A CASE STUDY ON FCV POLICY IN JAPAN: A META-GOVERNOR'S ROLE AND ITS LIMITS

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ABSTRACT

'Public-private collaborations' or 'governance networks' have been found indispensable in public policies such as those for introducing and diffusing new advanced technology. In particular, in recent years, policy managers have been required to make efforts with regard to the 'governance of governance' or 'meta-governance'. Comparing with Sørensen and Torfing's recent work on effective and democratic 'meta-governance', this paper researches the R&D policy on fuel cell vehicles (FCVs) in Japan observing how the stakeholders recognize the policy and its feasibility, to find evidence on the conventional theory and to modify it. Furthermore, this paper aims to examine what a 'meta-governor' has to do to attain a certain policy goal, and to analyze endogenous and/or exogenous factors (such as the difficulty in distributing resources *appropriately* to competing technologies, the vulnerability of the research flow to political tides and personnel reshuffles, etc.) that should be taken into consideration in the policy processes for introducing and diffusing brand-new technology. We conclude that the 'meta-governor' is only a component of the plural 'meta-governance network', which imposes on him the abovementioned limits.

Keywords: public-private collaborative governance, governance network, meta-governor, introduction and diffusion policy of advanced technology, FCV (fuel cell vehicle)

1. INTRODUCTION—RESEARCH AGENDA, PLAN, AND METHODS

Social science researchers and practitioners have been seeking an understanding of conditions under which public-private collaboration really works to attain 'public good' (Marsh & Rhodes 1992, Goldsmith & Eggers 2004). Now that various resources for public administration (such as human resources, financial resources, authority, and information) are increasingly scarce and fragmented, the government of an administrative state has to rely, to a greater extent than ever before, on private actors so that it can 'steer' them to carry out public policy effectively and efficiently (Osborne & Gaebler 1992).

We can easily find such a public-private governance network in R&D policies on advanced transport technology (in safety standard-setting process, for example, in Murakami 2009). This is because technical information and knowledge necessary for R&D are not produced and exchanged only within government organizations (in a narrow sense), but are often shared and utilized in a public-private governance network (or mainly in the private sector) (Foray 2004). The policy manager must achieve a public consensus on resource distribution for introducing a brand-new technology into society. The government, in many cases, is required to make an arrangement for agenda-setting, grants, or rule-making, so that private actors are encouraged to respond in some way or another (Goto 2003).

A governance network, in contrast to a conventional hierarchical 'government', brings up another question: what is the role of government and its limits in the emerging horizontal network? Sørensen and Torfing, public administration researchers at Roskilde University in Denmark, examine this issue theoretically in a recent paper. They argue that in a governance network, careful meta-governance, or 'governance of governance', mostly by politicians and public managers, is necessary in order to ensure that the network contributes to an effective and democratic governing of society (Sørensen & Torfing 2009). They also provide us with a systematic account of tools and methods for meta-governors to deploy.

This paper focuses on the FCV R&D policy process in Japan (the reasons for choosing this focus will be discussed later). It seems that there are not so many case studies on R&D policy on next generation vehicles (NGV) in Japan (an existing case study on other NGVs [Kajiki *et al*. 2008] is meaningful[1], however). First, we briefly discuss the nature of a governance network and look into the meta-governor's role and its limits, reviewing Sørensen and Torfing's latest paper in *Public Administration*; then, we describe the FCV policy process in detail, from the 1990s to the present, before further theoretical consideration.

[1] Although it does not adopt a network governance theoretical framework, Kajiki *et al*. (2008) identified encouraging and obstructive factors affecting R&D policies on low-emission vehicles (CNG, LPG, and hybrid vehicles). First, R&D policy on advanced vehicles involves leading actors like urban gas companies (for CNG), taxi companies (for LPG), and auto manufacturers (for hybrids), motivations of other actors, and absence of any barriers. Second, stagnation in technological development disturbs the policy with higher costs, delays in infrastructure construction, and an extreme dependence on a specific market (a track industry in a severe situation or a taxi industry that intensively pursues economy and durability).

We find, through the case study, that meta-governors in the process certainly worked well with administrative tools, but they are now find it difficult to distribute resources appropriately and strategically to competing technologies because of their scientific/social uncertainty and are facing some other environmental changes. We conclude that a meta-governor is only a component of a plural "meta-governance network', which imposes some limits on him.

We carry out this case study by means of reviewing official and unofficial written materials, referring to information on the Internet, taking part in symposiums on next generation vehicles (NGV), and conducting interviews (between June 2008 and November 2009) of those in public and private sectors who were and are concerned with the FCV policy.

2. GOVERNANCE NETWORK AND THE META-GOVERNOR

2.1. Governance Network

Sørensen and Torfing point out that governance networks have proliferated to an astonishing extent within different countries, policy areas and levels of governance (refer, for example, to Hajer and Wagenaar 2003, Peters 2004, Torfing 2007).

They define a 'governance network' as 'a stable articulation of mutually dependent, but operationally autonomous actors from state, market and civil society, who interact through conflict-ridden negotiations that take place within an institutionalised framework of rules, norms, shared knowledge and social imaginaries; facilitate self-regulated policy making in the shadow of hierarchy; and contribute to the production of "public value" in a broad sense of problem definitions, visions, ideas, plans and concrete regulations that are deemed relevant to broad sections of the population.' As with other observations on the governance network (Rhodes 1997), conventional 'government' is seen only as a part of the network system, which has been followed by the political discourse of 'hollowed state'.

Earlier researchers of governance were primarily interested in describing different kinds of networks and showing how they function as mechanisms of governance (Marsh and Rhodes 1992). Researchers that followed later tried to assess the normative and political impact of governance networks and to improve their performance (Hodge & Greve 2007). The attempt to assess and improve the impact and performance of governance networks may invoke an entire range of normative criteria in terms of equity, democracy, goal attainment, productivity, stability, conflict resolution, learning capacity and so on (Hood 1976, Richardson 2002, for example). Sørensen and Torfing note that their focus is on the impact of governance networks on what they broadly define as effective and democratic governance (Sørensen & Torfing 2009).

According to them, the principal actors in the 'governance network,' interact through negotiations that possibly combine bargaining with consensus-seeking deliberation. When a governance network is first formed, there are no agreed norms, procedures, or 'the constitution,' to predetermine where and how a legitimate decision is to be made. The ongoing interaction of the network actors, however, will eventually lead to the formulation of a framework of rules, norms, values and ideas that is both precarious and incomplete. The

institutionalised interaction facilitates a self-regulated policy-making process that always proceeds in the 'shadow of hierarchy' cast by public/private meta-governors (Scharpf 1994).

