop a richer understanding of the conditions for change, and the potential future benefits. Of particular interest is the potential for shared mobility resources to reach out of the city centre, to get reductions in private car use on a larger scale. There is also a need to look closer into the impact on energy use, when a larger number of shared cars relies on electrical power, hydrogen or other alternative fuel systems.

Approaches, hypotheses and choice of method

Theoretical approach

Moving from an unsustainable use of energy in the transport sector towards a low-carbon and low-energy urban mobility system requires deep structural changes of both an established transport system and of ingrained mobility patterns. Therefore, a transition of the transport system implies both technological and non-technological innovations. However, existing systems tend to be very difficult to “dislodge” because they are stabilised by various lock-in

processes that lead to path dependent developments and “entrapment” (Fagerberg 2000). This makes it difficult for innovative sustainable solutions to develop and bring about radical structural changes. However, innovations do take place, and *transition research* focuses on how and why existing systems endure and re-produce; what mechanisms destabilise them and open up for successful experiments and new development pathways (Geels et al. 2008).

Transition research applies a *system perspective* in studies of socio-technical transitions, i.e. major changes in technological, organisational and institutional terms related to production and consumption. Such large-scale changes often involve a broad range of actors and typically unfold over considerable time-spans and may result in new products, services, business models and organisational forms (Farla et al 2012). The introduction of the automobile radically changed the mobility and settlement patterns. A transformation of household mobility practices due to shared consumption and large-scale reduction of privately owned fossil-fuelled car in urban areas might also have substantial impacts, not only on energy use and on GHG missions, but also on urban and land use planning and life urban life-styles.

Transition research often applies a Multi-level perspective (MLP) (Geels, 2002, 2005) or an innovation system perspective related to technological, sectoral or territorial innovations (Bergek et al 2008). MLP argues that transitions come about through interacting processes within and between three analytical levels - niches, socio-technical regimes and an exogenous socio-technical landscape and, that structural changes start as radical innovations or transition experiments in niches. Niches are the micro level units where radically novelties emerge. Within the field of shared mobility studies, small business units or local communities that currently are initiating shared mobility services will represent the niches. As these niches are crucial drivers of systemic change, we will conduct cases studies of multiple such units.

The innovation system approach is useful for identifying the key players and institutions in the fields of transition, activities and processes carried out by these, weaknesses in the innovation systems and key drivers and inhibiting factors (Jacobsson & Bergek, 2011). This approach also has an active policy dimension and engage in developing targeted tools and policy mixes that can help reduce or remove barriers (Negro & Hekkert, 2010). A main challenge for transition policy is often to induce up-scaling processes in order to bring about the deep structural changes necessary for transition.

The MLP and innovation system approach often tend to overlook activities and behavioural changes that takes part on a micro-level (Shove & Walker 2010; Cairns et al 2014; Schwanen et al 2012). However, now also authors within the transition research school increasingly emphasise the need to incorporate a micro-level perspective in technological innovation studies (Bergek et al 2015, Farla et al 2012). We do know that transport innovations are usually only adopted if they suit the mobility needs, habits and routines of the potential users (Nijhuis, 2013). In a complex mobility system, both the technical aspects of the transport system (vehicles, infrastructure, etc.), the organizational models (individual car ownership, car and bike sharing, and ticketing schemes, etc.), the regulatory framework, the user habits, are all co-evolving (Berger et al., 2014).

This project will combine the system approach with a micro-level perspective based on *social practice theories*. Such theories have proven to be particularly useful for analysing “routinized” practises like every day travels (Reckwitz 2002; Schwanen et al 2012; Cresswell 2010; Webb 2012). Travel behaviours and consumption of mobility services are social practices embedded in various social contexts, including social norms, family and work situation and spatial location (Berger et al., 2014). Changes in travel routines, therefore, should be analysed within a network of other household-related activities (Pooley et al 2011).

