THE CITY AS AN ENVIRONMENT FOR RADICAL CHANGE: THE CASE OF LOW-CARBON URBAN MOBILITY

Gerardo Marletto
DEIR/CRENoS, Università di Sassari and CREI, Università di Roma Tre
marletto@uniss.it

(DRAFT – PLEASE DO NOT QUOTE)

1. Introduction

In recent years several scholars have tried to analyse the future of the transport sector, with the aim of understanding how its environmental impacts may be reduced drastically: mid- and long-term scenarios have been developed in order to select those policies which can de-carbonize transport activities (Hickman and Banister, 2007; Bristow et al., 2008; Lutsey and Sperling, 2009; Mc Collum and Yang, 2009); both car and post-car futures have been discussed in detail by economists, planners, sociologists, technologists (Dennis and Urry, 2009; Sperling and Gordon, 2009; Mees, 2010; Wells, 2010; Zapata and Nieuwenhuis, 2010); some of these future studies have explicitly considered the interaction of economic, institutional and technological variables in the transition towards more sustainable transport systems (Hoogma et al., 2002; Elzen et al., 2004; Kemp and Rotmans, 2004; Nykvist and Whitmarsh, 2008; Vergragt and Brown, 2007); others have focussed on the crucial role played by dominant actors in the generation of – and resistance to – incremental and radical transport innovations (Kendall, 2008; Freyssenet, 2009; van Bree et al., 2010).

This paper is located at the intersection of such research streams and it is mainly aimed at analysing the role of the city in the generation of low-carbon urban mobility.

The paper is based on a socio-technical (ST) analysis of the role played by actors in the future dynamics of urban mobility; a specific attention is given to existing "core-actors" (Smith et al., 2005), that is, those actors who are interested in reproducing the established car regime, and to "enactors" (Suurs et al., 2009), that is, those actors who are interested in embedding emerging alternatives into the economy and the society as a whole.

Three ST scenarios of urban mobility are provided: "Automobility", emerging from the reconfiguration of the existing car regime; "Electricity", where the car becomes nothing but an element of an energy system driven by new core-actors; "Ecocity", where a new vision of urban mobility is implemented by coalitions of urban actors. Then, an exercise of "policy backcasting" is proposed in order to show that the bottom-up initiative of coalitions of urban actors is a necessary condition for the establishment of the "Ecocity" regime, but it is not sufficient; a top-down policy initiative – better if implemented at European level – is also needed to achieve the critical mass for radical change. A multilevel policy approach to sustainable mobility emerges which is based on a self-sustained process: urban coalitions advocate for central resources, these in turn empower urban coalitions, and so forth.

The paper is composed of three parts. The first part explains the basic concepts of the ST approach. The second part builds the three ST scenarios, starting from a brief analysis of the current situation of urban mobility. The third part develops the backasting exercise.

2. A socio-technical framework

2.1. Systems, actors and change

The ST system is the basic concept of the framework. A ST system fulfils a societal function (health, housing, feeding, etc.) and it is made of a structure of interacting institutions, technologies and markets (Perez, 2002, ch. 14; Geels, 2005; Raven, 2006; Schot and Geels, 2007; Smith et al., 2010) . The ST system is a meso concept: at the micro level we find its individual constituents (rules, norms, artefacts, knowledge, preferences, financial resources, etc.); at the macro level societal phenomena and trends can be found.[1]

ST systems are not static and closed: they are reproduced and changed through a structure-and-agency dynamics, and they interact with other systems and with the overall macro level. Such a dynamics is homeostatic and path-dependent.[2]

In the framework, a ST system is considered as:

- a ST regime, when it dominates the alternatives. The existence of a regime usually generates pervasive lock-in phenomena;
- a ST niche, when it is partially or totally protected from the interaction with other ST systems. ST niches are particularly relevant for the experimentation of novelties.[3]

The role of actors in the functioning of ST systems is stressed by the literature; some authors explicitly consider ST systems as networks of actors (however they are named[4]). Every actor features a certain amount of power, legitimacy and networking ability.

Two kinds of actors are relevant to understand the dynamics of ST systems and their interaction:

- core-actors are those actors who are interested in – and actively act for – the reproduction of an existing socio-technical system. Core-actors of a regime feature high levels of power, legitimacy and networking ability and they are able to use their endowments to influence politics and policy; (Smith et al., 2005)
- the enactors are those actors who are interested in the emergence and establishment of a new ST system (Suurs et al., 2010). Through empowerment, legitimisation and the creation of an advocacy coalition, successful enactors are able to gain an increasing ability to influence political discourses, agendas and formal norms and policies: they act as "institutional entrepreneurs". (Bergek et al., 2008a and 2008b; Avelino and Rotmans, 2009; Hung and Whittington, 2011)[5].

---

1 In the ST approach the macro level is usually named "ST landscape" (Geels, 2005).

2 For a detailed analysis of the structure and dynamics of a ST system, see Marletto (2011).

3 In the ST literature the concept of an "ordinary" ST system which co-exists with a regime and with other systems and niches is missing. Some scholars have tried to fill this conceptual void by using hybrid concept such as the "niche-regime" or the "empowered niche" (Haxeltine et al., 2008; Frantzeskaki and de Han, 2009; Kohler et al., 2009).

4 For example: Avelino and Rotmans (2009) refer to "constellations" of actors; Holtz et al. (2008) to "alignments" of actors.

5 The seminal paper on the issue of legitimacy and institutionalisation as relevant conditions for the establishment of new industries is Aldrich and Fiol (1994). For an application to the early American automotive industry, see: Rao (2004).

Other kinds of actors may be considered: non-core actors (or "fringe" actors) , that is those actors who take part in a ST system without assuming a relevant role in its reproduction; outsiders, that is those actors external to a given ST system.