We have to note that there is divergence in theory on the question of how to define 'governance,' which is likely to prescribe the respective stance of researchers towards 'governance network.' Some indicate that governments still have the authority to 'steer' the society (Osborne & Gaebler 1992, Peters 2004, for example), others say that government seems absolutely to be 'hollowed' in society (Rhodes 1997, Kickert *et al.* 1997). The idea of a meta-governor mediates between both the persuasive discussions as described later in this work.

2.2. The Idea of Meta-governor

2.2.1. Making the Governance Network 'Effective' and 'Democratic'

Before discussing the meta-governor's role, Sørensen and Torfing argue how to assess a governance network.

First, they make a suggestion that the *effectiveness* of governance networks can be measured in terms of their capacity to accomplish the following: (1) produce a clear and well-informed understanding of the often complex and crosscutting policy problems and policy opportunities at hand; (2) generate innovative, proactive and yet feasible policy options that match the joint perception of the problems and challenges facing the network actors; (3) reach joint policy decisions that go beyond the least common denominator while avoiding excessive costs and unwarranted cost shifting; (4) ensure a relatively smooth policy implementation based on a continuous coordination and a high degree of legitimacy and programme responsibility among all the relevant and affected actors, including target groups, client advocacy groups, stakeholder organizations, public administrators and politicians; (5) provide a flexible adjustment of policy solutions and public services in the face of changing demands, conditions and preferences; (6) create favourable conditions for future cooperation through cognitive, strategic and institutional learning that constructs common frameworks, spurs the development of interdependency and builds mutual trust.

They next claim that a governance network is *democratically* anchored to the extent that it: (1) is monitored by elected politicians capable of influencing the relatively self-regulated policy processes proceeding within the network; (2) comprises private business and civil society actors whose performance in the network is critically assessed by the members of the organizations and groups they claim to represent; (3) is accountable to the citizens affected by the decisions of the network and capable of scrutinizing and contesting publicly available accounts of how the network has handled different policy issues; (4) re-enacts a series of commonly accepted democratic rules and norms ensuring the broad inclusion of relevant and affected actors, procedural fairness and agonistic respect among actors perceiving one another as legitimate adversaries rather than enemies.

2.2.2. The Meta-governor's Tools and Methods

Elected politicians and public managers can employ different tools as described below in their efforts to meta-govern governance networks, in order to make governance more effective and democratic; (1) *network design* that aims to influence the scope, character, composition and institutional procedures of the networks; (2) *network framing* that seeks to determine the political goals, fiscal conditions, legal basis and discursive story-line of the networks; (3) *network management* that attempts to reduce tensions, resolve conflicts, empower particular actors and lower the transaction costs in networks by providing different kinds of material and immaterial inputs and resources; (4) *network participation* that endeavours to influence the policy agenda, the range of feasible options, the premises for decision-making and the negotiated policy outputs.

While the first and second forms of meta-governance are performed 'hands-off,' that is, at a distance from the self-regulating governance networks, the third and fourth forms are performed 'hands-on,' that is, through close interaction between the meta-governors and the individual governance networks. In contrast to the New Public Management doctrine, prescribing the use of hands-off meta-governance only, Sørensen and Torfing believe that the meta-governance of governance networks is most successful when the meta-governors combine hands-off and hands-on meta-governance tools (Sørensen & Torfing 2009).

That is why we assume that the idea of meta-governor mediates between a number of definitions of 'governance' and the position of a government in the network. Thus, the third answer to the question of where to locate the government in network governance can be obtained when we regard politicians and public managers in the public sector as meta-governors while a part of the government descends to only some component of networked society (see also Jessop 2003)[2].

2.2.3. Conditions for Meta-governance

Sørensen and Torfing then explain that in order to realise the potentials of the public meta-governance of governance networks, the following three basic conditions must be met; (1) the relevant political authorities and public agencies must assign responsibility for the strategic governance of particular networks to the politicians and public managers who are directly or indirectly involved in the networked governance processes and, therefore, have the required knowledge of the organizational and political landscape to act as meta-

[2] As shown in chapter 3, some politicians and FCV propellers in the ministry, who performed not only quite at a distance from the FCV R&D governance network (*network design, framing*), but also through close interaction with the network (*network management, participation*), can be analysed as meta-governors that Sørensen and Torfing define. Moreover, we assert that it is appropriate to select the policy on FCV for a case study for reasons below. First, there are few case studies so far on NGV R&D policy process from the perspectives of governance network and of meta-governors' role and its limits, in particular. Second, its high technical/political uncertainty helps us to examine what the governance network really is because such an uncertainty blur a boundary between the public domain and the private, and that it enables us to see it as an example of a network or a quasi-market (see also chapter 1 'interdependency'). Third, the outcome we may gain from the case study of precedent FCV R&D policy is useful for NGV R&D in the future because meta-governors' effort is, we think, a must for it.

governors; (2) the public meta-governors must have sufficient understanding of how governance networks can contribute to effective and democratic governance, and they must know how their form and functioning can be influenced through a negotiated deployment of different meta-governance tools; (3) the public meta-governors must possess a range of strategic and collaborative competences in order to craft, execute and revise their meta-governance strategies in a context-sensitive manner (Sørensen & Torfing 2009).

2.3. Applying the Theory to Actual Policies

The conditions for meta-governance introduced in the last section and the more precise characteristics of meta-governor should be examined in accumulative case studies on actual policies, which Sørensen and Torfing seem to anticipate.

To contribute to this study in an academic/practical sense, we choose a governance network of the FCV R&D policy in Japan as the object of our case study. An analysis on R&D policies on NGV and abstraction of the conditions it operates under that make it successful are necessary for stakeholders in the public/private domain; this is because it is a typical public policy wherein stakeholders must make a behavioural decision under conditions of significant technological/societal uncertainty, and so, meta-governors, who, with some restrictions, are delegated to allot various resources to certain areas with both the short-term and long-term view, must act strategically to achieve 'public good.'

In this paper, we would also like to contribute as much as possible to discussions in public policy study by looking in detail into a R&D policy process in Japan to see how administrative resources and practical regulatory authority are fragmented and how they try to 'collaborate.' More concretely, our aim is to consider what stakeholders in the governance network expect the meta-governors to do and what meta-governors are (not) able to do in conditions provided, an understanding of which will be useful for academic/practical purposes.

