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The Future of Car Mobility 2014-2030: Material for a Debate on Framing Smart Mobility

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Abstract: Smart mobility, seen as car based solutions with greater fuel efficiency and shifts to cars that are essentially information technology-products, is sometimes presented as the way forward for car mobility. This article presents developments, visions and scenarios for a debate on the role and the frame of smart mobility in the future of car mobility. Sustainability and life style issues are introduced as important backgrounds. As for a majority of households smart mobility solutions are important, it can be concluded that an important minority of households is searching for other solutions than technological framed smart mobility.

Key words: Car mobility, trends, scenarios, user perspectives, sustainability.

1. Introduction

In the next two decades, car mobility in the societies in the developed world will face an interesting situation. These societies are growing towards car dependence [1]. However, also in these societies, car mobility needs to reach CO_2-targets, certainly on the longer run, that need great investments in new car technologies, conventional, electric, information technology-based. And there can arise a problem with uncertainties related to the delivery of energy for the cars, certainly seen on a world scale. Connected to these trends, two other trends can be identified: a trend towards saturation in the volume of car mobility, and other attitudes towards car mobility in the younger generations.

In this rather unclear picture, "smart mobility" is coined as a way to move forward. Smart mobility is a word with different meanings, but will here be used as standing for car based solutions, with great fuel efficiencies, and a shift towards cars that are basically information technology-based products [2]. Cars in smart mobility are able to connect to each other and are information producing elements, which could lead to automated driving solutions, to more targeted traffic management and to more clever and focused mobility.

In this article, material for the debate on the role and frame of smart mobility in the now evolving developments around car mobility will be presented.

2. State of the Art on Car Mobility

What is the situation on car mobility in the economically most developed part of the world? Where does car mobility stand in 2014? Is car mobility still growing, do we reach saturation, or are we already in a situation of "peak car"? And could trends and developments be related to the different age groups?

2.1 Growth in Car Mobility Is Slowing Down

In Europe, there are great differences in the number of cars per capita [1]. The spectrum runs from Denmark with 380 cars per 1,000 inhabitants to Italy with 580 cars per 1,000 inhabitants. Most richer EU countries have car ownership rates around 480 cars.

Most countries still have some growth in car ownership, with Finland still having rather steep growth. In three bigger countries, the United Kingdom,

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Germany and France, since 2005, no growth can be seen anymore, with a very interesting situation in Germany: Car ownership per capita fell between 2000 and 2005, and is now consequently lower than in 2000 (510 versus 490). In the US, we can see a stagnation in car ownership from 2000 onwards at the level of 810 cars per capita. Looking at the vehicle kilometers travelled, we see all richer EU countries with very slow to zero growth since 2000, with now vehicle kilometers travelled in a range of 8,500~11,500 km per capita (Fig. 1) [3].

2.2 Difference in Age Groups Related to Car Mobility Is Growing

Looking at the results on car mobility in the different age groups, interesting developments can be noticed.

In the US, from age 40, people still drive the same number of miles as they did before 2000. But the younger generation drives far less (Table 1) [4].

Similar trends are occurring in other developed countries [5].

Car ownership and car travel declined, and use of other modes increased, among German and British 20-29 year olds [6]. To present a quote of the study of Kuhnimhof et.al [6] presented at TRB (Transportation Research Board), "The overall trend is composed of the following developments: Private car availability is decreasing among young travelers. There is a significant reduction of automobile mileage in dai1y travel with increases in other modes, predominantly public transport. This is not only caused by the decline in car availability but also by the increasing multimodal behavior of car owners. Moreover, as long distance travel journeys get longer, there is also a shift from the automobile to air travel in long distance travel. Finally, men have reduced their automobile travel more significantly than women".

In the US, the younger generation appears to place less value on vehicle ownership and suburban living due a combination of high costs, improved travel options and changing preferences [7]. And Sivak and