A taxonomy of ST changes, in which the role of actors is explicitly considered (Geels and Schot, 2007), is at centre stage of our framework:

- transformation occurs when core-actors adjust the existing regime after pressures coming by outsiders;
- reconfiguration takes place when core-actors are able to reproduce the existing regime by integrating new non-core actors;
- substitution is the result of a "battle": new core-actors win on old core-actors and transform the existing regime;
- de-alignment and re-alignment involve new core-actors – usually coming from one or more niches – who destabilise the existing regime and establish a new.

In the ST approach to change, policy and politics stay centre stage. Because of the widespread path-dependent and lock-in phenomena generated by the existing regime, the creation of new regimes must be adaptively managed through reflexive governance and societal learning. Niches are essential, not so much to incubate market and technological novelties, as to gradually build up, legitimate and broaden a coalition of enactors sharing a vision and a political discourse, and advocating all changes needed to overcome existing core-actors and create a new regime. This is why specific policy measures should be aimed at nurturing and clustering niches, while others should try to destabilise the existing regime. A specific attention must be given to political and institutional issues, especially to the ability of supporters of transitions to promote new discourses and broader coalitions for social change, with the aim of overcoming incumbent powers. (Hoogma et al., 2002, ch. 6; Brown et al., 2004; Raven, 2006; Loorbach, 2007; Schot and Geels, 2007; Haxeltine et al., 2008; Foxon et al., 2009; Meadowcroft, 2009; Nill and Kemp, 2009; Smith and Kern, 2009; Voß et al., 2009; Smith et al., 2010)

Bergek et al. (2008a, 2008b) are more explicit on the need of empowering, coalescing and legitimising enactors: indeed, a weak advocacy coalition can be among the blocking mechanisms in the formative stage of a new regime.

2.2. Change and space: the role of the city

ST systems are usually analysed at a national/international level because this is the spatial dimension of their reproduction. The city – and the local level – is taken into account, but just as a recipient of the implementation of a process of change generated at higher scale.

Only in recent years the active role of the city has raised the interest of scholars of ST dynamics. The city is considered as a place where: coalitions for change can be build more easily; local knowledge and relational resources may be mobilised for innovative practices; political deliberation is more fluid – that is, the city is a friendly environment for the establishment and reproduction of ST niches. (Hodson and Marvin, 2007; Smith et al., 2010: 5.3; Bulkeley et al., 2011)

But – as clearly stated by Geels (2011) – the city can feature a more relevant role than the mere hosting of niches. Cities are primary actors of ST change when national and international systems

are collection of local systems: regimes have a national/international dimension in terms of regulation or technical knowledge, but implementation and operation tend to occur in cities and localities. In these kinds of systems, the overall ST dynamics consists of accumulations of local and urban dynamics.

This implies two more relevant considerations. 1) The analysis of ST change must be place-specific: "cities are involved in shaping and directing transitions, but the capacity to do so, the actors involved and the politics of these processes vary from place to place" (Bulkeley et al., 2011: p. 6). 2). City governments and other local agents are crucial actors in managing and organizing ST systems, but such systems reproduce beyond the local boundaries, this is why action at the national/international level should be analyzed too (Smith et al., 2010). The normative implication is apparent: "the governance of these systems is increasingly polycentric, at multiple levels or scales of governance, and control is dispersed and distributed" (Hodson and Marvin, 2010, p. 482) – that is, a multilevel approach to policy must be adopted in order to integrate top-down and bottom-up dynamics.

3. Urban mobility: the current regime and three scenarios

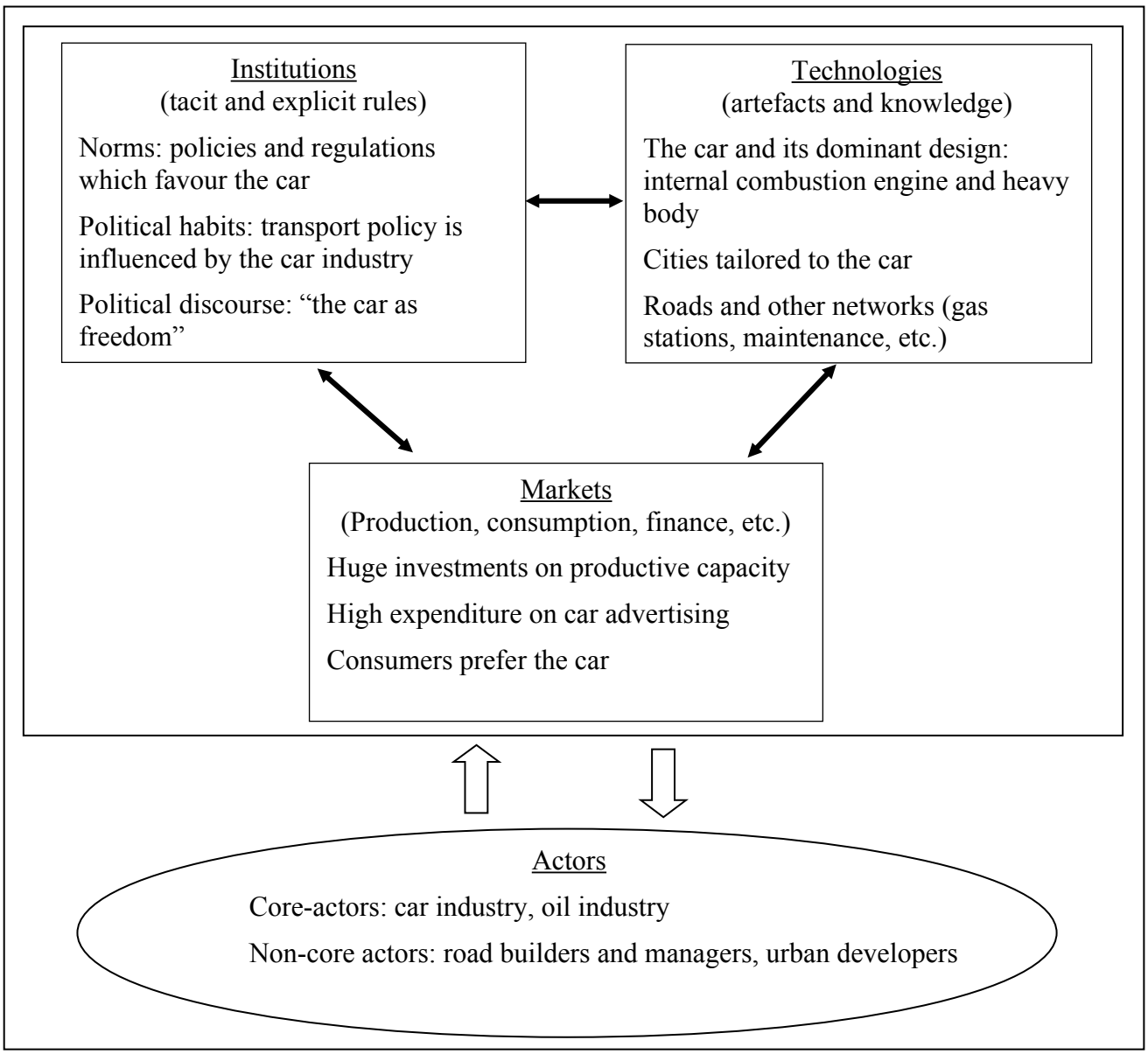
3.1. The current situation of urban mobility: a socio-technical analysis