Even though any actors in the private domain can be 'policy entrepreneurs', a notion similar to the idea of meta-governors (Laws *et al.* 2001), we focus on delegated political propellers in the public domain, as defined by Sørensen and Torfing, such as politicians and administrative officers in the departments of new energy, automobiles, and an international strategic project on FC, and a general manager in the FC promotive department who leads the whole project in collaboration with the Cabinet Counsellor and group of members of parliament.

3. CASE STUDY: R&D POLICY ON FCV IN JAPAN

3.1 An Outline of FCV policies

3.1.1. 'NECAR' and FCV development after it

Daimler-Benz A.G., after publicising an FCV named NECAR1 in 1994, announced in 1997 a brand-new FCV (NECAR3) based on a mini vehicle design. It declared a daring plan for mass production, aiming to put the FCV into practical use no later than 2004. Although other auto manufacturers had hesitated to branch out in the FCV area at that time, this plan encouraged them to start working harder for FCV development, in competition with each other.

The California Fuel Cell Partnership (CaFCP) was organized in April 1999 for joint research and tests on FCVs, including fuel development and studies on fuel supply, on the initiative of the State government. CaFCP consisted of Ballard Power Systems Inc., Daimler, Ford Motor Company, three major oil companies, and later, Honda, Volkswagen, General Motors, and Toyota took part in it. Toyota started developing an FCV in 1992, and first demonstrated FCEV with its self-made FC at the international conference on EV (EVS13) held in Japan (October 1996).

3.1.2. Public-private collaborative R&D projects on FCVs in Japan

In 2000, the Obuchi administration (1998-2000) launched several collaborative projects on issues around information technology, aging society, and natural environment with industries and universities to make technological advances against problems such as global warming. A project on the polymer electrolyte fuel cell (PEFC) is one of the policies approved in the annual budget. The Ministry of Economy, Trade and Industry (METI) started three new projects related to FCs (to establish evaluation methods for PEFC standard-setting, to develop testing devices of FCs, and to seek new technology for cost reduction and mass production for practical use of FCVs).

There were numerous problems in the practical use of PEFC; the technical ones are issues with FC stack and fuel processor systems, standard-setting suited for the consumer market, and reviews of current regulatory standards. In September 1999, auto manufacturers, energy companies, material companies, researchers, and the authorities established an FC study group for the purpose of exchanging opinions as an informal working group (WG) under the general direction of the Agency for Natural Resources and Energy. The WG published a report in November 2001 clarifying the significance of FCV for the future, suggesting a direction of further development. In addition, it approved a document 'The Strategies for Technical Development' in August 2001 to share information on relevant technologies for PEFC, setting respective goals for each technology, and on tasks that every stakeholder has to achieve. Based on the strategy, companies voluntarily established 'The Conference for Promoting Practical Use of FC' in March 2001. Member companies

discussed targeted solutions for recognized problems with FCs and made requests and suggestions to the government at the conference.

In 2002, a project for proof tests on FCVs, named JHFC (Japan Hydrogen & Fuel Cell Demonstration Project), started in line with the example of CaFCP. JHFC succeeds in obtaining a national subsidy of 2,000 million yen annually through projects in METI. In these projects, public service corporations such as JARI (Japan Automobile Research Institute) and 'the Association for Promoting Engineering' under METI have been taking the initiative to conduct proof tests and to develop infrastructure. Auto manufacturers in Japan (Toyota, Honda, Nissan, Mitsubishi, Suzuki, Hino), Daimler, and General Motors have also taken part in the proof tests. Fifteen organizations, including oil companies, currently participate in the project to establish a hydrogen fuel station, and to test its processing.

3.1.3. Political influence on FCVs

The Koizumi administration (2001-2006) which used, in a policy speech in 2001, the slogan 'hydrogen energy' for the first time, set a definite policy target to put FCVs into practical use within three years. In addition, the government decided to purchase FCVs and to comprehensively review safety regulatory standards. In December 2001, the Prime Minister Koizumi was reported to have done an FCV test-drive, sending a strong message to the public that the government had an interest in working on FCVs. The Prime Minister said at a ministers conference in April 2002 that it was important to introduce the FCV in Japan in order to make it a pioneer in the world in confronting problems with environment, energy security, and growing competitiveness of industries.

In February 2002, five vice-ministers from METI, MLIT (Ministry of Land, Infrastructure, Transport and Tourism), and MOE (Ministry of Environment) organized the FCV Project Team, which examined how to enforce FCV policies (Fuku daijin nenryo denchi purojekuto chi-mu 2002). Toyota and Honda then started leasing FCVs to departments in the government, and a few companies followed suit in using them.

3.1.4 Strategies for developing FC—Progress in FCV technology in three aspects

(A) From 'processor system' towards 'high-pressured hydrogen storage system'

From the 1990s to the early 2000s, most automobile companies were engaged in developing both FCVs with a pure hydrogen system and those with methanol processing systems. These days, most FCVs adopt high-pressure hydrogen tanks with pure hydrogen, among other storage methods such as those with liquid hydrogen or hydrogen storage alloys. A technical problem at present is for the question of how to store hydrogen at higher pressure (35Mpa towards 70Mpa and higher) in a tank.

(B) From 'ministerial authorisation' to 'type certification[3]'

[3] A vehicle is 'authorised by the minister' for the purpose of setting and revising regulatory standards when it is not allowed to run on public roads because it does not meet existing standards. On the other hand, in 'type certification', the authority monitors a sample car and its quality control system in the manufacturer. After the type is certificated, examinations on completed cars are delegated to the

In February 2001, the minister authorised Mazda's FCV ('Premacy-FC-EV'; methanol transfer) and that of DaimlerChrysler, both of which started to run on public roads. The minister also authorized Toyota's FCV ('KLUGER FCHV4'; high-pressured, in June 2002), that of Honda ('FCX-V3' in July 2001), and that of Nissan ('X-TRAIL FCV' in December 2002). The authorisation encouraged their lease business in the U.S. and in Japan. Till the end of 2003, FCVs from nine companies including manufacturers overseas had been authorized by the minister, and some were still being tested on roads.

