CHAPTER 15

Challenges and Approaches for Smart Innovative Transport System Replication

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Introduction

The environment changes are highly met worldwide, especially inside very crowded urban cities and metropolitan zones. Urban cities with high levels of visitors are subject for the environmental changes in addition to the committed resources to fulfill all the potential activities. The environmental changes apply to several societal levels, depending on the involvement of each in the wellbeing definition. While more citizens will come to urban areas, the environmental changes will change accordingly with their life styles. Urban cities all around the globe have to be prepared for massive changes in terms of sustainable development.

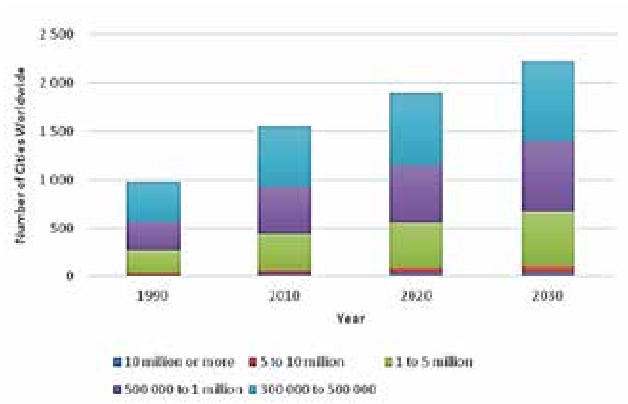
Improving technological level will bring cities to new eras in terms of involving citizens in daily activities. By implementing new innovative life styles, the cities will have different growth and development. The already powerful links created between environment, social and economy are bringing together the bearable, viable and equitable solutions for a better living by introducing new innovative technologies. Several development directions are being followed by many urban cities, having at least one main common objective: to transform the current urban city to an eco-urban-city. The latter refers to a sustainable city designed and implemented as an environmental friendly solution to the inhabitants of urban cities who face several problems regarding emissions, noise and no green areas, with high energy consumption, low level on recycling, low level to regenerate energy, wasting water and natural resources, amongst other scenarios.

Making everybody understand the eco-green city requirement and its importance and the ways to achieve it represents one major objective for the new urban cities. The cities have to be prepared for the future, have to be optimised and configured to achieve the improved livability and social inclusion. More than 66% of the world population will be living in urban areas by 2020 (Croitorescu and Ruichek, 2015) while by 2050, it is expected that nearly 70% of the world's population will live in urban areas (UN-HABITAT, 2012).

More cities are expected to appear and to the number of cities may be of 1/3 higher comparing 2010 when 1551 cities (UN, 2014) were declared worldwide to 2030 when more than 2000 cities are expected to be declared (Moir, Moonen & Clark, 2014). Figure 1 (Moir et al, 2014) presents the perspective of the number of cities from 1990 to 2030, for different population sizes.

Projections show that urbanization combined with the overall growth of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 percent of the increase concentrated in Asia and Africa, according to a new United Nations (UN) report (UN, 2014). Currently, the urban population live in cities with less than 500,000 inhabitants, confirming that the people will continue to live in smaller cities rather than in bigger ones. The United Nations said that urbanization is now "unstoppable". In 2010, Anna Tibaijuka, outgoing director of UN-Habitat at that time, said: "Just over half the world now lives in cities but by 2050, over 70% of the world will be urban dwellers. By then, only 14% of people in rich countries will live outside cities, and 33% in poor countries." (UN, 2010). In the same year, Eduardo Lopez Moreno, co-author of the UN 2014 report, said: "Most of the wealth in rural areas already comes from people in urban areas sending money back", referring to the migration to cities, while making economic sense that is affecting the rural economy too (The Guardian, 2010).

Figure 1. Global number of cities 2030 horizon



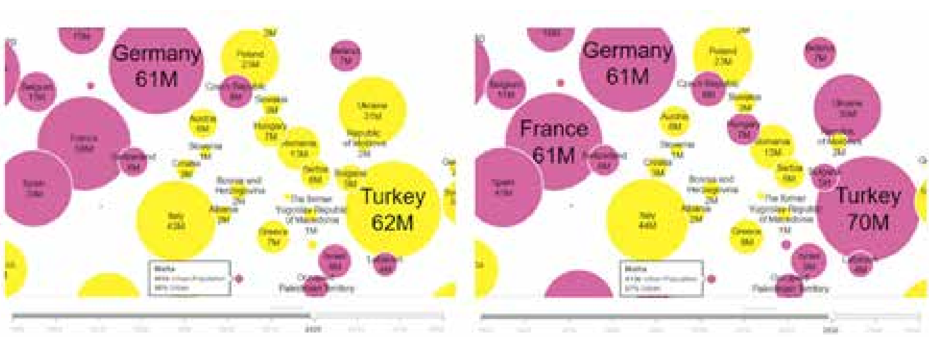
Source: (Moir et al, 2014)

Cities are pushing beyond their limits and are merging into new massive conurbations known as `mega-regions`, which are linked both physically and economically. Their expansion drives economic growth but also leads to urban sprawl, rising inequalities and urban unrest (The Guardian, 2010).