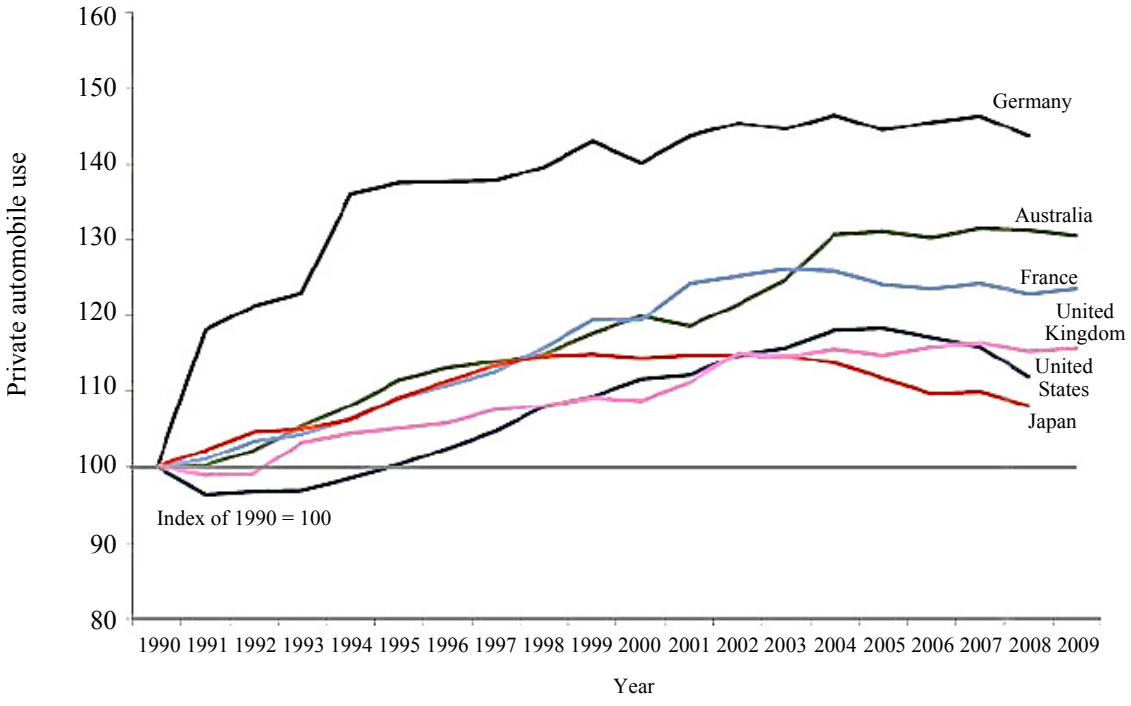

Fig. 1 Private automobile use, 1990-2009.
Source: International transport forum statistics, Goodwin [3].

Table 1 Miles travelled per age category, 2001 and 2008 in the US.

Age	Average miles in 2001	Average miles in 2008
15-19	4,200	3,800
20-24	10,300	8,200
25-29	11,800	9,500
30-34	12,000	10,000
35-39	13,300	10,800

Source: Ref. [4].

Schoettle [8] found that, controlling for other factors, increased Internet use is associated with reduced young drivers' (16~30) license rates, suggesting that telecommunications substitutes for physical travel.

2.3 A Situation of "Peak Car" Could Be Reached in the Developed World

Peak car is the situation where car mobility will not grow any further and has reached its highest point. It looks like Germany has now reached a peak car-situation already.

Levine and Jones [5] state in their report for the RAC (Royal Automobile Club) Foundation: "The aggregated traffic trends for Britain seem to show a 'peak car' phenomenon (the situation in which there is no increase over a sustained period of time (in some cases an actual decline) in average car mileage per person, even during periods of economic growth), with car use leveling off per person since the 1990s. But a closer look finds that this is limited to specific groups and areas. It does not apply to women's car travel outside London, which has shown a steady increase between July, 1995 and July, 2005. Indeed, if we just look at private car use (excluding driving in company cars), then overall car travel per person outside London continued to grow up to the start of recession, and for those residents aged over 30 was flat in London rather than showing a steady decline".

Goodwin [3] wrote an overview article on peak car. He concludes, looking at many facts and figures: "It seems to me that evidence for the full version of the peak car hypothesis—we have now passed peak car use and are on a new, firmly established, downward trend—is not yet definite. But the evidence for its full rebuttal—we are still on a long-term trend of increase with only temporary interruptions due to recession—is even less persuasive. The key element of the discussion in the last year has been that there are changing features of car use, which clearly precede the recession and simply do not fit the traditional forecasts" [3].

2.4 A Paradigm Shift in the Car Attitude of the Younger Generation Can Be Noticed

People born before 1980 grew up during the period of automobile ascendency, when vehicle design and roadway improvements provided direct user benefits, and many of the indirect costs of automobile dependency were less visible. Driving was considered exciting and fun. Most members of that generation aspired to live in automobile-oriented suburbs.