Authoritative scholars of ST systems recognize the petrol car as the regime of urban mobility with the car and oil industries playing the role of core-actors (see, among others: Geels, 2005; Holtz et al., 2008)[6]. Figure 1 synthesise the main institutional, technological and economic elements of the car regime, stressing the role of its core-actors. One should only add that – as stressed by Dennis and Urry (2009) – the car regime is currently under pressure of "landscape" phenomena, such as: climate change, peak oil, urbanisation (especially in poor and emerging countries) and digitisation of daily life.

Public transport and the bicycle are two other ST systems of urban mobility which co-exist with the car regime, without threatening its dominant role (Frantzeskaki and de Han, 2009; Kohler et al., 2009). Many others ST niches complement the picture which are based on both technological and organisational novelties (bio-fuels, hybrid and electric cars, hydrogen fuel cells, car downsizing, car sharing, bike sharing, new urbanism, etc.) (Nykvist and Whitmarsh, 2008; Bento, 2010; Falconer et al., 2010; Suurs et al., 2010; van Bree et al,, 2010; Zapata and Nieuwenhuis, 2010).

[6] See also Marletto (2011) for a survey of the literature on this issue.

Figure 1. The constituents of the car regime



3.2. The future evolution of urban mobility: three socio-technical scenarios

The foreseeable evolution of urban mobility can be synthesised into three ST scenarios, all of which incorporate the technology of electric propulsion.[7]

The first scenario ("Automobility") emerges from the reconfiguration of the existing car regime and is generated by the integration in the car industry of new non-core industrial actors (producers of: batteries, electric engines, new materials, etc.). The hybrid propulsion is choosen as the entry-point to a process of technological innovation because it is compatible with the current core competences, sunk investments and interdependencies of the automotive industry, and it is flexible enough to

[7] Actually, some carmakers – Fiat and Volvo are the most important– are still implementing innovation strategies that are not based on the option of electric propulsion, such as downsizing and alternative fuels (Freyssenet, 2011).

allow the future access to battery and fuel cell electric cars. (Hekkert and van den Hoed, 2006; Oltra and Saint Jean, 2009; Sovacool and Hirsh, 2009; Avadykian and Llerena, 2010; Fontaras and Samaras, 2010; van Bree et al., 2010)

In the second scenario ("Electricity") the car becomes nothing but an element of an energy system whose core-actor is the electric industry. Local and national electric operators are interested in the diffusion of electric vehicles, not only because they already own – or manage – the essential facility of electric grids, but also because they aim at the new frontier of 'smart grids' (that is, grids which are able to exchange electricity with batteries in both directions); some of them have already started joint industrial and commercial programs with automotive companies – especially with those, such as Nissan-Renault, which are implementing the option of full-electric cars – and with emerging managers of battery-charge and battery-swap networks (such as Better Place)[8]. (Lund and Kempton, 2008; Andersen et al., 2009; Barkenbus, 2009; Deloitte, 2009; Zhou et al., 2011).

In the third scenario ("Ecocity") coalitions of urban actors (public transport companies, local governments, NGOs, providers of technologies, etc.) support new visions of urban mobility which are based on dense and multifunctional cities, public and shared transport, and non-motorised mobility. Some medium and big cities – such as Zurich in Switzerland, Freiburg in Germany, Malmo in Sweden, Bogotà in Colombia, Curitiba in Brazil – may be considered as established niches of such a new approach to urban life and mobility. Seminal elements of these scenario can be discovered in current and future national transport policies too; for example, in California and China, respectively. (Pla and Segarra, 2008; Dennis and Urry, 2009, ch. 6; Sperling and Gordon, 2009, ch. 7-8; Hodson and Marvin, 2010; Moloney et al., 2010; Buehler and Pucher, 2011; Hull, 2011, ch. 7)

Table 1 shows the main features of three considered scenario, in terms of: transition pathways driving the process of change; core-actors influencing political institutions; economic and technological transformations.