According to Global Health Observatory (GHO) data, the urban population in 2014 accounted for 54% of the total global population, up from 34% in 1960, and continues to grow. The urban population growth, in absolute numbers, is concentrated in the less developed regions of the world. It is estimated that by 2017, even in less developed countries, a majority of people will be living in urban areas (WHO, 2016). According to World Health Organization, the global urban population is expected to grow approximately 1.84% per year between 2015 and 2020, 1.63% per year between 2020 and 2025, and 1.44% per year between 2025 and 2030 (WHO, 2016).

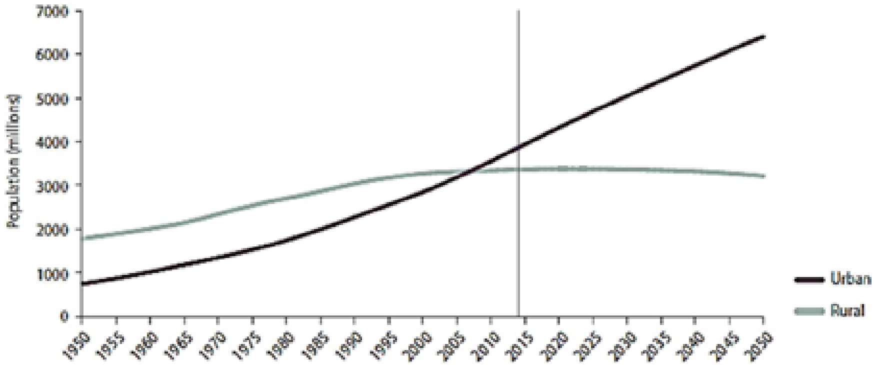
UNICEF (United Nations Children's Fund works for children's rights, survival, development and protection) presented the urban maps as annual graphics from 1960 to 2050 that depicts countries and territories with 2050 urban populations exceeding 100 000 (UNICEF 1, 2012). Circles are scaled in proportion to urban population size. For each country different percentage of people living in cities and towns are presented in addition to the size of their urban population (in millions). Visible growth are seen for most of the countries regarding the expectations for 2020 and 2030 and more (figure 2). Globally, rural populations expected to decrease as urban populations continue to grow (UN, 2015), because more people live in urban areas than in rural areas. The reverse of the global rural-urban population distribution was presented in (UN, 2015), while the data confirms that in 2007, for the first time in history, the global urban population exceeded the global rural population, and the world population has remained predominantly urban thereafter (Figure 3).

Figure 2. The UNICEF perspectives regarding urban population growth, 2020 and 2030 expectations



Source: (UNICEF 1, 2012)

Figure 3. Urban and rural population evolution in the world, 1950-2050



Source: (UN, 2015)

Together with the continuous evolutions, including cities from the low and middle-income countries, the urban cities need new urban design, planning and management for all the activities inside (including transport). The planning for climate change is mandatory, in terms of strategic decision-making processes that incorporates urban objectives to help determine the priorities and allocate the needed resources.

Mobility is fundamental to all societies, being the supporting part for economy, travelling, industry and agriculture. The urban cities have to reduce greenhouse gasses used in energy systems (energy used for transportation) by implementing leading challenges (means of transport that not depend on fossil fuels).

The world greenhouse gas emissions include the 15% emission corresponding to the transport sector, being part of the 76% CO2 emissions (second half of 2010), as results of burning fossil fuels. Natural indicators are able to be used to determine the clear, quantifiable measure for an objective as the volume of greenhouse gasses generated by transport sector are.

The transport sector is typically responsible for about a quarter of the energy-related greenhouse gas production (Figure 4) and private cars account for a significant proportion of this activity (Ingram et al, 2014). Several EU targets have been set to reduce the environmental impacts of transport in Europe, including its greenhouse gas emissions. The transport sector's targets are part of the EU's overall goal to reduce greenhouse gas emission by 80-95% by 2050.