The parliament passed a bill in March 2005 on FCVs, with regulatory standards against car crushing to prevent hydrogen leaks. Toyota and Honda took a first step towards mass production of FCVs by obtaining 'type certification'. Before the bill, manufacturers had to get ministerial authorisation with some restrictions even to do running tests on FCVs. The bill established basic safety standards, referring to technical data from the past projects, potentially allowing manufacturers to produce a number of FCVs of a certificated type, in the same way as they produced other ordinary gasoline vehicles.

(C) In-house part production and higher-pressured storage of hydrogen

Although the question of whether manufacturers make parts by themselves or not is one about a trade secret, we know that Honda made its FCV (FCX) with stacks of its own making, authorised by EPA and CARB in the U.S. in January 2004, and it began leasing them to the state government of New York. In February 2005, Nissan also produced stacks by itself with tanks able to store two-times higher-pressured hydrogen and got its tank of 70Mpa authorized by the minister. Toyota FCHV has already carried its own-made hydrogen tank of 35Mpa with its own stacks (Morita *et al.* 2007).

3.1.5. A relative decline of public attention to FCVs

Eliica, which was developed in 2004 by a research team in Keio University, triggered an interest in EVs (electric vehicles). Eliica is 8-wheeled with an in-wheel motor and records speed of 370km/h. The press was highly interested in Eliica, and public expectations of EVs rapidly became more complex, largely because nearly forty companies including major banks had invested on it.

Departments of new energy and automobiles in METI decided to subsidise EV batteries, not the EV itself. This was mainly because they recognized that lithium ion batteries and solutions for EV safety were more crucial at that time.

The department of new energy was gradually being forced to distribute resources for bio-fuels as they became more popular, and thus, their commitment to FCVs has lessened. Moreover, key people who supported FCVs in the government with specialized knowledge and personal connections were unable to stay involved in the FCV policy because they were forced to move to other departments as a result of personnel reshuffling[4].

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manufacturer. 'Type certification' is more useful for manufacturers because they do not need to have their products checked individually by the authority, and it also is evidence that their car is acceptable for public use.

[4] To further his political and administrative reform, the Prime Minister Koizumi condemned politicians who were not in favour of his policy, calling even those in the same Liberal Democratic Party (LDP) the 'opposition', and after the overwhelming majority in the election to the Lower House in 2005, more

3.1.6. Policy evaluation on FCV

In June 2009, the department of policy evaluation in the MIC (the Ministry of Internal Affairs and Communication) advised four ministries (MIC, MLIT, METI, MOE) to rethink the FCV policy. Assuming the FCV to be a promising vehicle from among NGVs, the four ministries had invested 19.7 billion yen in sum from 2004 to 2007 on related projects including basic research, proof tests, and governmental prior procurement. The policy evaluation pointed out that the outcome of FCV policy (only 49 FCVs were actually driven in Japan at the end of 2007) was far below the policy goal set before (50 thousand FCVs at the end of 2010). Acknowledging that FCV policies were mainly intended to achieve its practical use rather than to promote its supply, the report indicated that its extremely high price (100 million yen for one) and unsolved technical problems, such as that of FC durability, seemed to prevent the FCV from becoming popular. The policy evaluation recommended that the four ministries again review the FCV policy to make the project more effective and efficient.

Table 1 *– The number of FCVs in Japan (retrieved from the policy evaluation report)*

	2002	*2003*	*2004*	*2005*	*2006*	*2007*
Central government	*5*	*7*	*8*	*8*	*7*	*7*
Local government	*0*	*2*	*5*	*5*	*5*	*5*
The private domain	*15*	*40*	*48*	*47*	*38*	*30*
Sum	*20*	*49*	*61*	*60*	*50*	*42*

3.2. An analysis on recognition of problems of each stakeholder

In this chapter, we analyse the recognition of problems of each stakeholder with regard to FCV policy, based on the results of interviews and perusal of relevant documents.

3.2.1. Automobile manufacturers

(a) Their expectations of the FCV and recognition of problems

Auto manufacturers question in the first place whether it is meaningful to introduce FCVs into society considering their pros and cons. The fact that their hybrid vehicles are widely driven seems to strongly affect their views. FCVs are still one of the solutions for problems such as global warming, energy security and toxic gas (NOx, SOx, CO, and PM) exhaustion, a fact that tempts auto manufacturers to get extensively involved in the FCV R&D process.

However, most manufacturers look at FCVs (and FC-gasoline hybrid cars) as temporally feasible alternatives to the ideal of a pure EV. In other words, they feel that they do not have to take much pain over the development of FCVs if pure EVs are likely to be put into practical use. Technical barriers to the use of pure EVs (its battery and trouble with electricity charging) are still to be overcome. The FC, on the other hand, is expected mainly to be an alternative battery.

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than a few politicians concerned with the FCV were forced to leave the administration.

The FC is still said to have technical problems in terms of its costs, durability, energy density, total efficiency, and CO_2 emissions on its way to refining hydrogen. Some leading auto manufacturers, on the contrary, believe that these technical problems are almost solved. FC performance is improving steadily in the high-pressured hydrogen system, and maximum motor output is also increasing gradually. Platinum that works as a catalyst when hydrogen changes into positive ions, the cost of which has been a cause of worry, is to be replaced in the near future with molecule-level coating technology and a new method using carbon fibre. Auto manufacturers envision that the FCV will be put into practical use as early as 2030~40 (this perspective is much more modest than that of the government) anticipating that universities and other institutes will engage harder than ever in the basic research required to make this happen.

Some auto manufacturers work in line with think tanks' well-to-wheel analysis (life cycle analysis), which measures total efficiency from mining of prime energy to consumption of energy when driving (Toyota Motor Corporation *et al.* 2004). The analytical results contain an element of uncertainty as they are affected by potential technological developments, the growing market and regulations to be revised. Auto manufacturers continue the analysis because they think that the vehicle type and fuel to be socially adopted should be chosen after consideration of many factors such as energy security, social costs of infrastructure and safety. It is important for them to search for an optimum combination of vehicle and fuel.

Auto manufacturers stress that cost performance, usefulness, and comfort for users are still important. Some manufacturers consider that the most practical mode is to introduce large FCVs, like buses or trucks, because their size is well suited to a large hydrogen tank and they can manage with the limited number of fuel supply spots. Most auto manufacturers worry about the huge loss of prior investment in case these FCVs fail as they themselves have to pay costs for a while. There can be differences of opinion in each department even in the same auto company.