Some more considerations about such scenarios can be developed with regards to their likelihood and environmental sustainability.[9]

The "Automobility" scenario is the more probable because of pervasive lock-in phenomena generated by the existing car regime, but its technological transition is too slow to reach the ambitious target of a low-carbon mobility.

The likelihood of the "Electricity" scenario strongly depends on the ability of the electric industry to influence institutions and overcome the conservative strategies of the car industry; moreover, its environmental sustainability will be conditioned by the energy mix used to run electric cars, that is, a fact which refer more to the energy societal function than to the mobility.

"Ecocity" is the most sustainable scenario because of the effective combination of reduced mobility and transport efficiency, but it is the least likely one because it is supported by urban coalitions that

[8] It is still under dispute which is the more profitable business model: smart grids connected to batteries which are located inside the vehicle or in battery-swap stations (Deloitte, 2009; Zhou et al., 2011).

[9] The evaluation of the likelihood and environmental sustainability of the three scenarios is based on the extensive literature on the subject; see among others: Rajan (2006); Bristow et al. (2008); Kendall (2008); Hacker et al. (2009); McCollum and Yang (2009); Rijkee and van Essen (2010); Doucette and McCulloch (2011).

are not able to act on the national/international level, which is needed to challenge the existing car regime and to establish a new regime of low-carbon urban mobility.

Table 1. Three socio-technical scenarios of urban mobility

Scenario 1: Automobility	
Transition pathway	Reconfiguration (integration of new non-core actors)
Institutional driver and core-actors	Transport policy is influenced by the car industry
Technologies and markets	Hybrid car → Electric car
Scenario 2: Electricity	
Transition pathway	Substitution (new core-actors emerge after a battle with old core-actors)
Institutional driver and core-actors	Transport and energy policies are influenced by the electricity industry
Technologies and markets	Electric car + Smart grids
Scenario 3: Ecocity	
Transition pathway	De-alignment and re-alignment (a coalition of new core-actors support a new vision of urban mobility)
Institutional driver and core-actors	An integrated and multilevel urban policy is influenced by coalitions of local NGOs, governments and industries
Technologies and markets	New urbanism (dense and multifunctional cities) + "3Bs" (Buses, Bicycles, Batteries)

4. Towards the "Ecocity" scenario: a socio-technical exercise of policy backcasting

4.1. Socio-technical conditions and guidelines for policy backasting

Policy backasting is a technique aimed at selecting those policies which may be effective in reaching a given desirable scenario. Usually such a scenario is defined in terms of technological or market targets[10]; but in this paper the scenario is defined in terms of the ST conditions which are needed to establish a regime of low-carbon urban mobility[11].

Then the relevant questions are: Which is the desirable scenario? At which ST conditions should transport policy be aimed at?

[10] For an application to policies for low-carbon mobility see Hickman and Banister (2007).
[11] A similar approach is applied by Vergragt and Brown (2007); see also Moriarty and Honnery (2008).

As stated above, the "Ecocity" is the most sustainable scenario, this is why it is used as the desirable scenario in this policy backcasting exercise. Then, two main ST conditions for its establishment are selected and some ST guidelines for designing effective policies are suggested.

First ST condition for the Ecocity scenario: The existing car regime should be destabilised and urban mobility should be unlocked from it.

Two policy guidelines may be derived from this first ST condition:
- implement actions which are explicitly aimed at destabilising the existing car regime and to weaken its core-actors;
- reach the critical mass of intervention which is needed to overcome path-dependence and lock-in phenomena generated by the existing car regime.[12]

Second ST condition for the Ecocity scenario: A new regime of urban mobility must be established

Three policy guidelines may be derived from this second ST condition:
- act on all dimensions of ST change – that is, institutions, technologies and markets – in order to ensure their dynamic alignment towards the Ecocity scenario;
- explicitly support the empowerment, networking and legitimacy of the potential enactors of the new regime of urban mobility, who are now established in a limited number of scattered urban niches.

4.2. 2012-2030: A European integrated policy for low-carbon urban mobility

The "Ecocity" scenario may be reached by a long-lasting European integrated policy which is backed by relevant financial resources. Such a policy may be articulated in a preliminary consultation, three framework regulations, a programme for urban planning and an industrial initiative. Some details follow.

The preliminary consultation (2012-2013)

A task-force of mid to high level European Commission officials coming from several General-Directorates (Climate Action, Mobility and Transport, Energy, Environment, Enterprise and Industry, Research and Innovation) is responsible for involving all relevant stakeholders (authorities and other public bodies, associations and other non-governmental bodies)[13] in a series of three conferences aimed at establishing a shared political discourse and creating the habit of networking:
- in Conference 1, the relevant basic data and foreseeable trends about urban mobility and its environmental impacts are discussed;
- in Conference 2, a vision of 2030 low-carbon urban mobility in Europe is discussed.[14] An example of such a vision is proposed in Box 1;
- in Conference 3, a mid-term European policy for low-carbon urban mobility is discussed.

Three framework Regulations (2014)

[12] For similar considerations about the diffusion of hydrogen and fuel cells in transport activities, see Bento (2011).

[13] Stakeholders coming from the automotive and oil industries are not invited to the three conferences.

[14] Visioning exercises are considered crucial both in "transition arenas" (Kemp et al., 2011) and in backcasting procedures aimed at generating second-order learning (Vergragt and Brown, 2007).

Three Regulations are adopted in order to make the unlocking of the car regime more viable:
- Reg. 12/2014 which establishes that new urban developments are admitted only near main public transport nodes;[15]
- Reg. 112/2014 which strictly regulate car advertising. Among the new norms: a mandatory colour-coded energy efficiency label[16], the prohibition of television ads, a European fund to carry out information campaigns on sustainable mobility which is funded by car manufacturers who devote to it 5% of their advertising budget;
- Reg. 113/2014 which prohibits all public incentives to buy cars, having recognised their inconsistency with the European environmental policy.