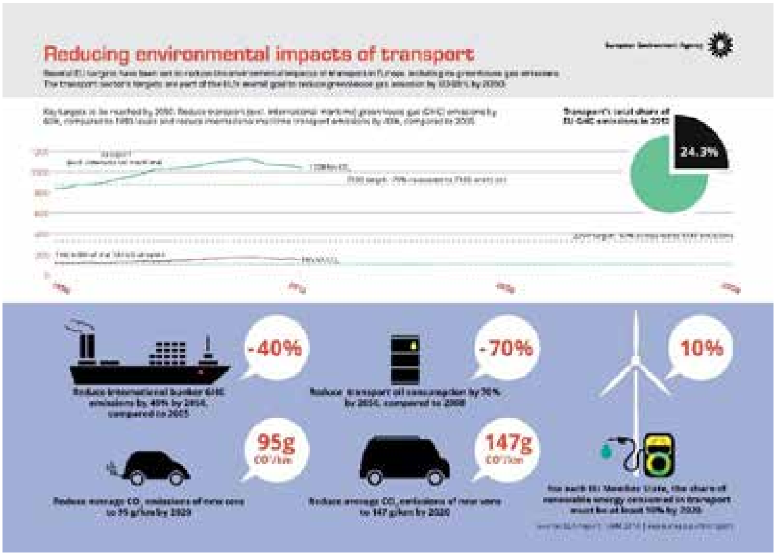
According to the Impact Assessment SEC(2011) 358 of the European Commission, without efficient steps towards sustainable mobility the CO2 emissions from transport would remain one third higher than their 1990 level by 2050. According to the "White Paper on Transport", one of the requirements is to achieve a reduction of the greenhouse gas emission with at least 60 % by 2050 in the transport sector of the European Union (EU) with respect to 1990.

Private cars have a significant role for this percentage as well as light freight road vehicles. As car ownership rates climb in developing countries and urban development continues to spread, further separating the distances between the places people live, work and shop, the greenhouse gas emissions associated with this travel will continue to rise (Ingram et al, 2014). Developing countries met stringent problems by private cars usage even for very short distances in urban environment, being in charge with high quantities of harmful emissions and noise when unnecessary, in addition to traffic congestion and areas vulnerable to climate changes. Planners can help mitigate greenhouse gas emissions by working to reduce vehicle miles travelled and urban congestion through strategies such as compact, high density, mixed-use development (Ingram et al, 2014).

Strategically planned development can also direct development to areas less vulnerable to climate change impacts. The renewable energy in transport represent a well set target unavailable to be met by the last years. Although, the sustainability criteria is representative for reducing environmental impacts from transport. The urban transport has an important role in urban development on several levels. By improving the transport network, the urban traffic congestion will decrease, while implementing new greener modes of transport (public transport, bus transport, cycling, walking etc.) represent the ways in reducing greenhouse gas emissions (Figure 5).

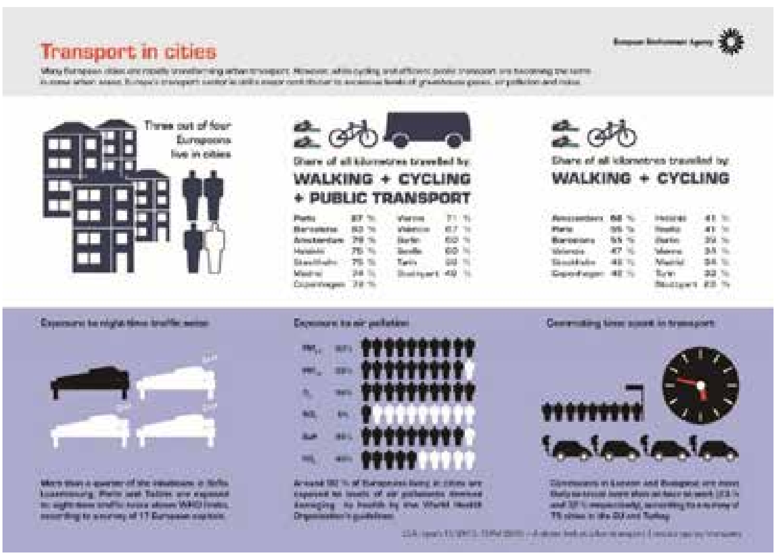
Changing the means of transport in urban cities is a needed reality for increasing the quality of life for the three quarters of Europeans living in cities. As road transport is known as the major pollution source in cities, both by the emissions and by the noise people are exposed also during night, and the private cars are still very often used, many urban cities are trying to encourage people to use public transport, especially the non-motorised modes of transport, while simultaneously restricting the usage of private cars in different areas. Urban city cars should be environmental-friendly and to make the transport more pleasant, with less time spending in traffic. Not only do the infrastructure and the means of transport need improvement but also the people perception need to be adapted to the new era, an innovative new life and with great contribution to wellbeing. The air pollution coming from road transport in urban cities expose many citizens to emissions with high impact on human health.

