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Transformative innovation policy for a sustainable mobility transition: missions or challenges?

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Transformative innovation policy has been identified as an emerging policy paradigm which seeks to directly promote innovation pathways that address contemporary societal challenges. This contrasts with preferences for policies limited to indirect framework conditions ('innovation systems') to facilitate economic competitiveness. The emergence of perspectives on transformative innovation policy reveals a contrast between approaches which emphasise a techno-science driven perspective and those which favour a socio-technical system framing (Diercks, Larsen & Steward 2019).

The former is often termed 'mission-oriented' innovation policy, a concept originally formulated from a partly critical viewpoint (Ergas 1987) but which has recently been revived in positive terms as a policy aspiration (Mazzucato 2017). Although this new advocacy of 'mission oriented' innovation policy seeks to embrace social innovation, its roots are located in an evolutionary economics (neo-Schumpeterian) approach to the dynamics of innovation which envisages long term transformation as characterised by fundamental techno-scientific breakthroughs, driven by R&D developments.

In contrast a 'challenge-led' perspective on transformative innovation policy is framed in terms of the reconfiguration of socio-technical systems defined as the provision of key end-uses such as shelter, comfort, mobility, communication, and food. (Schot & Steinmuller 2018). Attention to such fundamental transitions in socio-technical systems draws on relational sociology (including STS) which seeks explanation through interpretive meso-level processes shaped through new societal challenges such as sustainability or social inclusion. (Steward 2012)

Both 'mission-oriented' and 'challenge-led' approaches subscribe to the need for transformative criteria of societal directionality and a broader remit for innovation policy. However they focus on different types of strategic actions, key actors, and favoured modes of innovation. This is expressed through different policy narratives. Examples of 'mission oriented' narratives emphasise lead technologies: 'the intelligent economy' (KPMG), the 'bioeconomy' (EU) and the 'nano-society' (Berger). They tend to focus on science and business actors and an R&D mode of innovation. Examples of 'challenge-led' narratives instead highlight normative system attributes: 'sustainable consumption and production' (UNEP), 'the circular economy' (EU), 'the low carbon society' (SETA). They often give more attention to broader knowledge and public actors and a demand led mode of innovation. The balance between these contrasting narratives and networks is critical to the future of innovation policy.

The domain of sustainable mobility is a particularly striking example of these contrasting approaches. Mission oriented perspectives are accompanied by narratives of new technologies of electrification, the autonomous vehicle and the hydrogen fuel cell; with networks of manufacturers and physical infrastructure providers. Challenge oriented approaches express narratives of new systems of inter-modality, mobility as a service, intelligent and integrated mobility; with networks of transport operators, local authorities and information providers.

This is the focus of our empirical research on urban transitions in Japan and its implications for innovation policy. (Aoyagi et al 2016). Through documentary and interview research we map out the sociotechnical networks of actors and actions to explore the discourses of transformation and their policy implications.

Japan is of particular interest from an innovation policy perspective because of its exemplary status in the emergence of the 'innovation systems' approach which became the prevalent innovation policy paradigm from the late 1980s. While many countries were seen to be skewed toward either top-down government or bottom-up business approaches, Japan was seen to offer a virtuous combination of the two (Ergas 1987). Chris Freeman defined it has the 'most effective' innovation policy of the late 20th century which was best suited to shape long term shifts of technoeconomic paradigm. (Freeman 1988) This distinction was considered to arise from a combination of a national strategic capability for expert led technology foresight along with an interactive innovation management style of large business organisations. This combination was facilitated by a collaborative mode of business/state governance and a shared 'systemic' cognitive style of business and government leaders. This Japanese innovation system which underpinned the global success of the manufacturing sectors of vehicles and electronic consumer goods was also seen to express a deeper longer term transformative potential.

A critical response to recent proposals for a new transformative innovation policy framing has come from prominent members of the 'innovation system' school of policy experts. (Fagerberg 2018, Lundvall 2019). They argue that the innovation system perspective remains a robust and effective framework for innovation policy which is fully adequate to address emerging global challenges of climate change and environmental sustainability. This implies that there is no need for a fundamental systemic reconceptualisation from the technoeconomic to the sociotechnical. One of the goals of our research is to assess the degree to which this may or may not be the case.

We focus on two mobility transition pathways which have received recent policy attention in Japan – hydrogen based fuel cell vehicles, and mobility as a service.