The "Eco-cities" programs (2014-2019 and 2020-2025)

These programs are adopted to promote the diffusion of urban plans for sustainable mobility. They are based on a multilevel approach[17]: top-down co-funding criteria are used to select bottom-up proposals. Co-funding criteria are explicitly based on the 3-Ls/3Bs approach to urban and transport planning[18] and on a preference for plans supported by coalitions of local actors.

The "Alessandro Volta" (AV) initiative (2015-)

This is an impressive action for technological and organizational innovation in the domain of low-carbon urban mobility and it is explicitly aimed at creating a new European firm. Following the industrial model used in the case of Airbus[19], the initiative is developed through three phases:
- Phase 1 (2015-2019): a network of more than 60 firms and research bodies is promoted with the goal of developing the "AV" integrated platform for electric urban mobility;[20]
- Phase 2 (2020-2023): thanks to the experimental implementation in 35 pilot cities (and the cross-funding of the "Ecocities" program), the AV platform is improved and its elements are standardised;
- Phase 3 (2023-): to achieve the worldwide commercialisation of the AV platform, the European industrial consortium AV is created; all public funding is ceased.

Box 1 - 2030: A vision of low-carbon urban mobility

The newly published TERM 2029 Report of the European Environmental Agency confirms that CO2 emissions from transport and km driven by car remains below 2000 level. This important result was achieved because of two converging urban and industrial dynamics.

On the urban side, the European Commission recently stated that 63% of medium and large European cities have adopted the so-called "3-Ls/3Bs" transport system. In this system, mobility is mainly based on collective and shared transport (the first B=Buses), non-motorised modes (the

[15] For norms which explicitly link transport plans and projects to density standards, see the Californian Senate Bill No. 375 (approved by Governor September 30, 2008).
[16] This is one of the proposals of the campaign "Driving the change" supported by some of the major European environmental NGOs. See: www.drivingthechange.eu.
[17] Such a multilevel approach is similar to that followed by the European programs "Marco Polo" and "Urban". See: http://ec.europa.eu/transport/marcopolo/ and http://ec.europa.eu/regional_policy/urban2/intro_en.htm.
[18] For a brief description of the 3-Ls/3Bs approach, see below, Box 1.
[19] For a detailed history of Airbus, see: http://www.airbus.com/company/history/the-narrative/.
[20] A similar network has been recently launched on a smaller scale by the project "Green e-Motions", co-funded by the European 7th Framework Program. See: www.greenemotion-project.eu.

second B=Bicycles) and electric propulsion (the third B=batteries); moreover, all transport services are accessible through portable ICT devices. Individual cars recorded a significant decrease of their transport share also because of a 3-Levels integrated approach to urban and transport planning: Level 1 is made of "decabornised" dense areas, where only non-motorised and electric collective and shared transport means are admitted; Level 2 is composed by "zone 30" dense areas, where also electric individual cars may circulate at the maximum speed of 30 km/h; at Level 3 we find some "city gates", located at the border with dispersed urban areas, where are available: an integrated node of collective and shared transport, a parking for internal combustion cars and several recharge and battery-swap stations for electric cars.

Regarding the industrial dynamics which have affected the structure of urban mobility in Europe, Deloitte and other consulting firms specializing in transport alleged that less than ten global players compete in the world market of integrated low-carbon urban mobility systems. Some of them were leaders of the traditional automotive industry, such as Nissan-Reanult-EDF or Toyota, which merged in 2018 with Japan Railways; others are led by electricity big companies, such as the GGB joint-ventures, promoted by General Electric, General Motors and Ballard, the leader of fuel-cells batteries; some of them are smaller new entrants, such as the Chinese BYD, the Israeli Better Place and the European AV[21]. It must also be stressed that some automotive firms stopped manufacturing cars; this is the case of Fiat-Chrysler and Volkswagen-Audi, which specialised on earthmoving and agricultural equipments, and converted to renewable energy, respectively.

4.3. A socio-technical check of the proposed policy tools

ST guidelines presented in par. 4.1. may now be used to check the potential effectiveness of the proposed European integrated policy for low-carbon urban mobility. See table 2 for an overview of the following considerations.

With reference to the first ST guideline ('Destabilise the car regime and weaken its core-actors') it must be said that the automotive and oil industries are not involved both in the preliminary consultation and the "Alessandro Volta" initiative (with the only exception of those car manufacturers who are already implementing a strategy for battery electric vehicles). Moreover, the automotive industry is hit by new restrictive norms on advertising and incentives, and the car is considered only as a secondary option in local plans funded by the "Eco-cities" programs.

The second ST guideline ('Reach a critical mass of intervention in order to unlock the car regime') inspired mainly the "Ecocities" programs and the "Alessandro Volta" initiative: they are both long-lasting and massively funded policies explicitly aimed at overcoming the resistance to change of the existing car regime. This is why an integrated approach to the promotion of all organisational and technological alternatives to the internal combustion is adopted.

The proposed integrated policy is consistent with the third guideline too ('Act simultaneously on institutions, technologies and markets'): the preliminary consultation has the implicit goal of creating an habitual relation (that is, a new informal political institution) between officials of the European Commission DGs and those stakeholders who are now outsiders of the existing car regime, but may become enactors of a new low-carbon urban mobility regime; the other three policy tools promote the market penetration of new technologies, both stimulating their demand with incentives and directly supporting their production.

[21] AV stays for Alessandro Volta, for more details see above.