(b) What they want meta-governors to do

Some auto manufacturers expect meta-governors to make comprehensive policy decisions considering energy security and environment. They are eager for an effective FCV policy to resolve technical and societal problems, across boundaries of categories of NGVs, such as FCV, EV and bio-diesel. Policies should be effective to establish infrastructure for hydrogen supply to 'mediate' between automobile and oil industries on fuel supply, to promote FCVs with tax reductions or subsidies or to engage in city planning based on public usage of cars.

3.2.2. Oil companies

(a) Their expectations with regard to hydrogen made from oil and recognition of problems

Oil companies, from those purchasing crude oil to those refining it, have been in a firm position in Japan as fuel suppliers for conventional automobiles because of the complete reliance on imported oil. As the FCV introduction has been followed by a political discourse on an 'oil-free future,' oil companies, especially their sales departments, have been paying close attention to FCV development. On the other hand, oil companies have been required to deal with air pollution from SOx and NOx and CO_2 emissions. As the oil market is expected to shrink in the long term, oil companies willingly took part in the 'Hydrogen-FC proof test

project' when FCV development became more focused in 2003. One oil company said that, in keeping with its 'corporate social responsibility' vision, it wanted to be a leader in technical advancement even if some other new type of energy replaces oil.

It is difficult to produce hydrogen by means electrolysis of water with natural gas or other natural energies. Oil companies find it easier and cheaper to produce hydrogen from oil because they have the in-house know-how to manage this process. It seems possible for them to seize a most part of the fuel supply process with their existing equipments (for the desulfurization process); some companies are said to be able at present to supply hydrogen to millions of FCVs. They recognise that their capacity to produce hydrogen and for CO_2 collection are advantageous for their participation in a hydrogen society.

There are some problems, however, to be considered. First, oil cannot be made cheaper unless technological innovation drastically improves FCV performance; this is because the hydrogen price is a total of that of oil and other production costs, and their prices are closely linked. This is why some oil companies make efforts not only towards an FCV but also for R&D of in-house co-generation systems. They see that in-house co-generation systems will become popular much earlier than FCVs will; that is, FCV and hydrogen stations cannot be put into practical use before the former succeeds (Izuka 2006).

Second, it is not necessarily beneficial for oil companies to demarcate parts of their existing gas stations to be hydrogen stations, as often believed[5]. It is true that it can be convenient for them to prepare sites for use as hydrogen stations because FCVs also need to stop, like conventional gasoline vehicles, to refuel. However, gas stations in rural districts, which have the monopoly there, will not easily approve the use of part of their premises as hydrogen stations if they cannot recover the cost with enough visiting FCVs. Gas stations in urban areas are so competitive with regard to other neighbouring stations that they will also not agree to this move, as it could benefit the others. They have to obtain their neighbours' consensus when diverting space in existing stations because hydrogen is dangerous. Thus, diverting space in existing stations is likely to drastically change profit distribution in oil companies.

Thirdly, technologies are still to be established and refined with regard to how to refine hydrogen, how to carry it safely to stations, and how to fuel FCVs with it, to say nothing of safety standards (The committee on the next generation vehicles and fuels 2007). Hydrogen gas is so difficult to deal with its leakage has caused accidents[6]. Detailed standards are necessary on hydrogen, both in liquid and gas (of the pressure of 35Mpa and 70Mpa) forms. Rule makers have to be careful with regard to safety standards and qualifications of supervisors of tanks, hydrogen stations, and equipments for automatic shut-offs in case of hydrogen leakage.

In addition, whether or not the hydrogen supply can meet the demands of the emerging FCV transport sector is a matter of public debate. The hydrogen supply in JHFC has proved to be only enough to meet the needs of five small FCVs. It is necessary to maintain a corresponding amount of hydrogen for FCVs, whether on-site or off-site.

[5] Oil companies announce that they are willing to do their best to popularize hydrogen stations. The Petroleum Association of Japan, too, asserts that it is quite economical to use existing gas stations as hydrogen stations if the FCV is to emerge (http://www.paj.gr.jp/eco/environment/01-3.html).
[6] Hydrogen produced in oil factories is of about 20Mpa. It gets more dangerous when put into an FCV at higher pressure.

In sum, oil companies doubt whether the government is yet ready to support FCV R&D even as public concern declines. After the postponement of the policy goal, they are no longer aware of when FCVs will be put into public use. Oil companies are standing at a crossroads, where they must decide how to commit to the 'hydrogen society'.

(b) What they want meta-governors to do

First, oil companies want meta-governors to keep encouraging the R&D project to continue. The government could trust private companies, such as gas companies, to carry out the proof tests because forms of hydrogen are various, depending on to the methods of compounding it. However, the proof tests, especially those on FCVs, which cannot help but involve a large amount of resources, are not suited for individual implementation, and it is not very efficient to support them with individual grants. Moreover, governmental leadership is a must, because experimental data over a long term are necessary for setting regulatory standards on FCV for public use. Meta-governors have to make efforts to obtain up-to-date information to manage the project, overcoming barriers in terms of companies' trade secrets.

Second, oil companies want meta-governors to set generous rules to govern their experiments. Oil companies, for example, have to get authorisation on individual tanks under the current rules, when they deal with carbon fibre tanks to store high-pressured hydrogen. Positions of hydrogen dispensers and how to place partitions are not clearly understandable from fragmented laws such as the High-pressured Gas Law and the Fire Protection Law. Oil companies recognise that their experiments could proceed more smoothly if meta-governors set up models of hydrogen stations in collaboration with JHFC and if they had show rough picture of systematic regulatory rules based on the project.

3.3. Government as a meta-governor

(1) An overview of the governmental policies

The government indicated the significance of FCV R&D for 'energy high-efficiency,' 'diversification of energy supply,' 'job creation in new industries and strengthening their competitiveness,' 'decentralisation of electric power,' 'unburdening on environment' (it is necessary to note that they reflect the position and priorities of each department in the government). The 'unburdening on environment' is, under the missions of the Kyoto Protocol, regarded as an important cause in terms of FCV policy, since the transport sector accounts for the bulk of CO_2 emissions.

The FCV regulatory system was reviewed for its practical use. Related ministries looked again at regulations and rules on FCVs, and 28 articles in six rules including the Road Transport Vehicle Act had been revised by the end of 2004. In addition, MLIT developed safety and environmental standards and a type certification system on FCV and summarized the results from the study group on large-sized FCVs with regard to its safety and environmental impact. These policies, since the end of 2004, have allowed FCVs to run on public roads and hydrogen stations to be located even in city centres. At the end of 2007, 20 FCVs with type certification, 22 with ministerial authorization, and 12 hydrogen stations existed in Japan.