Figure 4. Reducing environmental impacts of transport



Source: (EEA, 2016a)

Figure 5. A closer look at urban transport



Source: (EEA, 2016b)

Urban cities employ different means of transport, depending on their available infrastructure (water transport, road private cars transport, bus and tram and metro transport, cycling, walking and transport independent lifestyle etc.) and their transport defined zones. Significant effort should be done for organising transport in restricted and protected areas, as well as inside inaccessible areas for everybody. These efforts will bring undoubtedly improvements to the life quality. In addition to the transport infrastructure improvements, the new innovative solutions for the means of transport have their important roles. New green vehicles have to be introduced, being able to regenerate part of the energy while operating, with high energy efficiency, high level of recyclability and low-carbon used materials and low-carbon emissions. Sustainable electric mobility needs to be tackled on all major urban areas, supporting also the cities both for becoming smart and innovative and citizens friendly. Safety is a prior task for all the transport solutions, therefore futuristic tasks are taken into account, one of them being the autonomous driving that comes to fulfill this requirement.

During recent years, the road vehicles became more efficient and met all the exposed targets regarding the emissions and the energy efficiency. Well debated subjects for road transport emissions come from the different driving cycles, because there are some differences between real-world driving emissions and the emissions recorded in the test cycle. The future approaches to determine the real emissions are being introduced to legislation and testing procedures, so international standard tests may be available soon.

Sustainable Mobility

Sustainable mobility in Europe is defined by the European Commission by taking action on urban transport through various policies and funding of projects including CIVITAS. The 2009 Action Plan on Urban Mobility was a major step for European action in this area and its implementation is helping to create cleaner and better urban transport systems. The European Commission's guiding document on transport from 2011, the White Paper on Transport, highlights the importance of the urban dimension. Among other actions is the target to phase out the use of conventionally-fueled vehicles in cities by 2050. In addition after the 2011 Transport White Paper, the European Commission came up in 2013 with an Urban Mobility Package that addresses different initiatives (Civitas, 2013).

Urban mobility seems to be reported to the number of inhabitants and the facing problems caused by transport and traffic. The noise and the harmful emissions reduction, together with the fair prices for transport and to the transport minimum impact on ecosystems represent solutions to be achieved. Daily, several obstacles are met while trying to adopt solutions in order to reduce traffic. In addition, the green vehicle solutions are also facing difficulties in being used because of the charging infrastructure availability. A major challenge is to enhance mobility in the same time while reducing emissions, reducing congestion and increasing safety and security.

The sustainable transport have to allow the basic access and development to the needs of individuals and to design a safer infrastructure, while affordable, efficient and less polluting transportation systems. The sustainable transport have to address social, environmental and climate issues and to assure their impact by using solutions for the vehicles, for the infrastructure and for the source of energy used for transport. The transportation system effectiveness represents the way on how to measure sustainable transport. Based on it, the needed solutions for improvement take into account the short-term activities by controlling vehicles' emissions and reducing fuel consumption and the long-term activities by replacing the conventional vehicles' powertrains with alternative powertrains (hybrid and/or electric and/or using less polluting fuels).

Transport systems are the major emitters of greenhouse gases inside cities. From an automotive perception, by introducing green vehicles, the intention is to have less environmental impact than using conventional vehicles, while assuring safe, secure and pleasure to use. The green vehicles include hybrid vehicles, having at least two different energy storage devices, the electric vehicles that are using only electricity for propulsion and as a back-up may use small internal combustion engines as range extenders, and the vehicles that are using only cleaner fuels as for example the compressed natural gas (CNG) (methane stored at high pressure), bio-ethanol, bio-diesel or hydrogen.