Socio-technical system theories and practice theories are to a large degree complementary to each other. A systemic change depends on transformations in individual’s everyday routines and behaviour, which in turn is influenced by changes on a regime or

landscape level. Thus, to combine such theories is both relevant and fruitful in this field (Watson 2012, Millard-Ball et al 2011).

Research objective and questions

The overall research objective is *to develop an understanding of the conditions for systemic changes in the transport system, focussing in particular on transitions from privately owned means of transportation toward shared mobility services, household practices, and the subsequent potential for energy reductions.*

Subordinated research questions

The overall objective is investigated through the following four derived research questions which again are closely linked to the five central work packages:

- What are the key technical, political and social factors influencing a transition in the transport system towards low-carbon and low-energy urban mobility, related to utilisation of shared mobility services? (WP1)
- What are the key factors in households affecting on a transition toward utilisation of shared mobility services? (WP2 & WP4)
- How can stakeholders (transport and city-regions authorities, private product developers) stimulate to transitions of shared mobility services in urban regions? (WP3)
- What is the potential future uptake of shared mobility services, and what is the potential future reductions in energy? (WP5)

Choice of methods

This study will adopt a *comparative case study approach* focusing on the emerging new providers of shared mobility services within the national contexts of the UK, Sweden, the Netherlands and Norway. Case study as a reach strategy is particularly well suited to investigate complex social phenomena in a real life setting, to explore influential factors and social processes, and to develop new concepts and theories (Ragin 1987; Yin 2003). By comparing cases of niches across multiple cities and nations, we intend to develop a general understanding of internal and external factors that affect the up-scaling and success of the niches, as well as on critical differences across the cases.

The analysis of the cases will proceed through four main steps. First a description of 1-3 cases in each country, mainly based on review of pre-existing documents as well as interviews with product developers and managers. The car sharing enterprises and communities of users will be analysed within the framework of socio-technical system theory. This gives us an overview and general understanding of each of the cases

In the second step, *in-depth interviews* is conducted in 12-15 households in each country, related to the cases. The objective is to explore and understand mobility practises in the households and the barriers and drivers related to possible changes towards increased use of shared mobility services. These studies will help us to understand the decision making and negotiations in the households, as well as the challenges related to a potential change in travel behaviour. As niches depend on behavioural changes across a given region or area, it is necessary to also investigate households in the regions. Case studies will be done with both users and non-users of car sharing arrangements, across different life stages and geographical locations. These studies, then, broadens the case studies in the first step by including user and potential users. We will rely on a snowball approach to access household informants.

In step three, a *household survey* will supplement the in-depth interviews in order to throw light on how households in the same geographical areas as the cases think about a possible change from private cars to a collectively shared system. The survey will be used to further test out concepts and constellations that has been brought up in the in-depth interviews

and to understand the possibilities for behavioural changes across different household segments. Due to extensive demand of resources, this survey will be conducted only in Norway.

In step four, *workshops* is carried out with policymakers and stakeholders involved in planning of future urban transport systems. In line with the multi-level perspective, we seek to understand the processes operating on a regime-level, involving representatives from industries, science and political spheres. Workshops will take place in each of the four countries and the results will be input in a Delphi-study (described below). Through the workshops, the project will develop knowledge about how actors on a policy and business level understand the development of niche activities, and what measures that can be taken too stimulate changes.

In step five, a cross- national, real time *Delphi-study* distributed as a web-application, is conducted to estimate the future development of shared mobility services (Turoff et al 2002; Chia-Chen et al 2007). Participants are a panel of international experts within transportation research, policy makers, technical experts and social sciences experts. The stakeholder workshops will provide input to the Delfi study. The final projections describing possible future lines of development is then used as input to model 2-3 scenarios for the future uptake of shared mobility services. The scenarios are subsequently used to estimate the potential reduction in energy use and emissions of greenhouse gasses. The traffic work generated in the respective scenarios will be implemented in the HBEFA model (HBEFA 2009) and will be compared to the state of the art scenario from earlier projects (Compett, EMIROAD), in order to estimate the energy uptake of the Norwegian vehicle park. In addition to the savings in energy uptake, the model will deliver local emission factors such as nitrogen oxides (NOx) and particular matter (PM), thereby creating a solid base for guidelines for a sustainable future traffic system (Hausberger et al 2009).