People born after 1980 tend to drive significantly less, rely more on alternative modes, and many prefer to live in more compact, multi-modal urban environments [9]. Much of the money, time and excitement that previous generations directed at their cars is directed at electronic devices for young people, including mobile telephones, computers and sound systems [8].

Consumer preferences can be difficult to measure and these trends are not universal. Certainly, many young people love their cars and are reluctant to use alternative modes, and some young people who currently drive little will probably drive more as they become more economically successful and have children.

However, available evidence indicates that consumer preferences are changing in ways that support more urban, multi-modal lifestyles, particularly for younger people, which is likely to reduce automobile travel demand and increase demand for alternative modes.

However, as a contrast to all new trends over a

longer period until now, a rather stable landscape on car mobility can be noticed: The stabilizing and destabilizing trends for the car regime are known for years already.

We can see the following stabilizing trends, responsible for the huge share of car mobility in total mobility, and for the growth in this mode until recently:

- globalization;
- the creation of the network society;
- the economic growth, resulting in prosperity.

And we can notice the following destabilizing trends, responsible for putting at least question marks at the sustainability of the domination of car mobility:

- climate change;
- the delivery situation and the related pricing situation on fossil fuels;
- the impact of information technology on car mobility.

All in all, car mobility as a system (the regime of car mobility) still looks fairly stable, at least from the outside. There are however interesting new trends.

3. Wishes and Expectations of Car Customers

Consulting firms, active in the automotive world, produced yearly state of the art reports for the business world. From reports of companies like Arthur D. Little [10], Roland Berger [11] and KPMG [12, 13], a number of trends among car customers in most developed countries can be noticed. Seven trends can be noticed:

(1) Car driving finds its budgetary frontiers. Customers feel they need to drive cheaper, need to optimize their driving costs and urge for more efficiency;

(2) Cars are more than ever seen as just commodities, not as important expressions of lifestyles;

(3) Sustainability becomes somewhat more important, especially in the younger generations. However, most households do not want to pay more;

(4) Car driving time is more and more considered as "not connected"-time, rather useless time;

(5) There is a trend towards ever greater safety in and of cars, especially with the older drivers;

(6) Owning a car becomes, for many younger, urban and households less important than having access to a car, when needed;

(7) The suburban middle classes and middle ages would like to have a broader range of IT (information technology)-services in cars.

Arthur D. Little [10] presents a division of new mobility types, which is useful in understanding these trends: greenovators (27% of car driving households), reflecting the socio-ecological consequences of mobility, with a demand for innovative and sustainable solutions; family cruisers (11%), with an increasing demand for mobility in an increasingly fragmented network of family and friends; silver drivers (24%), proactive in their third phase of life, experienced with products, high quality (and safety) awareness; high-frequency commuters (24%), with a daily life characterized by high frequency of mobility; global jet setters (2%), with global mobility requirements as a prerequisite for their jobs; sensation seekers (4%), seeing mobility as a symbol of leisure time, fun and lifestyle, status and prestige; and low-end mobility (8%), households with limited mobility budgets, a need for affordable solutions, and a willingness to downgrade mobility.

From the analysis and with the trends and this division in mind, three "poles in future car mobility" could be identified:

(1) A first pole would be around the older drivers. Older households will remain driving and they mostly have budgets available. We know from Motivaction [14] studies in the Netherlands that older drivers have an inclination towards buying new cars. They seem to be keener on safety than on information technology-services, as they drive more outside the congestion periods. This pole centers on the silver

drivers, and contains some 25% of car driving households;

(2) A second pole would be around the middle aged drivers. Most middle aged drivers have families and a need for mobility in increasingly fragmented networks. Many of them will be commuters. They have a wish for clever, flexible cars. And in most of these households, two cars will be the standard. They have to be careful for budgetary consequences. Sustainability is not that important for them, but these households like to have services on board that make their frequent car travel easier and more reliable and predictable. This pole centers on high-frequency commuters and on the family cruisers, and contains of some 40% of car driving households;

(3) And a third pole would be around younger drivers. These drivers have grown up in the Internet age. Driving time for them is often seen as "not-connected time", and they support innovative and sustainable solutions for car driving. Cars are seen by many younger drivers as just commodities, and not any longer as special products. They need cars, but they do not need, and certainly not in all households, cars of their own. Cars should not cost that much, not all services possible are needed, cars just have to bring you somewhere when public transport, where you can be connected, which fails to deliver the service. This pole centers on the greenovators, and contains some 25% of car driving households.