Finally, only the framework Regulations are not consistent with the fourth guideline (‘Support a coalition of new core-actors’). The preliminary consultation is implicitly aimed at legitimising and coalescing local supporters of a new regime of low-carbon urban mobility; the “Ecocities” programs give preference to the funding of local plans proposed by coalitions of local actors; the “Alessandro Volta” initiative promote and fund a network (then transformed in an industrial consortium) of firms and research bodies devoted to radical innovation in urban mobility.

Table 2 – A socio-technical policy check of a European integrated policy for low-carbon urban mobility

Socio-technical guidelines	Policy tools			
	Preliminary consultation	**Framework Regulations**	**"Eco-cities" programs**	**"Alessandro Volta" (AV) initiative**
1. Destabilise the car regime and weaken its core-actors	Stakeholders of the automotive and oil industries are not invited	The automotive industry is hit by new rules on advertising and the ban of incentives to buy cars	Only local plans are funded which ban the electric car and the internal combustion car from central and dense urban areas, respectively	The oil industry is not involved in the initiative. Only automotive industries are involved which are implementing a strategy for electric propulsion
2. Reach a critical mass of intervention in order to unlock the car regime	All relevant stakeholder are involved	The new norms for urban planning make the new demand of mobility more consistent with collective and shared transport, than whit the individual car	This is a long-lasting (12 years) and massively funded policy. Plans are funded which integrate all alternatives to the internal combustion car	This is a long-lasting (9 years) and massively funded policy. It is oriented to electric mobility
3. Act simultaneously on institutions, technologies and markets	The consultation is also aimed at creating an habitual relation between EC officials and outsiders	The Regulations act on technologies and markets	Promotion of the "3Bs": public and shared transport, non-motorized transport and electric propulsion (technologies and demand side of the market)	Design, experimentation and commercialisation of an integrated platform for electric urban mobility (technologies and supply side of the market)
4. Support a coalition of enactors of a regime of low-carbon urban mobility	Potential new core-actors are invited to the consultation	-	Preference for local plans proposed by coalitions of local actors	A network of firms and research bodies is created. Then the network is transformed in an industrial consortium.

5. Conclusions

The socio-technical approach to the analysis of societal change supplies the appropriate conceptual tools for envisaging a policy for urban mobility which is able to meet the challenging goal of decarbonisation.

If one focuses on the role that actors play in the future transformation of urban transport, three scenario may be considered: "Automobility", that is, the conservative option, led by the automotive industry; "Electricity", that is the integration of electric cars and smart grids; "Ecocity", that is the combination of urban density and transport efficiency.

The "Ecocity" scenario emerge as the more sustainable scenario and the less likely. Local roots are both the strength and the weakness of this scenario. Using the city as a "niche" for radical change, local coalitions are able to overcome the resistance to change coming from the existing car regime, which is mainly reproduced at a national/international level. At the same time, the action at urban level is not sufficient to go beyond the boundaries of urban environments, with the risk of leaving to other new powerful actors (such as managers of electric grids and producers of batteries) the initiative of creating an alternative regime of urban mobility.

A multilevel policy for low-carbon urban mobility is the only tool that may accommodate the city-specific bottom-up initiatives for innovating urban transport systems, and foster the diffusion of the "Ecocity" vision to urban areas that are less ready to radical change.

An exercise of policy backcasting shows that a long-lasting European integrated policy should be implemented to empower local actors and diffuse urban experimentation, with the overall aim of reaching the critical mass which is needed to unlock the car regime and trigger the institutional, technological and economic transition towards a new regime of low-carbon mobility.

References

Aldrich H.E., Fiol M., 1994. Fools Rush in? The Institutional Context of Industry Creation. The Academy of Management Review, 19: 645-670

Andersen P.H., Mathews J.A., Rask M., 2009. Integrating private transport into renewable energy policy: The strategy of creating intelligent recharging grids for electric vehicles. Energy Policy, 37: 2481–2486

Avadikyan A., Llerena P., 2010. A real options reasoning approach to hybrid vehicle investments. Technological Forecasting & Social Change, 77 (4), 649–661

Avelino F., Rotmans J., 2009. Power in Transition. An Interdisciplinary Framework to Study Power in Relation to Structural Change. European Journal of Social Theory, 12: 543–569.

Barkenbus J., 2009. Our electric automotive future: CO2 savings through a disruptive technology. Policy and Society, 27: 399–410

Bento N., 2010. Is carbon lock-in blocking investments in the hydrogen economy? A survey of actors' strategies. Energy Policy, 38: 7189–7199

Bergek A., Jacobsson S., Carlsson B., Lindmark S., Rickne A., 2008a. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. Research Policy, 37 (3), 407–429

Bergek A., Jacobsson S., Sandén B., 2008b. 'Legitimation' and 'development of positive externalities': Two key processes in the formation phase of technological innovation systems. Technology Analysis & Strategic Management, 20: 575-592.

Bristow A.L., Tight M., Pridmore A., May A.D., 2008. Developing pathways to low carbon land-based passenger transport in Great Britain by 2050. Energy Policy, 36: 3427-3435

Brown H.S., Vergragt P.J., Green K., Berchicci L., 2004. Bounded socio-technical experiments (BSTEs): higher order learning for transition towards sustainable mobility. In: Elzen B., Geels F.W., Green K. (eds.). System innovation and the transition to sustainability. Edward Elgar, Cheltenham

Buehler R., Pucher J., 2011. Sustainable Transport in Freiburg: Lessons from Germany's Environmental Capital. International Journal of Sustainable Transportation, 5: 43-70

Bulkeley H., Castan Broto V., Hodson M., Marvin S. (2011). Introduction, In: Bulkeley H., Castan Broto V., Hodson M., Marvin S. (Eds.) Cities and Low Carbon Transitions. Routledge, Abingdon