Second, the government has supported R&D for achieving lower costs and higher performance for FCs. From 2003 to 2007, METI promoted fundamental research in hydrogen production, storage, transport, and supply. It tested, from 2006 to 2010, FCVs and hydrogen equipment based on the previous R&D result. METI recognised that although they have succeeded in enhancing power density and durability of FC stacks, extending the operating range and improving the hydrogen storage tank to make it smaller, cheaper and safer, the R&D is still far from attaining a tangible output. Some manufacturers add that the technology has so progressed that the cost could be less than 10 million yen if produced on a massive scale, but the performance and cost is still far from sufficient for the automobile market.

Third, the government purchased FCVs as part of its public procurement exercise. After the Cabinet Secretariat, Cabinet Office, METI, MLIT, and MOE in the government bought seven FCVs in the period until the end of 2003, the number of procured FCVs decreased to only one in 2004. Local governments have got 3 FCVs with a governmental subsidy initiated by MOE. In addition, MOE has held as many as 45 Low Emission Vehicles Fairs co-sponsored by local governments to showcase FCVs, EVs, CNG, and the other advanced vehicles between 2004 and 2007, attracting 88 million visitors in total.

With regard to the issue of international standardisation of the FCV regulatory system, METI has been working hard to adapt the Japanese technical standards to the Global Technical Regulation (GTR), based on the revised version of the Road Transport Vehicle Act. GTR will be set to not later than 2010 in the United Nations member states.

(2) Automobile Division, Manufacturing Industries Bureau, METI

The automobile division has exclusively the most important mission of maintaining and strengthening competitiveness of the automotive industry, and in close cooperation with the industry, it is required to prepare policies for NGVs, including FCV.

The automobile division recognises that although FCVs have been the most promising zero-emission vehicles from among next-generation cars, there are yet technical barriers to be overcome in terms of cost, when compared with EVs, which are about to appear in the market. However, METI still continues to invest some financial resources in FCVs. The growing amount of resources invested in NGVs and other energy development in the situation of public pressure for budget reduction illustrates how the extent of attention they get from METI[7].

By 2008, tax on FCV purchasing was reduced by 2.7%, and 2/3 of property tax for hydrogen stations was reduced after three years of establishment (Automobile division in METI 2007). The automobile division recognises that this is an important issue to consider the extent of tax preferential treatment to introduce based on cost reductions for the FCV manufacturers, in order to sustain their market competitiveness.

[7] METI has been budgeting no small amount since 2000. In 2008 FY, it spent 58.2 billion yen for promoting policies on NGV and fuels (56.6 billion in 2007), 4.1 billion yen from the general budget for innovative R&D for FCs (18 billion in 2007), and 62.9 billion yen from the special account on energy (44.3 billion in 2007), according to the official paper.

(3) New Energy Division, Office for FC promotion

According to an officer, who was for four years a chief in the 'New Energy Division,' a director of international strategy for FC, and a manager in the 'Office for FC promotion,' after obtaining substantial power to deal with the budget, he searched for and hired FC specialists from outside the government (such as local governments of Fukuoka and Osaka Prefecture), and launched a full-fledged Institute in the partnerships with industry (e.g. GM and foreign officials) and academia (e.g. an authoritative professor on material research, and other famous researchers).

Since the Secretary of the Resources and Energy Agency (REA) faces many political issues with regard to oilfields, rare metals, and crude oil, each department (and its director) is substantially responsible for its policy (although the assistant director or other staff may be responsible in some cases). Policy implementation depends largely on the directors' motivations, characteristics, beliefs, and values; this is especially true in REA. However, as the director of the New Energy Division is not usually from a scientific background, scientists outside the government in a narrow sense (National Institute of Advanced Industrial Science and Technology, for instance) often make political decisions on R&D policy that require technological knowledge, which poses the government some political problems.

The government initiated the establishment of study groups and demonstrated FCV to the public with other practitioners, auto manufacturers and gas companies. The New Energy Division and Automobile Division tied up at the time and cooperated in the study group on battery development.

The New Energy Division, however, has gradually become negative with regard to the FCV policy due to its increasing interest on bio-fuels. Both divisions have arrived at different behavioural principles with regard to the subsidy on electric power development (such as wind power generation), FC, and bio-fuels, and they ended up somewhat in conflict with each other[8].

The success in the Vice Ministers Project Team exceeded official expectations. When the vice-ministers decided to put FCV issues on their agenda, cooperation between the director in New Energy Division, the manager in Office for Fuel Cell Promotion, and the Cabinet Counsellor worked well. They persuaded auto manufacturers to join them and achieved some positive results.

The then vice-minister of METI was especially significant in making the policy. In 2003, when FCs in Japan were losing attention, he, as a secretary general, established a 'diet member federation' on FCVs, in which members (with directors and councillors from the ministries) freely expressed their opinions on budgeting. Cooperation between the diet members who had a strong interest in new technology and the officials lasted for a while, even though, at the 'diet member federation' meeting, an officer's frank explanation of the fact that FCV research had not progressed as expected depressed the participants.

However, in around 2005, when the vice-minister and the other FC promoters were regarded as 'anti-reformers' over the postal privatisation issue and lost their influence (see footnote 4), the 'diet member federation' on FCV ceased its discussions. The members

[8] The General Council on Science and Technology in the Cabinet Office (a department in charge of management of inter-ministerial relationships) discusses hydrogen-production with nuclear power energy in a working group for Hydrogen Energy Systems.

founded the 'Hydrogen Energy Conference' in 2005. This conference has been expected to promote a comprehensive role in building a hydrogen society from the respective viewpoints of related industries and the executive and legislative branches (Shin enerugi shinbun 2005).

The (then) Prime Minister Koizumi was also the most powerful political supporter of FCVs. The official who promoted them kept in touch with the secretary close to the Prime Minister after they collaborated on another Cabinet Office project.

The JHFC project, which was organized by public and private actors to understand the effects of energy conservation (CO_2 reduction and efficiency) and a decrease in negative environmental impact and to obtain public recognition for FC has been important in terms of knowledge sharing of the basic experiment data and proof tests.