There is a danger of over-systematization of the three poles. Note the situation that at least 10% of car driving households will not fit in these poles, and that, in most western European countries, some 20% of all households are car-less.

For producers of cars, a number of elements should be guiding on the western European car markets:

- There will be a stabilization in car purchases in the years to come;
- There is a more differentiated market for cars growing (the three poles);
- There is a need to produce cheaper, stripped, but more sustainable cars;
- Downsizing prices with higher performance on sustainability issues is asked.

Car producers have to rethink their strategy. Are they primarily:

- product focused manufacturers?
- service focused manufacturers?
- basic mobility providers?
- mobility services providers?

It seems necessary to adapt to new markets, to look at the chains in car mobility, and to organize partner networks with providers of information technology—industries and mobility services.

Especially, the new situation of three different futures on car mobility, related to the three poles, asks for rethinking the producers' positioning and market strategies. This rethinking is now taking place and forms a background for investments in smart mobility.

4. Sustainability and Oil: Framing the Future or Just One Aspect?

One of the great challenges in the future of car mobility is sustainability, meaning here the complex of climate change, reaching more sustainable cars, and using less fossils fuels. There seems to be no consensus on the role of sustainability and fossil fuel development in shaping and framing future car mobility.

To present a spectrum, Arthur D. Little sees the rising of the greenovator, willing to pay a little bit extra for sustainability, and asking for low weight and stripped cars. Arthur D. Little also notes a development towards a greener economy.

Shell Germany [15] presented two scenarios to reach CO_2-targets. The common denominator in these scenarios is that targets will not be reached completely and that it will take a long time, until after 2030, to come near to these targets. This is due to the situation in western Europe that the turnover rate of the car park is long, some 16~17 years.

Even in the US, the turnover rate is a critical factor:

"Over the last decades, one striking feature of the household vehicle fleet is the increase in the number of years an average vehicle is operated. In 1977, about one out of six vehicles were 10 years old or older and automobiles averaged 6.4 years of age. In 2009, vehicles averaged 9.6 years of age—a 50% increase of 3.2 years and nearly two out of five cars were in the old stage category" [7].

In *Automobility in Transition* [16], the authors note that policy makers hope for technical solutions on fossil fuels and sustainability. These authors frame the ever present enthusiasm for greener power trains (fuel cells, hybrids and electricity) as a successive hype pattern and state that the notion of sustainable mobility is much weaker than the notion of sustainable energy.

The consulting firm Roland Berger [11] sees a growth in environmental awareness, translated in a need to create higher efficiency levels in using fuels. And in the Global Automotive Executive Search 2012 of KPMG [12], this fuel efficiency is, together with environmental issues, considered to be the top priority of car customers. KPMG notes a rather slow perspective for full electric cars, not reaching higher levels than 15% at 2025.

In the Europe wide EU Trans Visions study [17], targets are formulated that can be reached when policy makers take their full responsibility. A target of 58% CO_2 reduction from passenger cars in 2050 (compared to 1995) can be reached with a combination of fuel efficiency, speed reduction, introducing pricing policies and selective road investments. Trans Tools mention four possible scenarios on reaching sustainable mobility: a hypermobility scenario, a constraints scenario, a decoupled scenario (with decoupling of driving kilometers and environmental damage), and a scenario focused on reduced mobility.

More academic articles relate to this range in options and visions.

The objective of CO_2 reduction in a range from 60%~80% reduction (from the levels of 1995/2000) creates enthusiasm among transport researchers in different countries. Scenarios for reaching this challenging objective for transport are being designed. In this section, a short introduction to the spectrum of considerations and views will be given [1, 18].

Sperling [19] from the Institute of Transport Studies of the University of California presented in a keynote lecture in November 2010 his *Steps into Postfossil Mobility*. His comprehensive plan consists of measures in three so called arenas: Vehicles must become far more energy efficient; The carbon content of fuels must be greatly reduced; Consumers and travelers must behave in more eco-friendly manners. Sperling considers this last arena the most difficult one: "Cars are firmly entrenched in our culture and modern way of life. Reducing inefficient car dependent vehicle travel requires reforming monopolistic transit agencies, anachronistic land use controls, distorted taxing policies, and the mindset of millions of drivers who have been conditioned to reflexively in the car every morning" [19].