Deloitte, 2009. A new era. Accelerating toward 2020 - An automotive industry transformed. Deloitte Touche Tohmatsu

DfT-Department for Transport, 2009. Low Carbon Transport: a Greener Future. A Carbon Reduction Strategy for Transport. London, July 2009

Doucette R.T., McCulloch M.D., 2011. Modeling the CO2 emissions from battery electric vehicles given the power generation mixes of different countries. Energy Policy, 39: 803–811

EC-European Commission, 2011. White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. COM(20012)

Elzen B., Geels F.W., Hofman P.S., Green K., 2004. Socio-technical scenarios as a tool for transition policy: an example from the traffic and transport domain. In: Elzen B., Geels F.W., Green K. (eds.). System innovation and the transition to sustainability. Edward Elgar, Cheltenham

Falconer R., Newman P., Giles-Corti B., 2010. Is practice aligned with the principles? Implementing New Urbanism in Perth, Western Australia. Transport Policy, 17: 287–294

Fontaras G., Samaras Z., 2010. On the way to 130g CO2/km. Estimating the future characteristics of the average European passenger car. Energy Policy, 38: 1826–1833

Foxon T.J., Reed M.S., Stringer L.C. (2009). Governing Long-Term Social-Ecological Change: What Can the Adaptive Management and Transition Management Approaches Learn from Each Other? Environmental Policy and Governance, 19 (1), 3-20

Frantzeskaki N., de Haan H., 2011. Transitions: Two steps from theory to policy. Futures, 41: 593–606

Freyssenet M., 2009. The second automobile revolution: trajectories of the world carmakers in the 21st century. Palgrave Macmillan, Basingstoke

Geels F.W., 2005a. Technological Transitions and System Innovations: A Co-evolutionary and Socio-Technical Analysis. Edward Elgar, Cheltenham

Geels F.W., 2011. The role of cities in technological transitions: analytical clarifications and historical examples, In: Bulkeley H., Castan Broto V., Hodson M., Marvin S. (Eds.) Cities and Low Carbon Transitions. Routledge, Abingdon

Geels W.F., Schot J., 2007. Typology of sociotechnical transition pathways. Research Policy, 36: 399–417

Hacker F., Harthan R., Matthes F., Zimmer W., 2009. Environmental impacts and impact on the electricity market of a large scale introduction of electric cars in Europe. Critical Review of Literature. ETC/ACC Technical Paper 2009/4, European Topic Centre on Air and Climate Change, July 2009

Haxeltine A., Whitmarsh L., Bergman N., 2008. A Conceptual Framework for transition modelling. International Juornal of Innovation and Sustainable Development, 3: 93-114

Hekkert M., van den Hoed R., 2006. Competing technologies and the struggle towards a new dominant design: the emergence of the hybrid vehicle at the expense of the fuel-cell vehicle? In: Nieuwenhuis P., Vergragt P., Wells P. (eds.). The Business of Sustainable Mobility. From vision to reality. Greenleaf Publishing, Sheffield

Hickman R., Banister D., 2007. Looking over the horizon: Transport and reduced CO2 emissions in the UK by 2030. Transport Policy, 14: 377–387

Hodson M., Marvin S., 2007. Cities mediating technological transitions: the adaptability of infrastructure and infrastructures of adaptability? In: Geyer H.S. (Ed.), International Handbook of Urban Policy. Volume 1 (Contentious Global Issues). Edward Elgar, Cheltenham and Northampton (MA).

Hodson M., Marvin S., 2010. Can cities shape socio-technical transitions and how would we know if they were? Research Policy: 39: 477–485

Holtz G., Brugnach M., Pahl-Wostl C., 2008. Specifying 'regime' — A framework for defining and describing regimes in transition research. Technological Forecasting & Social Change, 75: 623–643

Hoogma R., Kemp R., Schot J., Truffer B., 2002. Experimenting for sustainable transport: the approach of strategic niche management. Spon Press, Oxon

Hull A., 2011. Transport Matters. Integrated approaches to planning city-regions. Routledge, London and New York

Hung S., Whittington R., 2011. Agency in national innovation systems: Institutional entrepreneurship and the professionalization of Taiwanese IT. Research Policy, 40: 526–538

Kemp R., Rotmans J., 2004. Managing the transition to sustainable mobility. In: Elzen B., Geels F.W., Green K. (eds.). System innovation and the transition to sustainability. Edward Elgar, Cheltenham

Kemp R., Avelino F., Bressers N., 2011. Transition management as a model for sustainable mobility. European Transport, 47: 26-46

Kendall G., 2008. Plugged in, The end of the oil age. WWF, Brussels

Köhler J., Whitmarsh L., Nykvist B., Schilperoord M., Bergman N., Haxeltine A., 2009. A transitions model for sustainable mobility. Ecological Economics, 68: 2985–2995

Loorbach D. (2007). Transition Management: New Mode of Governance for Sustainable Development. International Books, Utrecht

Lund H., Kempton W., 2008. Integration of renewable energy into the transport and electricity sectors through V2G. Energy Policy, 36: 3578– 3587

Lutsey N., Sperling D., 2009. Greenhouse gas mitigation supply curve for the United States for transport versus other sectors. Transportation Research Part D, 14: 222–229

Marletto G., 2011. Structure, agency and change in the car regime. A review of the literature. European Transport, 47: 71-88

McCollum D., Yang C., 2009. Achieving deep reductions in US transport greenhouse gas emissions: Scenario analysis and policy implications. Energy Policy, 37: 5580-5596

Meadowcroft J., 2009. What about the politics? Sustainable development, transition management, and long term energy transitions. Policy Science, 42: 323–340

Mees P., 2010. Transport for Suburbia. Beyond the Automobile Age. Earthscan, London and Washington