In its first phase (2002-2005), there was a high enrolment figure of various stakeholders and it attracted significant public attention. It resulted in the proof of the energy efficiency of FCVs, leading to the construction of ten hydrogen stations in the metropolitan areas. Though an end to the project was once discussed due to a failure in information sharing and budget reductions, it continued because there was thought to be a great loss in stopping R&D per se. Mutual trust between the government, industry, and academia also contributed to its survival.

In its second phase (2006-2010), it has been obtaining empirical data to display the progress of FCV technology inside and outside Japan, as well as a developing high-pressured hydrogen station (to 70MPa), implementing further proof tests on hydrogen storage and confirming the evolution of the fuel performance (Iwase *et al.* 2009). On the other hand, some challenges have also been recognized. After gaining public attention, JHFC has been aiming at concrete technological developments with regard to hydrogen pressure and inter-station telecommunication to adjust refuelling speed. It has become difficult to motivate stakeholders in these issues, and financial resources have not been used effectively. Problems with information sharing due to trade secrets are also making it difficult to collaborate.

The government tried to involve the Ministry of Health, Labour and Welfare (MHLW) in a project on FCV wheelchairs, but this attempt did not work well because of a disagreement with auto manufacturers and decline of governmental leadership. Nonetheless, JHFC has played an important role in the spread of hydrogen stations even in the western part of Japan.

4. CONSIDERATIONS- POLITICIANS AND PUBLIC MANAGERS AS META-GOVERNORS

4.1 Roles that meta-governors have played in the FCV policy

We can point out that besides the important roles of auto manufacturers and oil companies, politicians and public managers as meta-governor also made efforts in overcoming a social and technical barrier in the governance network. We observed that meta-governors actually used some governmental tools--assistance on R&D in private companies (subsidy, commission expense, tax relief, various financings, and acceptances

through banks and governmental loan guarantees), R&D in the national laboratories, framework-making for joint research between private companies, promoting scientific information sharing among stakeholders, and enacting and maintenance of technical standards and governmental procurements. The prior procurements meant a governmental demonstration to the market without so much impact. The meta-governor played an important role in setting regulatory rules corresponding to technological advancement and establishing bold policy targets and time schedules with the backing of politician.

The policy evaluation by MIC on FCV policy was also meaningful in terms of clarifying policy alternatives and policy orientation[9]. Although ministries and other bureaus are altogether in one body of the government, a political orientation through policy evaluation from distant department like MIC can be persuasive and can contribute to democratic governance by exposing government action to the public. Conversely, it may attract public attention if MIC evaluates it positively, which will reduce uncertainty for stakeholders.

R&D projects are often composed of proof tests and basic researches. Governmental leadership and support are needed, especially for basic research, because it is difficult to assess and balance performance, results, and the cost.

Although auto manufacturers in Japan started FCV R&D in the latter half of the 1990s, the sector has not yet gotten over the cost barrier (to make it 1/100 cheaper than it was). Engineers have reached a consensus that they cannot realise such a breakthrough only with cost reduction and mass production and that they need to return to the basics of science. However, it is difficult to do joint research with other manufacturers because of trade secrets. Manufacturers are mainly interested in products, and it is too risky for them to invest much on basic researches (Ando 2007).

However, meta-governors' leadership and their management has been essential to the FCV policy, whether in gathering superior FC researchers from all over the world or in setting up projects for basic research. FCV research projects are likely to have useful results, and there are high expectations from companies that would usually tend to be uninterested in them.

For instance, the Solid Polymer Fuel Cell and Base Research Centre (FC-Cubic) was founded in 2005 with the aim of clarifying a scientific, reactive mechanism for FC, and accumulating findings. FC-Cubic is positioned as a national laboratory, where excellent young researchers come together from public and private spheres without any concerns of market competition and trade secrets. The Hydrogen Material New Science Research Centre (HYDROGENIUS) was established in 2006, with the aim of deepening basic scientific knowledge, achieving compact transportation and storing of mass hydrogen, and developing technology for safety in the 'hydrogen society. HYDROGENIUS is positioned as an outstanding national laboratory that gathers leading researchers from around the world and works intensively on data accumulation and analysis (Furusawa 2007).

Such collaborative governance between industry, government, and academia may be unique to Japan. According to an interview with an officer who had been in charge of it, the FCV project made earnest efforts even in taking care of guest researchers and their families (school arrangements for the children, residential accommodation, for example). These are also important management activities for a meta-governor.

[9] It can be regarded both as a tool of 'meta-governance' and an exogenous factor for meta-governors, however.

4.2. Recognition of problems of stakeholders in the network

Our description clarifies some discrepancies in recognition of FCV stakeholders with regard to technological feasibility and how to use FCV (FC).

A certain behaviour of one stakeholder is tied to another's, just as an oil company's stance toward hydrogen production cannot be independent of FCV development by auto manufacturers. Here, a recognition gap between stakeholders is likely to increase uncertainty. In the situation, stakeholders' behaviour, which is ultimately rational in economic sense and risk-averse, seems to us quite negative with regard to trends in FCV R&D.

An auto manufacturer, on one hand, says that FCV is suitable mainly for larger autos. An oil company, on the other hand, says that FC should be introduced first with co-generation batteries. Competition between FCV and EV is also an uncertain factor. Things could be better if these uncertainties converge in a definite way, but in case they remain a point of disturbance, the meta-governor needs to reduce uncertainty by leadership to make its policy clearer.

We have to note that even if there seems to be some discrepancy in recognition among stakeholders, they may be going in the same direction or the discrepancy may be just a problem of time span (that is, an apparent difference between a short-term and a mid/long-term aspect). Under the circumstances, the so-called '*dosho imu* (having different dreams even in the same bed)' in Japanese R&D policy can move forward dramatically depending on the good management of the meta-governor. The Kyoto Protocol and the slogan of environmental policy can be good causes to promote FCV policy[10].

4.3. Roles that meta-governors play in the FCV policy

Meta-governors, who are expected to have breadth of vision, can be a bridge between stakeholders such as auto manufacturers and oil companies to reduce uncertainty owing to their behaviours. This demands that problems with stakeholders on NGVs be clarified clearly structured. Such management on the part of meta-governors must work to create conditions that push the R&D policy on NGVs forward.

Stakeholders are eager for meta-governors to give financial support and maintain a suitable legal system. Also, meta-governors could play the following roles: to identify technical and social problems, to give guidance to solve them in the early stage of the policymaking with fundamental R&D and proof tests, to evaluate the policy as precisely as possible to make it reasonable (or sometimes, to decide to revoke the policy) and to allocate resources appropriately. In addition, it is important to set up R&D projects to mediate in the relationships between industry, university, and privates companies, taking care of business secrets and intellectual property protection. Meta-governors are expected to be neutral and to have a good network.