Sperling designs and defines a specific set of measures but warns for each arena: "Achieving a 50% to 80% net reduction in greenhouse gas emissions is not something that businesses, consumers and politicians can fully imagine. Life after cheap oil evokes images of crises to come. There is no escaping that there will be winners and losers, but strong leadership and good policy can ease the transition" [19].

In the United Kingdom, Buchan [20] prepared a report *A Low Carbon Policy for the UK*. His conclusion is: "Policies which produce more efficient patterns of travel will be needed alongside those for improving fuel consumption both in the medium and the long terms, and that they need to be implemented as a matter of urgency". There is a need for land use regulation, for behavioral change, with specific initiatives on shopping, the school run, work and leisure, walking and cycling, speed limits in car traffic, and on taxes.

The same line of thinking could be noticed in Sweden. Akerman and Hojer [21] published in 2005 *How Much Transport Can the Climate Stand—Sweden on a Sustainable Path Towards 2050*. The conclusion of their study is: "A development towards sustainable transport requires significant changes in the organization of daily activities and daily travel". To reach the objectives, total car travel volumes have to be cut strongly, more in urban areas and less in the rural areas.

For France, Lopez-Ruiz and Crozet [22] have prepared three quantitative scenarios in "*Sustainable Transport in France: Is a 75% Reduction in CO_2 Emissions Possible?*". In each of the three scenarios, a 50% reduction will be possible by 2050. However, it will be more difficult to achieve in Pegasus, a scenario promoting individual travel with strict technology standard. The other two scenarios create better results. In Chronos, constraints on speed are introduced, and green multi-modality is promoted. And in Hestia, the relationship between physical planning and transport is elaborated: Increase in densities is a key element, and the decoupling of transport activities and economic growth is promoted. Going further than the 50% would require very big advances in zero emission vehicles. To cite Crozet, "Au total, les grandes tendences dans les prochaines annees se resument ainsi: moins vite (en ville et sur la route), plus cher et plus concurrentiel" [22] (In total, the big trends in the coming years are: less speed (in the city and on the highway), more expensive, and more in concurrence with other modes (translation by author).

Moriarty and Honerty [23] clarify the challenges, climate change and oil depletion. Then, they analyze all the offered solutions—fuel efficiency, use of alternative fuels, and sustainable public transport. Confronting the challenges with the solutions, they find gaps. In their opinion, it will not be possible to find technical solutions for the two challenges. At best, a 2.5 times higher fuel efficiency can be reached, and this result could be offset with higher fuel costs and with lower car occupancy rates. And electricity in car mobility will find its boundaries in the non-availability of enough carbon neutral renewable energy to derive electricity from. From their analysis, they end with a far reaching conclusion: "…vehicle travel levels will need to be reduced threefold or even more, depending on population growth..." [23].

From the spectrum of views and visions, a few generic conclusions can be drawn:

- Sustainability is considered a great issue for the future;
- However, although there is a willingness towards taking sustainability into account, most car driving households do not want to pay much more for sustainability;
- Most authors expect rather long time periods (25 years plus) before car mobility will be sustainable;
- The possible perspective on fossil fuels with problems of scarcity, delivery and very high prices plays only a minor role in the actual societal and professional debates on car mobility;
- Much is expected from behavioral change of the younger generations;
- Much is also put in the hands of the policy makers: Their leadership should in some way lead to speeding up in reaching sustainable mobility.

To finalize, it seems that, on sustainability in relation to car mobility, a non-stable situation has to be faced. Sustainability issues are noticed, but are not met with clear focus, clever objectives and strong policies.

5. A World of Scenarios

A rather great number of scenarios on car mobility can be found. Transition is a key element in most of these scenarios. Three elements are central in the vocabulary of transition management: the landscape (important developing trends), the regime and the niches. Landscape elements related to car mobility were already introduced in the end of Section 2. The regime on car mobility, which can be seen as the

complete system of regulations, rules, laws, byelaws, institutions, which is now dominant, is still fairly stable.

Upcoming new areas that can be noticed are:

- cultural and socio-spatial changes, mostly related to urban mobility;
- user innovations related to information technology in cars (near to the regime);
- demand management and mobility management;
- intelligent transport systems and next generation traffic management (near to the regime);
- green power trains.

Also, a number of cracks are identified. Cracks in a system/regime are potential hick-ups, potential problem—creators for the stability of that system/regime.