A sustainable mobility city have to be shaped by its transport systems and how it is marketed to the citizens by convincing them to adopt the public transport systems than the public cars and, where possible, to adopt cycling, walking and car-sharing. The policies have a great impact at cities level. The geographic region is defining the available solutions and linking possibilities to the climate protection legislation. Transport plans differs from one city to another, but in addition to improving the roads and the parking lots, the main tasks have to identify and improve the transport networks for a better climate protection and to prioritize the transportation connections for vulnerable groups.

The European Commission adopted the Green Paper "Towards a new culture for urban mobility" on 25 September 2007 (ECGP, 2007). With the Green Paper, the Commission set a new European agenda for urban mobility, while respecting the responsibilities of local, regional and national authorities in this field. The Commission intended to facilitate the search for solutions by, for example, sharing best practice. One referred task is the congestion problem and how to mitigate its reduction. The private cars alternatives have to be attractive and easier to apply by rapidly changing the modes and the means of transport for the best routes. A derivative disputed subject from the congestion problem is the parking places availability inside urban city centers, solutions to be applied for it being the parking places outside the city centers, carpooling and car-sharing, in addition to the efficient public transport and freight transport using green vehicles.

Recent trends to introduce greener vehicles are well demonstrated by oil price changes and the already available technological innovations. Sustainable mobility must also support a good economy. The urban cities already used different mobility solutions that need to be updated and improved, in order to increase their competitiveness. The proposed solutions for better urban cities are based on the two innovative areas of vehicle development: electrification and autonomous driving. The urban cities have to test a set of applications that are based on these two technological fields and to evaluate their efficiency with respect to the aspects of sustainable mobility that were mentioned.

Challenging Technologies for Innovative Mobility Solutions

Vehicles Electrification Mobility Influences

The electrification of vehicles and autonomous driving are two key elements that will revolutionize the mobility of the future whilst providing various options to address and implement the main aspects of sustainability. Cities all around Europe must be well-prepared for the changes that will be initiated by these two fast developing technological fields in order to gain a maximum benefit towards sustainable mobility.

Electrification and autonomous driving are part of the measures to be adjusted to the rapidly developing technologies. Electric vehicles development plays an important role for all global car-manufacturers since this is a key-technology to reach the goals of CO2 reduction. Both hybrid and electric vehicles are already available for commercial use. However, research and new developments in these fields are necessary to make electric vehicles more efficient and affordable, in addition to the charging infrastructure availability, and to the continuous upgrade of the intelligent communication networks between vehicles and between vehicles and infrastructure.

The ultra-low carbon emissions vehicles are mandatory for achieving the climate goals. The market and the infrastructures must be prepared for the changes and the currently battery electric vehicles, the hybrid electric vehicles and the fuel cell vehicles keep to be the main qualified solutions. E-mobility in terms of electric or hydrogen vehicles can deliver sustainable solutions to stimulate the users.

There are several potential benefits of e-mobility while contributing to the sustainable mobility. The public grid charging designed for the electric vehicles and for the plug-in hybrid vehicles represent a cost balance together with the responsible car sharing and the light-weight, down-sized efficient powertrain and the efficient driving techniques. There are also several risks to be taken into account, the time to market and the time to user, in addition to the discouragement to use different fuels, to share the own vehicle with others and to use newly powertrain solutions represent boundaries in implementing e-mobility. E-mobility can affect the sustainable mobility in the way how policies are focused on the new trends.

Green vehicles are part of the e-mobility solutions. The green vehicles, presented as the electric vehicles and hybrid electric vehicles can be defined as many different categories, including: battery electric vehicles, plug-in hybrid vehicles and fuel-cell vehicles. Currently, the hybrid electric vehicles are the only available solution that do not need special improvements or changes to the infrastructure. The hybrid electric vehicles are using at least two energy storage systems, one for the fossil fuel and one for the electricity. Depending on the hybrid powertrain solution, the environmental performances are not increasing considerably, but some changes are able to be seen.

The battery electric vehicles are using only electricity as the main power source, supplied to an on-board battery that delivers electricity to one or more electric machines. The battery electric vehicles have zero emissions while being used, but the used energy may be produced in fossil fuel power plants (that pollute) or in photovoltaic power plants (that are eco-friendly solutions). The battery electric vehicles' range is one of the main obstacles in large scale implementation in addition to the charging infrastructure development. Some battery electric vehicles have a range extender that consists in a small size internal combustion engine that operates only when its operation is strictly necessary and the available battery state of charge is not enough for the drivers' demands. The range extender is able to produce electricity and to increase the standard available range, not being able to drive the wheels by itself.