In sum this methodical triangulation will generate unique knowledge related to the current practice of shared mobility services, relevant barriers and drivers on a both a household and policy level and, forecasts on potential uptake and development of car sharing systems on the longer term.

3. The project plan, project management, organisation and cooperation

The overall goal of this project is to study transitions in the transport system, related to uptake of new mobility services based on sharing. Our focus is not only on the technologies per se, but just as much on the social practises involved in ongoing and potential transitions. The project is conducted through six closely interlinked work packages (WPs), each with defined objectives and research questions.

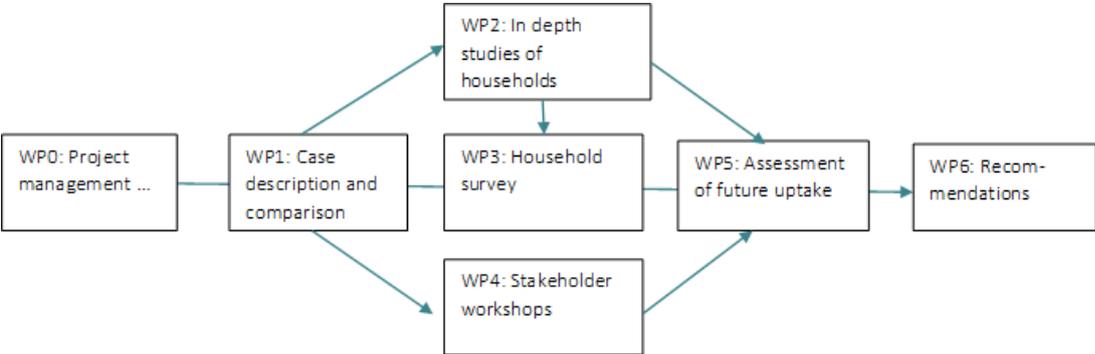


Figure 1. Overview of WPs

WP0. Management and communication. This work package contain all activities related to the planning and coordination of the project, as well as dissemination of key results.

Task 1: Specification of the research framework and detailed plan

Task 2: Initiate coordination of work by organising project meetings, workshops and document sharing.

Task 3: Initiate dissemination of key results to stakeholders, the general public and relevant scientific communities.

WP1. Description and comparison of cases. The aim of this work package is to describe and compare all cases in the project. 1-3 niches will be studied in each of the four countries to get an overview of central differences and similarities. The case studies are ongoing car-sharing communities located within a city/nation and the analysis is done within the framework of transition theory as described above. The work in this WP represent an important baseline study for the work in the forthcoming WPs.

Task 1: Developing research tools and framework for case description

Task2: Case studies of shared consumption mobility services based on document analysis and interviews with managers and employees in all countries/cities.

Task 3. Development of national write-ups

Task 4: Preparing an international cross-case analysis

WP2. In-depth studies of households. WP2 will conduct in-depth studies of households related to the cases. Analytical frameworks and concepts from social practice theories are used to guide the studies. Qualitative studies is conducted with households situated in geographical closeness to the cases described in WP2, and both existing and potential users will be included, as well as household involving families in different life-stages and family constellations. The studies will involve 12-15 households in each country. The outcome of the work is a closer understanding of key factors within households that influence on the future uptake of shared mobility services. The results will also be used to develop hypotheses that will be further examined in WP4 and WP5.

Task 1: Development of research tools and templates

Task 2: Selection of households - sharers & non-sharers

Task 3: Fieldwork with write-ups

Task 4: Cross case analysis

WP3. Household survey. In this work package, a household-survey will be conducted among a sample of potential users in 2-4 selected urban regions in Norway. The survey will be used to test hypotheses related to the uptake of shared mobility resources in households. The results will be a model that estimates the strength and interplay of key factors in the adoption process, as well as the possibilities for behaviour change across different household segments.