Cracks on car mobility are:

- lack of physical capacity and congestion;
- changing perception of cars, from lifestyles to just commodities;
- diminishing growth on car ownership and car use;
- problems with the delivery of fossil fuels;
- changing attitudes of major policy makers.

In *Automobility in Transition* [16], three possible scenarios are introduced:

(1) The first scenario contains greening car mobility, using smart grids and well-defined ITS (intelligent transportation systems) solutions. This is a rather technology oriented scenario, near to smart mobility;

(2) The second scenario is on creating multimodal transport services, redefining the car, from ownership to flexibility in use, and using the urban fabric in clever ways. This more urban mobility focused scenario is more societal based;

(3) The last scenario is continuing "business as usual", resulting in a spectrum of IT ideas and solutions in cars, and at the same time rather difficult future fuel deliveries.

The scenarios of Terlouw [24] are in the same range. He identifies: technology taken over, more or less comparable with the first scenario; conscious customer, more or less comparable with the second scenario; and exploiting conventional technologies, more or less comparable with the last scenario.

Roland Berger [11] also arrives at three scenarios: High tech is about clever cars with all IT-equipment; The budget scenario is about low cost cars, stripped cars and car sharing; Sustainability scenario is about introducing the whole spectrum of green technology.

It can be noted that scenarios "high tech" and "sustainability" seem to fit into the technology oriented scenario, while the "budget" scenario fits in the societal based scenario.

In general, three basic scenarios can be made from now on for the future of car mobility:

(1) A technology focused scenario: information technology, intelligent transport systems, smart grids and a full range of technical sustainability measures (focus on cars);

(2) A societal focused scenario: small cars, stripped cars, car sharing, relating to other modes, less focus on new information technologies (focus on multimodality);

(3) Business as usual: incremental changes, mostly related to sustainability and IT-services, no plan available.

In the United Kingdom, the Office of Science and Technology [25] commissioned, as part of its foresight program, a project on intelligent infrastructure systems.

In this project, four scenarios towards 2055 were developed [25]. Two axes of uncertainty were central in the design of the four scenarios: The first was whether we will develop transport systems with low environmental impact; the second was whether people will accept intelligent infrastructure (elements of driving being taken-over).

Basically, there are two success and two failing scenarios. The two failing scenarios are tribal trading (which describes a world that has gone through a sharp and savage energy shock with long distance

travel being a luxury) and good intention (wherein the market failed completely, and government has taken over to reduce carbon emissions, with a "big brother is watching you" attitude).

The two success scenarios are more interesting. The first is perpetual motion, which looks comparable to the alternative Shell Germany scenario. It describes a society driven by constant information, consumption and competition. Demand for travel remains strong, new, and cleaner fuel technologies are increasingly popular. Road use is causing less damage. Urry calls this scenario: "…essentially a version of what has been termed 'business as usual' or 'hypermobility'" [25]. It is however unclear how much CO_2 can be reduced in this scenario. There is also no attention for carless households or for fossil fuel delivery aspects.

The second scenario is urban colonies. In this scenario, investment in technology is primarily focused on minimizing environmental impact. Good environmental practice is in the heart of mobility policy: sustainable buildings, distributed power generation and new urban planning policies have created compact and dense cities. Transport is permitted only if green and clean: car use is still energy intensive and is restricted. Urry considers this scenario attractive, however, he makes a very interesting point: "How would this scenario come about? It is difficult to see its emergence as being a linear development from existing patterns or something that governments could simply introduce…There would be some kind of 'shock' to the system and this would almost certainly be a 'global' shock that provides a 'tipping point', a little akin to the global shock of 9-11…a global shock that is understood worldwide as a threat to the pattern of 'business as usual'" [25].

6. Framing Smart Mobility

There is a market for smart mobility, framed as making cars smarter, cleaner and safer. The search is for the most intelligent cars, and for a productive and efficient traffic network, which will have these intelligent cars as a basis. Smart planning and communication for the use of this network are also essential. Especially in households with persons aged between 40 and 60, there seems to be enthusiasm for this development. Smart mobility is, as mostly defined, in the sphere of the technology scenarios. And it is not about mobility in the broad perspective, but about cars. As noticed in Section 2, probably some 40% to 45% of households with cars see this route to smart mobility as their favorite route towards the future of mobility.

Near to this middle aged households is probably the position of most older car owning households. For them, not all IT services are necessary or useful (e.g., congestion information, as older households drive not much in rush hours). Safety and possibly sustainability are seen as more important, but they can, certainly for a part, be persuaded to buy smart mobile cars. Some 25% of households with cars belong to this group.