The plug-in hybrid vehicles are mainly powered by electricity usually on short distances, their range depending of their batteries technologies, having also additional systems to provide electricity when needed, while for operating above defined speeds the internal combustion engine is providing the vehicle's propulsion. For the plug-in hybrid powertrain, the charging to the grid solution is used in parallel to other charging solutions. The internal combustion engine is able to charge the battery using a generator, in addition to the recovery energy system that recovers the braking energy and store it in the batteries.

These vehicles are producing harmful emissions while the internal combustion engines are operating, but generally at low level due to the innovative technologies that allow the engine to operate near the economic pole most of the time.

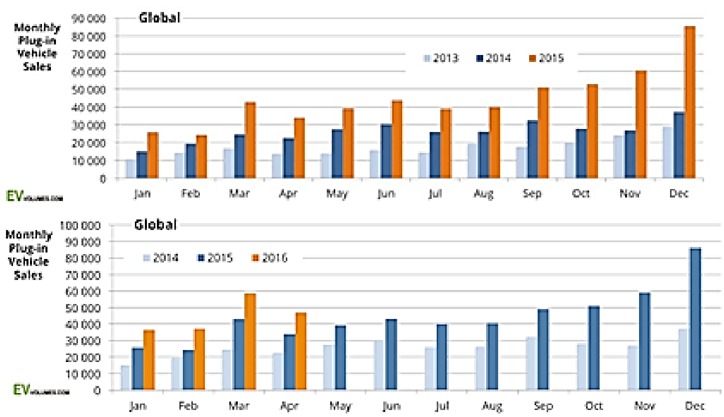
The fuel cell vehicles are using at least one electric machine for propulsion, the electricity being produced inside the vehicle, using dedicated equipment. The highest grade difficulties for the fuel-cell vehicles were solved, but the available infrastructure to charge the hydrogen tanks is limited. Even if the fuel cell vehicles are not so popular due to their high costs, the future will bring them as the main means of transport at least inside the crowded urban cities.

Electric and Hybrid Electric Vehicles Evolution and Charging Availabilities

During the last years, the electric and hybrid electric vehicles sales had considerable growth (Figure 6). Globally, more than half a million plug-in electric vehicles (including battery electric vehicles and hybrid electric vehicles with plug-in systems) were delivered to buyers in 2015 (Ayre, 2016), nearly 200 000 plug-ins being sold only in quarter 4 of 2015. The plug-in hybrid vehicles' sales grew faster, with 80%, than battery electric vehicles, that grew only with 64%.

Until April 2016, the plug-in vehicles sales worldwide were about 180,500 units, being higher with 42% than for the same period in 2015 (Figure 6), including beside the battery electric vehicles and the plug-in hybrid vehicles also few light commercial electric vehicle. Comparing with 2014, the sales were higher with 71% in 2015, while quarter 4 from 2015 was notably stronger in sales (Ayre, 2016).

Figure 6. Plug-in vehicles global sales



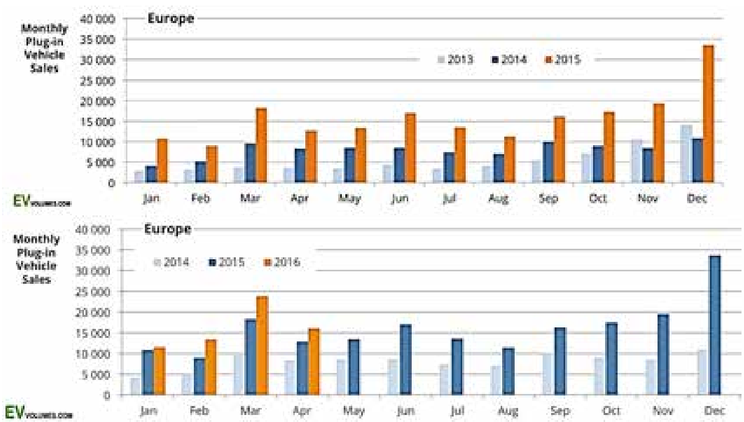
Source: (Ayre, 2016)

In Europe, during 2016, the plug-in vehicles sales were about under 65,000 units including April. Comparing with the sales from 2014 in the same period, the growth was higher with 99%. In 2015, the plug-in vehicles were sold near to 200,000 units, double than in 2014, including passenger electric vehicles and light freight transport electric vehicles.

Many European countries introduced facilities for electric vehicles' buyers, in order to help the growth for this kind of vehicles. But, the total increase is higher than the last year with only maximum 1% in this countries (Figure 7).