Hydrogen based fuel cell vehicles

Diffusion of fuel cell car has been long discussed since mid 1990', as this new energy car is a hope for post-carbon transportation system after fossil fuels. This new energy technology has been long time listed in, for example, climate change mitigation national plan in some of the ANEX I countries, as fuel cell vehicle or co-generation system which use hydrogen as its base energy. Japan has been investigated in this technology, and household fuel cell called "Ene-Farm" (Panasonic) has been sold more than 100,000 sets in Japan since 2008(Panasonic 23 March 2017 news release). As for this hydrogen, US and Germany is leading this field in technological development, but for the implementation, Japan goes ahead in terms of household usage (Ene-Farm: co-generation system for hot water and electricity, by hydrogen) and energy cell vehicles(Toyota and Honda).

Japan is the one of the leading countries for diffusion of Fuel Cell vehicles as well, with Mirai from Toyota and Clarity from Honda. Those two models are currently the only commercially available cars in the world. There are many challenges for fuel cell cars to be widely sold in future: 1) infrastructure: fuel cell vehicles need "Hydrogen station" for hydrogen supply in a certain density. 2)Price: the prices of them are over JPY10,000,000 even with governmental subsidize, Japanese consumer have to pay around JPY7,000,000. This is almost double price compare to their supposed competitive brands.3) Risk perception by the public. Japanese public watched the Hydrogen explosion on the television when March 2011 earthquake was happened. When people heard the word" Hydrogen", people often asked "is it safe? Is that explosible?" 4) Regulation for industry gas: Hydrogen has been used for manufacturing purpose for years. Hydrogen is regulated by the assumption for this. So, regulation system does not fit "fuel cell" system. Regulation for gas stand does not fit for fuel cell car. It assumes gasoline, or other conventional gas supply. Adjusting regulation system is a challenge as well.

The ministry of the Economy, Trade and Industry (METI) encourages related industries and sectors (e.g. vehicles, energy suppliers, gas suppliers as well as academia and local governments) to invest in relevant technologies and infrastructures to meet their goals of "the Strategic Roadmap for Hydrogen and Fuel Cells", which was first launched in June 2014 and revised in March 2016. The plan has three-step achievement plans, with the target years of mid-2020s (Phase 1), late 2020s (Phase 2), and around 2040s (Phase 3). This plan focuses not only vehicles, but also stationary fuel cells for heating and hot water supply for homes (Ene-Farm is one of those systems). The METI model utilizes hydrogen supply systems based on fossil fuel, such as natural gas and gases from byproducts of energy supply and industrial processes. But it is clear that the volume by those supply is not enough for the diffusion of fuel cell vehicles.

The Ministry of the Environment (MOE), on the other hand, promotes and subsidizes "renewable energy based" hydrogen supply system and fuel cell vehicles. MOE focuses on hydrogen supply systems with renewable energy. For fuel cell vehicles, Honda developed a bio- or solar energy-based hydrogen supply system called HSH (Honda Smart Hydrogen Station). This is compact and efficient and is less expensive compared to conventional hydrogen refueling stations, and currently this is the only system that can supply hydrogen directly from renewable energy sources. MOE subsidized this HSH in the initial (experimental) stage.

On local government level, the different departments and sections supports those METI and MOE systems. For METI system, the science and technology section or industry sections are in charge of hydrogen systems at the local level, while the environmental sections are often promoting MOE models. They both have their own networks for information exchange and policy cooperation the local level. In particular, METI utilizes their own local branches: for example, METI-Kanto Division, who is in charge of Tokyo metropolitan area and its surrounding prefectures, encourages local medium- and small-sized manufactures to join the local network for fuel cell vehicle parts manufacturing research and development. They hold research meetings, seminars, and other activities, which are designed to accelerate hydrogen R&D in the area

In October 2017 Honda made an announcement that they will build 100 stations by 2020. Honda building additional 100 stations is significant, as the current target in METI's strategic plan is to build 160 stations by 2020, and currently 78 stations are operational with 15 under construction. This Honda's strategies are included the aforementioned revised Strategic Plan of March 2016. Honda's HSH technology makes this target feasible.

In December 2017 eleven companies including vehicle sector (Honda, Toyota, Nissan), and infrastructure sector (hydrogen suppliers such as Iwatani, Japan Air Liquid) and financial sectors (Development Bank of Japan) announced that they established a new company whose aim is to build and manage hydrogen stations all over Japan in March 2018(News release 12 Dec 2017). This is clearly influenced by the Paris agreement, and following announcement of China, France, Germany and other countries' abolishing fossil fuel vehicle by 2040. This demonstrates the determination of the Japanese government to make hydrogen businesses successful.