The situation is different for two other groups:

(1) At first, for the carless households, some 20% of all households, for them, smart mobility as defined is a no-go area. Car solutions are not useful for them. They define sustainable mobility along other frames;

(2) And secondly, for the mostly younger households with cars, in customers wishes and in the scenarios for these households, a route towards smaller cars, stripped cars and low-budget cars, delivering basic mobility, could be identified. Ownership is less important than use and there seems to be a real need for car sharing and multimodal mobility services. This group is about 30% to 35% of the households with cars.

Combining the elements, we see the following picture arising:

- 20% car less households;
- 25% households aiming at basic car mobility (societal scenarios) (focus on younger people);

- 35% households in favor of technology solutions with a focus on smart mobility (focus on the middle aged);
- 20% households in favor of technology solutions with a focus on safety (focus on the elderly).

There is probably an interest of somewhat above 50% of all households for solutions in the area of technological defined smart mobility. The smaller half of all households seems to initially favor other solutions and is probably not yet willing to invest in smart solutions as defined**.**

To give this conclusion more background, it could be useful to identify why many IT based services are facing skepticism of a part of the car customers. In *Automobility in Transition* [16, 26], a number of reasons are given:

- too little involvement of the car users;
- too much focus on technical learning;
- too much already focused solutions;
- too much technological push;
- experiments dominated by the status quo.

KPMG [13] notices in *Self Driving Cars* the need for discussing technical adoption strategies. To quote, “It is 2022, and autonomous vehicle technology is fully developed within reach of most vehicle owners. Interest is high: The technology appeals to the usual technophiles, but many people are still on the fence”.

Some 50% of all households and some 60% of driving households will pick up smart mobility, the other 40%~50% will probably be still on the fence, or even further away. KPMG introduces three adoption scenarios: aggressive, base case and conservative. In the conservative scenario, the adoption level never reaches the critical mass needed to make smart technology the driver for car mobility in the future. When too many car driving households are not planning to invest in smart IT cars, the paradigm shift on car driving and car mobility will fail, the self steering perspectives and automated driving will not be introduced completely, thus leaving smart mobility as a useful package for many car drivers, but not as the solution for safe, reliable, connected mobility.

Smart mobility as the solution on car mobility can thus face problems of acceptance. In this respect, two basic different strategic attitudes are possible:

(1) To remain defining smart mobility as technology and create smart mobility solutions. These solutions will show car driving households the great advantages. The last 20% of car driving households just have to buy and introduce the technology, or will be unable to drive any longer (compare with Internet banking versus paper banking work);

(2) To define smart mobility broader as a bundle of solutions for mobility (not only car mobility, but also the slow modes and public transport) and take into account the wishes of many car customers for only basic car mobility with simple cars, develop a strategy towards multimodality, arrange and frame smart mobility into the broader search for sustainable mobility.

From the evidence presented here, Option (2) could be taken more serious. And an extra element could be introduced. At the moment, the relationship between the world of smart mobility solutions and the world of sustainable mobility is still rather weak. What, for example, is the relationship between reaching CO_2 targets of minus 60%~80% (2050 compared to 1995) and the smart mobility technology work? What can smart mobility deliver here? And what is the storyline from the smart mobility perspective towards the trends identified in this paper under the heading: younger generations, only basic car mobility, cheap, cost-effective car mobility, and multimodality and car sharing solutions ?

7. Conclusions: The Situation of Car Mobility from 2014 Onwards

Some conclusions could be drawn from this study:

- The greater picture on car mobility still looks rather stable: The regime still stands and most landscape developments are already known for a longer time;

- There are a few already well-known cracks in the system like congestion, while a big possible crack such as the delivery perspectives of fossil fuels does not get much attention in societal debates on car mobility;
- There seems to be a saturation in car mobility in the most developed countries on its way;
- Underneath this stability, two paradigmatic, but paradigmatic different, routes for the future of car mobility can be noted: a technology based route and a societal based route;
- Policy focus and investments are now concentrated on the technology based route, while a rather huge minority of customers certainly see a need or have a wish for the other route and already act accordingly;
- In a second analysis, the picture on car mobility looks less stable than on the first sight. No clear and broadly accepted strategies on car mobility for the future, relating to and using both routes, are being prepared.