Moloney S., Horne R.H., Fien J., 2010. Transitioning to low carbon communities-from behaviour change to systemic change: Lessons from Australia. Energy Policy, 38: 7614–7623

Moriarty P., Honnery D., 2008. Low-mobility: The future of transport. Futures, 40: 865–872

Nill J. and Kemp R. (2009). Evolutionary approaches for sustainable innovation policies: From niche to paradigm? Research Policy, 38 (4) 668–680

Nykvist B., Whitmarsh L., 2008. A multi-level analysis of sustainable mobility transitions: Niche development in the UK and Sweden. Technological Forecasting & Social Change, 75 (9), 1373–1387

Oltra V., Saint Jean M., 2009. Variety of technological trajectories in low emission vehicles (LEVs): A patent data analysis. Journal of Cleaner Production , 17: 201–213

Perez C., 2002. Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages. Edward Elgar, Cheltenham

Pla E., Segarra E. (eds.), 2008. Building Local Partnerships – Key Findings & Recommendations. Spicycles. Sustainable Planning & Innovation for Bicycles, WP6, October 2008

Rao H., 2004. Institutional activism in the early American automobile industry. Journal of Business Venturing, 19: 359–384

Rajan S.C., 2006. Climate change dilemma: technology, social change or both? An examination of long-term transport policy choices in the United States. Energy Policy, 34: 664–679

Raven, R.P.J.M., 2006. Towards alternative trajectories? Reconfigurations in the Dutch electricity regime. Research Policy, 35: 581–595

Rijkee A.G., van Essen H.P., 2010. Review of projections and scenarios for transport in 2050 Task 9 Report V produced as part of contract ENV.C.3/SER/2008/0053 between European Commission Directorate-General Environment and AEA Technology plc. www.eutransportghg2050.eu

Schot J., Geels F.W., 2007. Niches in evolutionary theories of technical change. A critical survey of the literature. Journal of Evolutionary Economics, 17: 605–622

Smith A., Stirling A., Berkhout B., 2005. The governance of sustainable socio-technical transitions. Research Policy, 34: 1491–1510

Smith A., Kern F., 2009. The transition storyline in Dutch environmental policy. Environmental Politics, 18: 78-98

Smith A.,Voß JP., Grin J., 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research Policy, 39: 435–448

Sovacool B.K., Hirsh R.F., 2009. Beyond batteries: An examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition. Energy Policy, 37 (3), 1095–1103

Spath P., Rohracher H., 2011. The 'eco-cities' Freiburg and Graz: the social dynamics of pioneering urban energy and climate governance, in: Bulkeley H., Castan Broto V., Hodson M., Marvin S. (Eds.) Cities and Low Carbon Transition, Routledge, Abingdon

Sperling D., Gordon G., 2009. Two Billion Cars. Driving toward sustainability. Oxford University Press, New York

Suurs R.A.A., Hekkert M.P., Kieboom S., Smits R.E.H.M., 2010. Understanding the formative stage of technological innovation system development: The case of natural gas as an automotive fuel. Energy Policy, 38: 419–431

The Climate Group, 2011. Delivering low carbon growth. A Guide to China's 12th Five Year Plan. HSBC, March 2011

van Bree B., Verbong G.P.J., Kramer G.J., 2010. A multi-level perspective on the introduction of hydrogen and battery-electric vehicles. Technological Forecasting & Social Change, 77: 529–540

Vergragt P.J., Szejnwald Brown H., 2007. Sustainable mobility: from technological innovation to societal learning. Journal of Cleaner Production, 15: 1104-1115

Voß J.P., Smith A., Grin J., 2009. Designing long-term policy: rethinking transition management. Policy Science, 42 (4), 275–302

Wells P.E., 2010. The Automotive Industry in an Era of Eco-austerity. Creating an Industry as if the Planet Mattered. Edward Elgar, Cheltenham

Zapata C., Nieuwenhuis P., 2010. Exploring innovation in the automotive industry: new technologies for cleaner cars. Journal of Cleaner Production, 18: 14–20

Zhou L., Watts J.W., Sase M., Miyata A., 2011. Charging ahead: battery electric vehicles and the transformation of an industry. Deloitte review, issue 7, 2011

Governing Urban Low Carbon Transitions. Cities are increasingly being recognised as critical arenas for addressing climate change. Since 2008, for the first time half of the world's population is living in towns and cities (UN 2008). The more.Â The project is used as a case study, following a participatory action research methodology. Our findings verified the three types of challenge mentioned in the literature - inherent, institutional and teamwork related.Â China represents a test-case of global significance regarding the challenges of urban mobility transition to more sustainable models. On the one hand, transportation accounts for approximately one quarter of global greenhouse gas more. Welcome to the urban-mobility revolution. Approaching the tipping point. Understanding how a cityâ€™s mobility system will evolve is complex.Â Cities worldwide are pouring investment into public transit as a way to improve mobility. BogotÃ¡ is well known for the TransMilenio bus rapid-transit (BRT) system, with its dedicated bus lanes, elevated bus stations, smart-card payment, and beautiful red buses.Â These new mobility services and product concepts could profoundly change both public and private transit (see sidebar â€œSan Francisco and the economics of travelâ€). Of course, not all of these start-ups will survive, but the technology, business models, and user experiences will likely improve. To deal with this, Japan has already set up a guideline for low carbon urban development to create more compact city to minimize travel distance and then encourages walking and bicycling as means of zero emission urban mo-bility to reduce environmental burden and energy consumption of the city and its citizen. This paper studied and summa-rized the development and implementation of low carbon city concept specifically focusing on the improvement on walking and bicycling facilities in Japanese cities. Urban population in 2014. Source: UNFPA, 2014.