Many types of charging types, charging point and charging equipment are available for the charging infrastructure. Electric car charging is different than fuelling a car with gasoline, being more convenient as far as you are at home and you spend a few seconds to plug in and unplug when ready to drive. But the time needed to charge in order to drive 100 kilometres is considerable higher than fuelling with gasoline. But concerning the environment while operating the vehicles, the advantages are evident for harmful emissions and noise.

Figure 7. Plug-in vehicles sales in Europe



Source: (Ayre, 2016)

Home charging is the most used solution, reaching 95% from the available charging options. There are several ways to charge the electric vehicle at home, depending on the available home equipment and the available type of electricity source (having also different voltage of 110V, 220V, 380V), the on-board charger types, that gives the time to charge from the acceptable state of discharge to the ready-to-drive state of charge. A home charging station has different particularities and prices, currently the existing stations including various types of cords and charging capacities, defined in driving range. The available electricity provider may apply special taxes for those who are charging their electric vehicles at home, or using dedicated charging points. Charging point exist near parking places, near restaurants or inside office buildings, where to have access people need to use special applications or login data, some being free, some not. The most important particularities for the charging points are that the electric vehicles may have different plug-in slots and cables, different charging maps allowing how fast to be charged. Several applications and maps are available for finding the closest charging point.

Figure 8. The Europe electric vehicles available charging infrastructure

Source: (www, Plug 1, 2016)

Figure 9. Paris electric vehicles' charging points reported in April 2016

Source: (www, Charge 1, 2016)

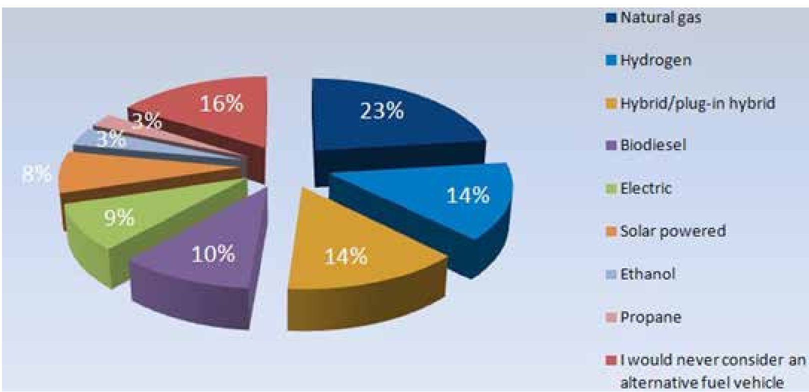
Worldwide, more than 100,000 charging points are available for charging. During the last years the charging point number increased considerably (Figure 8), being more frequently built than conventional fuel stations. Paris has the most number of charging points from Europe, but 84 charging stations (Shahan, 2016) are considered minimal for a city of that size (Figure 9) (www, Charge 1, 2016)

Alternative Fuels

It is considered that alternative fuels are just around the corner and the possibility to be used is supported by environmental friendly manufacturers (KBB, 2012). But, as expected, many fossil fuels producers maintain that alternative fuels are not viable solution, currently only 7% of the total energy consumption being reported to the alternative fuels consumption. People are looking more and more to use alternative fuels because of their lower prices than the fossil fuels and their less polluting advantages.

The available cheapest alternative fuels include the natural gas and the bio-fuels from vegetables. The most likely to be consider alternative fuels are the natural gas (23%) and hydrogen (14%) (Figure 10).

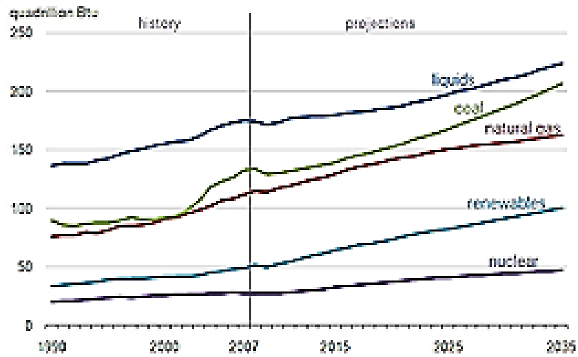
Figure 10. The most likely to be consider alternative fuels for use



Source: (www, KBB, 2012) (Smith, 2013)

According to International Environment Outlook 2016 (IEO, 2016) the usage of alternative liquid fuels increased, with a considerable CO2 emissions reduction of 40% in 1990 and only 36% in 2012. CO2 emissions coming from the natural gas usage represented 19% in 1990, while in 2012 was around 20% of the total greenhouse gasses, with expectations to increase until 2040 to 26%. The natural gas use will rise from 23% in 2012 to 26% in 2040, while the conventional liquid fuels use will decrease from 33% in 2012 to 30% to 2040 (figure 11, figure 12).