The emergence of Japan as a leading player in FCV introduction in the last 5 years poses some interesting questions for interpretation. Much of the research within the transitions community concluded that the rise in attention to FCVs during the 2000s could be regarded as hype from a sociology of expectations perspective and that a disappointment downswing was evident in the early 2010s. (Bakker & Budde 2012). The Japanese decision by METI to establish a Council for a Strategy for Hydrogen and Fuel Cells In December 2013 was a countercyclical move which can best be explained as a high level political response to the aftermath of the Fukushima disaster of 2011.

What distinguished this policy intervention is that it foregrounded broad economic and energy security concerns, and placed climate change and sustainability goals as a phased secondary features of this strategy. A shift to a hydrogen economy was defined primarily as the introduction of a new energy vector which could open up access to new sources of fossil fuels. Partnership with leading industrial gas companies was a key feature of this and enabled the promotion of an ambitious infrastructure programme of hydrogen refuelling stations. At the same time policy intervention was designed to enable the market entry of FCVs by leading Japanese companies, Toyota and Honda. The membership of the Strategic Council directly represented these actors in the creation of a detailed roadmap for a hydrogen transition.

In many ways this mode of policy making sits comfortably as a mission-oriented policy within the classic Japanese innovation systems approach – an expert driven systemic roadmap with close collaboration between government and key industrial business players. This favoured selective incumbents from the car industry, industrial gas suppliers, and the economic departments of government. Although it did not prioritise sustainability and the production of hydrogen from renewables, interesting it was seen as an opportunity by the environmental and climate change institutions of government to promote a more sustainable path in collaboration with business and local government players. So it can be seen as an illustration of the flexibility of the traditional innovation policy approach to address new challenges. However it is evident that the type of change envisaged is primarily concerned with 'hard' physical infrastructure, and although radical in technological terms has low demands for significant changes in lifestyle.

Mobility as a service

In striking contrast with the high profile promotion of the Hydrogen Economy strategy is a cluster of much more recent lower key policy engagements with a challenge-led mobility services perspective. The first of these was an interim report produced by a METI created 'Study Group on New Mobility Services Enabled by IoT and AI' in 2018. This accompanied the broad high level Future investment strategy from the Cabinet office in 2018 entitled: Transformation to "Society 5.0" and "Data Driven Society". Wide ranging in scope this includes a section on a next generation mobility system enabled by IT which is a very different perspective from the energy led transition of hydrogen based FCVs. In 2019 a further report was produced under the auspices of the Ministry of Land, Infrastructure, Transport and Tourism 'the Urban and regional new mobility services round-table'. These policy interventions are far less clearly linked with incumbent business interests and more influenced by policy analysts from an urban planning perspective.

They suggest that Japan has lagged behind developments in this area especially in the promotion of new mobility integrator roles both in the private sphere of the new generation of internet platform businesses and in the public sphere of place based mobility system coordinators. Incumbent businesses have been partially successful in introducing elements of a new mobility as a service system. The railway company JR East has introduced the Suica travel payment smartcard, while Toyota has developed a range of pioneering micromobility products. Yet the fragmented business base of existing mobility services is seen to present great difficulties for Japan to play a leading role in this area of transformative innovation.

Interestingly these policy reviews reveal a lack of confidence in the ability of the prevailing Japanese innovation system approach to rise to this challenge. They include extensive references to European strengths in civic led system innovation, US strengths in new business start ups and the need for changes in the university based knowledge system.

It is notable that Mobility as a Service requires significant changes in soft infrastructures through regulatory transformation of the traditional boundaries between mobility spaces of road and pavement use. It also implies radical changes in lifestyle toward a more sharing mode of transport provision and use.

Discussion

Our research shows a tension between the role of these two perspectives in the policies for sustainable mobility innovation in Japan. The policy mix for sustainable mobility transitions has contrasting emphases on mission and challenge oriented approaches. Documentary and interview research on narratives and networks shows the variety and viability of 'sustainable mobility' and 'hydrogen society' transition pathways. It suggests that although the traditional innovation policy approach in Japan may be able to address some mission oriented elements in this transition it is limited in its capacity to deal with the challenge led demands of system change.

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