[10] Shiroyama (2007) says that it is effective to adopt a managing tool at the meta-level, by which a public manager sets an appropriate agenda, frames social needs cleverly for the purpose of consensus building, structures issue perceptions of stakeholders, and helps in sharing policy goals of introducing a certain advanced technology to society.

4.4 Limits for meta-governors

First, since meta-governor is at a higher position where he can see the policy as a whole and can manage the governance network relatively freely by himself, he is requested to prioritise an advanced technology. Therefore, the meta-governor needs to work out a strategy for the resource allocation portfolio and may find it difficult to decide which technology to pick as promising for the future and how. Departments of automobile and energy cannot be too careful to give preferential treatment to FCVs (FC) in conditions of uncertainty. It is not easy to make a coherent policy for a sudden progress in technology. It is necessary for meta-governors to maintain a balance between various advanced technologies to disperse risks. The policy evaluation system often asks meta-governors to reduce resources to allocate because they are finite. Furthermore, it poses the problem of how to build social consensus.

Second, politics, which is the grounds for democratic legitimacy of meta-governors, and which is an important factor to move policies forwards, also poses certain limits. Even if an administrator works passionately for a specific policy, it cannot be carried out if he loses democratic support (support from politicians and others). For a R&D policy under uncertainty, this problem is more serious. However, on the contrary, it also suggests that a sudden surge of public attention in the political context could drastically move R&D policy into the limelight, as in the case of Obuchi to Koizumi administration which put relatively abundant resources in their positive political decision.

Third, the results of interviews show that the meta-governor's approach to the FCV policy largely affected its progress. This means that a policy especially under uncertainty is put into force not in a detached but in a subjective way. Meta-governors are observed as such to be motivated to take care of stakeholders. Data, even if objectively collected, are destined to contain such uncertainty and interpretative width that there is room for stakeholders' subjective interpretation to enter. A policy is thus largely more subject to the people concerned than generally thought. Therefore, changes in circumstance, such as with a personnel reshuffle, can change the direction of the policy.

Hence, even meta-governors (politicians and public managers) are unwillingly involved in another network existing for meta-governance. Meta-governance is not a closed world; it is only a container of a plural and multi-layered meta-governance network. There are a number of factors that force individual meta-governors to alter their ways of working or approaches.

5. CONCLUSION AND IMPLICATIONS

5.1. Concluding remarks

This paper has examined the meta-governor's role and its limitations by applying a newly-emerging meta-governance theory (Sørensen & Torfing 2009) to the FCV policy in Japan (in the period from around 1995 up to now). We found meta-governors investing efforts in designing, framing, managing, and participating in the FCV R&D governance network.

The meta-governors at first declared a challenging policy goal for the introduction of FCV, announced a time-schedule, and assumed leadership of it, setting up public-private projects for basic research and proof tests for FCV development. The meta-governors, especially an officer in METI, mediated amongst important stakeholders such as automobile manufacturers and oil companies, helping them share their perceptions on the issue; this communication was essential to reduce political and scientific uncertainty to some extent. The meta-governors willingly decided to invest large amounts of financial resources on FCV under administrations 'confronting global warming', and their political demonstration of prior procurement encouraged neighbouring stakeholders to join in the project, while not significantly affecting potential consumers' behaviour. They worked hard with administrative tools of agenda-setting, grants, forum-setting, and rule-making (though we have to continue looking at their work in the long term before making a final evaluation). They are now having difficulties in distributing resources appropriately and strategically to competing technologies because of scientific uncertainty and are facing other changes, such as meta-governor's personnel reshuffle, democratic pressure in favour of EVs, and negative policy evaluations on FCVs.

5.2. Lessons for meta-governors

The meta-governors' role is restricted by some conditions. We try to identify what they have to focus on when they execute policies such as those on R&D of advanced technology of transportation.

First, it is difficult for meta-governors to set reasonable priorities on alternatives of advanced technology and to distribute resources by means of portfolios, just because they have formal (that is, democratically delegated) administrative resources to manage the governance network and they are placed at an observatory position to look at the whole network whether they like it or not. This is the case especially with R&D policies on advanced technology with scientific uncertainty. Since it is linked with political uncertainty, it is more a difficult task for them to make a political decision on which technology to invest in.

Secondly, politics often disturbs meta-governors as it is their democratic ground of authority, though sometimes it radically pushes forward policies in a certain direction. Policy in the Obuchi and Koizumi administrations, which were interested in acting against global warming, led Japan to invest in the development of ecological vehicles. Political circumstances, such as public attention to EVs and personnel reshuffle under the Koizumi administration, were influential enough to transfer administrative concerns from FCV toward EV. Meta-governors have to be careful with politics disturbing the governance network, as it is plural and consists of a number of factors.

Third, meta-governors' characteristics and motivations are very decisive factors in meta-governance and the successful management of governance network. In other words, meta-governance calls for such patience and perseverance that a tough meta-governor with passionate belief in the policy goal is a must for carrying it out. Any policy seems so subject to meta-governors' characteristics that a change in circumstances such as a personnel reshuffle is likely to cut off continuity in policy.

5.3. Questions unresolved

In this paper, we conducted a case study with a slightly detailed description of FCV R&D policy in Japan as a typical public-private governance network. However, this is only an example of a governance network, and thus, our conclusion merely implies a temporal consideration before setting up a general theory. It is left for further studies to prove the theory of the 'meta-governor' empirically by means of more case studies on other policies, in Japan and overseas, and comparing those with each other, extracting unique points, and some common factors.

Second, we need to conduct interviews with other stakeholders such as politicians, other administrators from other departments, and FCV users (including individuals and organizations) in order to compare their viewpoints and to clarify differences in their recognition of the issue, which would affect policy outcomes. Further academic analysis in theory must also be useful for future meta-governors.

Third, relationships between R&D policy on advanced transportation technology and the market (behaviours of manufacturers and users) should be thoroughly examined theoretically and empirically. It was difficult for us to imagine an emergence of an FCV market because it is now so far from broad public use. It is assumed that, in the future, FCV market will, if it does, grow in relation with the gradual development of public infrastructure such as hydrogen stations. This reciprocal relationship could be observed in terms of R&D policy on advanced transportation with some social experimental factors, which would be a leading case on transportation policy.

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