References

[1] Jeekel, H. 2013. *The Car-Dependent Society: A European Perspective.* Farnham: Ashgate.

[2] Smart Mobility. 2014. "Driven by Technology." Smart Mobility. Accessed March 17, 2014. https://www.tue.nl/onderzoek/strategic-area-smart-mobility/over-smart-mobility/.

[3] Goodwin, P. 2012. "Three Views on Peak Car." *World Transport, Policy & Practice* 17: 8-17.

[4] Litman, T. 2015. *The Future Isn't What It Used To Be: Changing Trends and their Implications for Transport Planning.* Victoria: Victoria Transport Policy Institute.

[5] LeVine, S., and Jones, P. 2012. *On the Move.* A report of RAC Foundation.

[6] Kuhnimhof, T., Buehler, M., and Dargay, J. 2011. "A New Generation: Travel Trends among Young Britons and Germans." *TRB Journal* 2230: 58-67.

[7] Santos, A., McGuckin, N., Nakamoto, H. Y., Gray, D., and Liss, S. 2011. *Summary of Travel Trends. 2009 National Household Travel Survey.* US: Federal Highway Administration.

[8] Sivak, M., and Schoette, B. 2012. "Recent Changes in Age Composition of Drivers in 15 Countries." *Traffic Injury Prevention* 13 (2): 126-32.

[9] Davis, B., and Dutzik, T. 2012. *Transportation and the New Generation: Why Young People Are Driving Less and What It Means for Transportation Policy.* USA: Frontier Group, US PIRG Education Fund.

[10] Arthur D. Little. 2012. *The Future of Mobility 2020. The Automotive Industry in Upheaval?.* Boston: Arthur D. Little.

[11] Roland Berger Consultants. 2011. *Automotive landscape 2025. Opportunities and Challenges Ahead.* Amsterdam: Roland Berger Consultants.

[12] KPMG. 2012. *KPMG's Global Automotive Executive Survey 2012.* Amsterdam: KPMG.

[13] KPMG. 2012. *Self Driving Cars: The Next Revolution.* Amsterdam: KPMG.

[14] Motivaction. 2002. *Perceptions of Mobility and Mobility Profiles of the Dutch population.* Amsterdam: Motivaction. (in Dutch)

[15] Shell Deutschland. 2009. *Shell Scenarios for Passenger Cars until 2030: Facts, Trends and Handling Perspectives for Sustainable Car Mobility.* Germany: Shell Deutschland. (in German)

[16] Lyons, G., Jain, J., Mitchell, V., and May, A. 2012. "The Emergent Role of User Innovation in Reshaping Traveler Information Services." In *Automobility in Transition,* edited by Geels, F., Kemp, R., Dudley, G., and Lyons, G. New York: Routledge, 268-85.

[17] Transvisions. 2012. "Project for DG TREN." Transvisions. Accessed January 1, 2013. http://www.mcrit.com/transvisions.

[18] Kohler, J. 2006. "Transport and the Environment: Policy and Economic Considerations." In *UK Foresight Intelligent Infrastructure Systems Project,* Project report.

[19] Sperling, D. 2010. *Steps into Postfossil Mobility: A Vision and Policy Plan for Sustainable Transportation.* Keynote lecture.

[20] Buchan, K. 2008. *A Low Carbon Transport Policy for the UK, Phase 2.* Final report. Accessed March 22, 2014. http://www.transportclimate.org.

[21] Akerman, J., and Hojer, M. 2005. "How Much Transport Can the Climate Stand?—Sweden on a Sustainable Path in 2050." *Energy Policy* 34: 1944-55.

[22] Lopez-Ruiz, H., and Crozet, Y. 2010. "Sustainable Transport in France: Is a 75% Reduction in CO_2 Emissions Possible?." *Transportation Research Record* 2163: 124-32.

[23] Moriarty, P., and Honnery, D. 2009. "Australian Car Travel: An Uncertain Future." Presented at 30th Australasian Transport Research Forum, Melbourne.

[24] Terlouw, J. 2007. "Sustainability: Exploring the Road Ahead for Car Mobility." Master thesis, University of Twente.

[25] Foresight. 2007. *Intelligent Infrastructure Futures—Scenarios toward 2055—Perspective and Process.* London: Office of Science and Technology

[26] Geels, F. W., Kemp, R., Dudley, G., and Lyons, G. 2012. *Automobility in Transition. A Socio-Technical Analysis of Sustainable Transport.* New York: Routledge.