Task 1: Development of survey tool

Task 2: Distribution of survey to household sample

Task 3: Analysis of results

WP4. Workshops with stakeholders and developers. In this work package, we will conduct a series of workshops with stakeholders in each of the four countries. In addition to policymakers on local and national levels, we will involve business developers, technical experts and social researchers. The results from the WP will be used as a key input to the subsequent Delphi-study.

Task 1: Development of research tools and templates

- Task 2: Selection of workshop participants
- Task 3: Organizing stakeholder workshops
- Task 4: Analysing results from the workshops.

WP5. Assessment of future uptake of shared consumption of mobility services. The work in this project will provide an overview of the potential future uptake of shared mobility services in four countries, by the development and use of a quantitative Delphi study. Through a systematic communication process within a panel of experts, 1-3 scenarios will be elaborated. The scenario results is used to make estimations for the potential energy savings and reduction in greenhouse gasses (GHG) for each participating country.

- Task 1: Development of a tool for a web-based Delphi study
- Task 2: Distribution of survey to an international expert panel
- Task 3: Estimation of potential reduction in energy and GHG emissions

WP6. Conclusions & recommendations. Finally, all results will be integrated and overall conclusions drawn. The final report will document all results and will a list of as recommendations to policymakers related to the future use of shared mobility resources.

- Task 1: Final report integrating all key results
- Task 2: Seminar addressing key findings.

The project will publish 6-7 peer-reviewed articles in referee-based journals, such as *Journal of Transport Geography*; *Transportation Research Part A: Policy and Practice*; *Environmental Innovation and Societal Transitions* and *Technological Forecasting & Social Change*. Results will also be published in national professional journals, e.g. *Samferdsel, Plan and Tidsskrift for samfunnsforskning*. App. Cf. section 13 and “Dissemination of project results” in grant application for further details.

Project consortium

A consortium, led by the Institute of Transport Economics (TØI), will carry out the project. The research team at TØI consists of Senior research sociologist (PhD) **Tom Erik Julsrud** (project leader); Chief research sociologist (Dr.) **Randi Hjorthol**; Chief research economic sociologist (Dr.) **Ove Langeland**, Senior research economist (PhD) **Eivind Farstad**, and senior research engineer **Rolf Hageman**. The consortium has national and international research partners: Professor **Fulvio Castellacci**, University of Oslo (TIK). Associate Professor **Tim Schwanen** at Transport Studies Unit (TSU), University of Oxford (UK), **Lars Coenen**, Professor in Innovation Studies CIRCLE (Centre for Innovation, Research and Competence in the Learning Economy) at Lund University, Sweden, and Professor **Derk Loorbach** from the Dutch Research Institute for Transitions (Drift). TØI will take lead in all WPs, but work closely with each of the partners.

National and international cooperation and networking

The consortium possesses solid scientific knowledge on all issues in the project – transition research, innovation and policy analysis and, energy use and mobility patterns in the transport sector in territorial (urban) contexts. The project will also benefit from research expertise from CIENS, which is a leading national and international centre for interdisciplinary and multidisciplinary research on environment and society. TØI is a member of CIENS together with the University of Oslo and the project can draw on knowledge resources from natural sciences, technology, social sciences, and economics. TIK is member of the National *Centre for Sustainable Energy Studies* (CenCES) which is also highly relevant for this project.

