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Infrastructure development for sustainable road transport: a Nordic perspective on national and cross-national challenges within electrical mobility

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The formative EU transport policy focuses on region-wide initiatives to promote more sustainable transportation, including electrical mobility. The vow to integrate or coordinate the ongoing development of electrical mobility into a Europe-wide recharging-infrastructure confronts a number of challenges. As a region, Europe consists of a range of national contexts that differ in most respects that are relevant to realizing this shared aim. In preparation for a transition to standardized regional infrastructure, it is useful to study the implications of what it would mean at the more disaggregated level. This paper studies the national cases of Norway and Denmark within the context of the seemingly homogenous Nordic region.

Theoretical framework

The paper applies the theoretical framework of the multi-level perspective on socio-technical systems and transition theory. Transition is here understood as shifts or 'system innovations' between distinctive socio-technical configurations encompassing not only new technologies but also corresponding changes in markets, user practices, policy and cultural discourses as well as governing institutions [1]. Geels and Schot [2] characterize transitions as following: (a) co-evolution and multiple changes in socio-technical systems or configurations, (b) multi-actor interactions between social groups including firms, user groups, scientific communities, policy makers, social movements and special interest groups, (c) 'radical' change in terms of scope of change (not speed), (d) long-term processes over 40–50 year periods.

A group of Dutch researchers developed the multi-level perspective (MLP) on socio-technical systems which we have chosen as the main conceptual framework for studying the role of infrastructure development for sustainable road transport. The MLP distinguishes between three levels in a socio-technical system: (1) the socio-technical regime, (2) the socio-technical landscape, and (3) the level of niches [3:31f.]. These three levels form a kind of "nested hierarchy", a level of structuration they provide to local practices [3:32].

Infrastructure systems are special types of societal systems that include both the physical artefacts and the institutions which regulate and manage these systems [4]. Infrastructure systems have developed over a long period and are characterized by relative stability and inertia [5]. Infrastructure systems are influenced by technological and institutional lock-in mechanisms and characterized by path-dependencies and therefore difficult to change [6]. Technological lock-in mechanisms, such as economies of scale and sunk costs, network externalities and learning effects contribute to path-dependency. Relevant institutional lock-in mechanisms are asymmetries of power, institutional learning effects and collective action, referring to the emergence and subsequent reproduction of societal norms, customs, consumption patterns and formal regulation through coalition building in associative networks of individuals and organisations.

Discussion

The paper focuses on the different approaches taken at the national level to build battery electric vehicle (BEV) recharging infrastructure. Norway and Denmark provide apt, contrasting focal points and are both relatively far in the development, at least compared to many other countries. Despite its position as a large fossil-fuel exporter and its mountainous topography, Norway exhibits high – and rapidly growing – levels of penetration of BEVs. Denmark is developing a connected nation-wide infrastructure. In both countries the integration of the existing infrastructures of electricity systems and road transport systems is a challenge.

The paper takes stock of the factors that have contributed to these different developments and discusses the implications of further developments in terms of European ambitions and in terms of the role-out of EV charging infrastructure.

Based on domestic endowments, demography, policy contexts, each has pursued different approaches to EV recharging infrastructure and each has experienced different levels of BEV penetration. We look at a set of factors to explain these differences: the share of electricity from renewable resources, the types of renewable sources, the composition of fleets, public support for infrastructure, public sector incentives for BEV use, etc. This analysis can help inform a discussion of the transition from national to European transportation infrastructure. Implications for the building out of infrastructure for new energy carriers, for example hydrogen for use in fuel cell vehicles will also be drawn.

	Denmark	Norway
Geographies: distances, cities and rural areas	Well-connected and 'compact' country with rather short distances and no mountains	Long distances and many mountains, some more densely populated regions in the South
Renewable electricity production	Wind power – fluctuating In 2011, the share of renewable sources in electricity generation varied from 39%	Hydropower – rather stable, balancing In 2011, the share of renewable sources in electricity generation varied from 98%
Grid	Need for smart grids to exploit fluctuating wind power. Engagement by major energy companies and grid operators	Need for development of central grid and access to surplus of renewable electricity
Political approaches	National strategies and visions for electrical mobility. Considerable, but non-permanent tax-reduction on electric cars Few other incentives for customers to buy EVs. Local authorities supportive, e.g. parking/charging spaces and EVs in public car fleets.	National agency (Transnova) supporting infrastructure development – alignment with environmental NGOs Regional and local authorities supportive Many incentives for customers to buy EVs
Early mover	Early mover for battery switch stations and network operation centre, but one of the two main providers of infrastructure, Better Place, failed because of too high costs, just one car producer applying the switch concept, and too few costumers. Taken over by E.on. Both providers established some fast charging points.	1st stage: Early roll-out of 1st generation of charging points because of Think and Buddy – critical for new generation of EVs 2nd stage: Fast charging infrastructure
Consumer involvement	Full-service subscription based business model including batteries and charging. Ownership of batteries by Better Place might have provoked reluctance by customers	Environmental NGOs and consumer organisations very active
EV producer involvement	Involvement of Renault and Nissan. Moreover, sub suppliers in the car industry, e.g., Continental, A123 (batteries, control systems, etc.	Involvement of Mitsubishi, Nissan and Tesla
Charging points	1.700 charging points in 2013 (BP & Clever)	4.800 in February 2014
Charging infrastructure provider involvement	The two main providers are both in close alliance with energy companies. Better Place came from the outside (Israel). Clever is primarily Danish. Ensuring a degree of competition between providers is part of the policy. Kind of oligopoly situation. A limited number of other (small) infrastructure providers, e.g. car-sharing organisations	Counselling of national projects by different foreign actors (Epyon, ABB, TEPCO etc.) and national electricity providers – building own commercial actors, bottom-up approach
Market penetration of EVs	Ca. 1.300 EVs registered as personal vehicles in 2013	From ca. 1.700 EVs registered in 2008 to 12.000 in 2013. High number compared to other countries. Goal: in 2020 200.000 BEVs and PHEVs
Regional focus	Start with capital region, extended to other cities and main cross-national traffic corridors Goal: Geographical coverage should include not only clusters around a few cities, but be country-wide including also smaller towns, holiday areas, etc.	From one-sided domination of capital-region to development of a number of regions with higher market penetration and rollout of charging infrastructure Political shift from charging corridors between larger cities to clusters Exception of Tesla due to long range (500 km)

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