Table 1. Project organisation and work packages

| Work Packages | Year | | | | | | WP leader | Input |
|--|------|------|------|------|------|------|-----------|-------|
| | 2016 | 2017 | | 2018 | | 2019 | | |
| | 7-12 | 1-6 | 7-12 | 1-6 | 7-12 | 1-6 | | |
| WP0. Project management | | | | | | | TØI | |
| WP1. Case studies | | | | | | | TØI | All |
| WP2. In-dept studies households | | | | | | | TØI | All |
| WP3. Housholds survey | | | | | | | TØI | All |
| WP4. Workshop stakeholders | | | | | | | TØI | All |
| WP5. Delphi & Assessment | | | | | | | TØI | All |
| WP6.Synthesis, recommendation, communication | | | | | | | TØI | All |
| International seminar | | | | | | | TØI | |
| PhD | | | | | | | TIK | All |

TØI was lead partner of the recently completed COMPETT project (Competitive Electric Town Transport) which is part of the ERA-NET Electro-mobility programme that focused on technological development of battery and charging technology and on sociological investigations of the use of electric vehicles. This project also used a multi-level perspective (MLP) to look at the interaction of events and actors at the niche, regime and landscape levels and on adoption from a socio-technical perspective using the theory of diffusion of innovations (Figenbaum and kolbenstvedt 2015). TØI is also partner in a Nordic flagship research project focusing on an “energy-efficient and low-carbon Nordic transport system” (NOSTRA) financed by Nordic Energy Research (NER). The NOSTRA project will run for the period 2015-2019 and will produce relevant results for this project. In NOSTRA TØI cooperate closely with the Swedish Environmental Research Institute (IVL), Victoria Swedish ICT and The Technical University of Denmark (DTU) which all have solid experience in sustainable transport research.

The project will also draw on experiences and expertise from the international partners in the consortium. Coenen is one of the pioneers in research on the ‘geography of transitions’ focusing on the role of regions and cities in sustainability transitions. As founder of the Transition Management approach Prof. Jan Rotmans is one of the pioneers in transition research and together with Dr. Derk Loorbach has long experience with transition research and experiments. TØI has also ongoing collaboration with Prof. Tim Schwanen and Prof. David Banister from University of Oxford in two ongoing projects related to transport innovations (CRAFTTRANS) and commuting habits in the greater Oslo region (Travel behaviour change in Oslo & Akershus). The international partners will contribute to the project with case study experiments from their home countries, and as referees, co-authors and partners for knowledge exchange.

Ph.D. fellowship

The proposed Ph.D. fellowship will be situated in the Centre for Technology, Innovation and Culture/TIK Centre within the Social Science Faculty of the University of Oslo. The fellowship will be internationally announced and can be expected to result in a highly competitive recruitment among a large number of applicants. The TIK Centre has a well-established and well-structured Ph.D. programme that emphasizes close supervision of candidates by experienced senior staff/ professors, advanced course work in areas of relevance to the candidates’ projects, a clearly structured study plan, and mechanisms for regular evaluations of candidates’ on-going work. The successful candidate for the position will be part of a

multidisciplinary cohort of Ph.D. fellows at the Centre, as well as participate in on-going research programs with senior scholars, international guest researchers and extensive scientific networks that will provide a fruitful scientific framework for supporting the work.

Compliance with strategic documents: For the participating institutions in the consortium, innovation and policy research and urban transport are central themes emphasized in their strategic plans. TØI, TIK, DRIFT, University of Lund and University of Oxford all have long research traditions and strong competence on these themes and the project will contribute to increase and consolidate this competence. **Relevance to society:** New knowledge about how cities can accomplish restructuring of the energy system and improved energy efficiency related to the transport sector will be highly relevant for regional and national government and for industries. **Environmental perspectives:** The project will contribute to increased knowledge on how integrated sustainable urban energy solutions, together with behavioural changes, can pave the way for a transition to low-carbon urban transport. **Ethical aspects:** The project will follow the Norwegian legal and ethical guidelines regulating data collection, analysis and publication. All empirical studies (surveys and case studies) will be reported to NSD which is the Private Ombudsman for Research, before being conducted. Findings will be subjected to scrutiny from peers nationally and internationally to secure scientific quality and honesty. **Gender equality and gender perspectives:** The project promotes gender equality in Norwegian research by applying a gender perspective in the project, and particularly in the household studies. The project team member Hjorthol is also a pioneer in research on gender issues in everyday mobility patterns. We will also endeavour to recruit a female PhD student to the project.

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