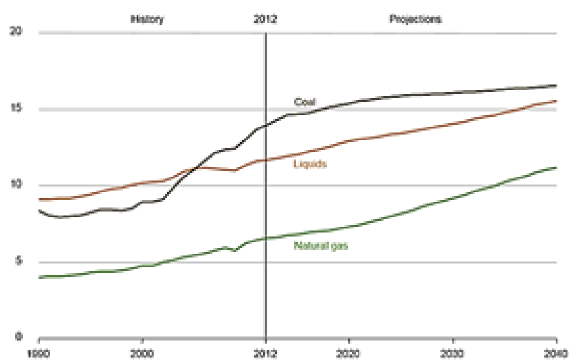
Figure 11. World energy use by fuel type



Source: (USEIA, 2016)

Other liquid fuels – including biofuels, CTL (Coal to Liquid Fuels), GTL (Gas to liquids), kerogen (oil shale), and refinery gain – currently supply a relatively small portion of total world petroleum and other liquid fuels, accounting for about 16% of the total in 2012. Other liquid fuels are projected to grow modestly in importance in the International Environment Outlook 2016 Reference case, as the other liquids share of the world's total liquids supply increases to 18% in 2040.

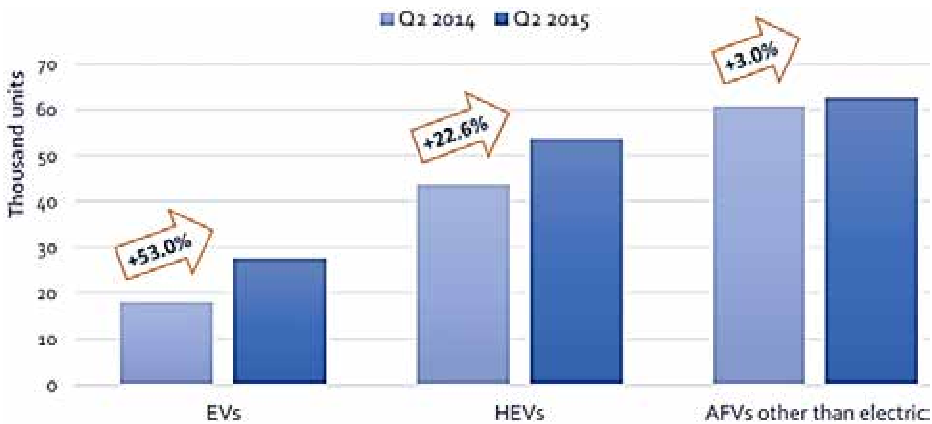
Figure 12. World energy related CO2 emissions by fuel type



Source: (USEIA, 2016)

In the second quarter of 2015, total alternative fuel vehicle registrations in the EU increased (+17.4%), totaling 143,595. Of these, electric vehicle (EV) registrations significantly grew (+53.0%), rising from 18,024 units in Q2 2014 to 27,575 units in Q2 2015 (figure 13). Demand for new hybrid vehicles (HEV) also increased (+22.6%), totaling 53,443 units. 62,577 new passenger cars in the second quarter (+3.0%) were powered by propane and natural gas (www, ACEA 1, 2015).

Figure 13. New alternative fuel vehicle (AFV) registrations in the EU by engine type



Source: (www, ACEA 1, 2015)

Hydrogen is used as an alternative fuel, being a renewable alternative to petroleum fuels. It has been successfully demonstrated to be used for road vehicles, but the production cost, the on-board storage and the safety methods to prevent hazards during operation represent analysis activities to be taken into account. There are two types of road vehicles engines that burn hydrogen. One is an internal combustion engine, the other is a fuel cell. Hydrogen is a clean-burning fuel that can be produced from coal, natural gas, petroleum, solar, or wind energy. A vehicle operating on a fuel cell, which generates electricity by harnessing the reaction of hydrogen and oxygen to make water, produces no CO or VOC (Volatile Organic Compound) emissions and extremely low NOx emissions.

People are expecting higher performances from the hydrogen fuelled vehicles, less costs and better comfort, but currently the already on the market fuel-cell vehicles are very expensive compared with conventional and even hybrid and electric vehicles.

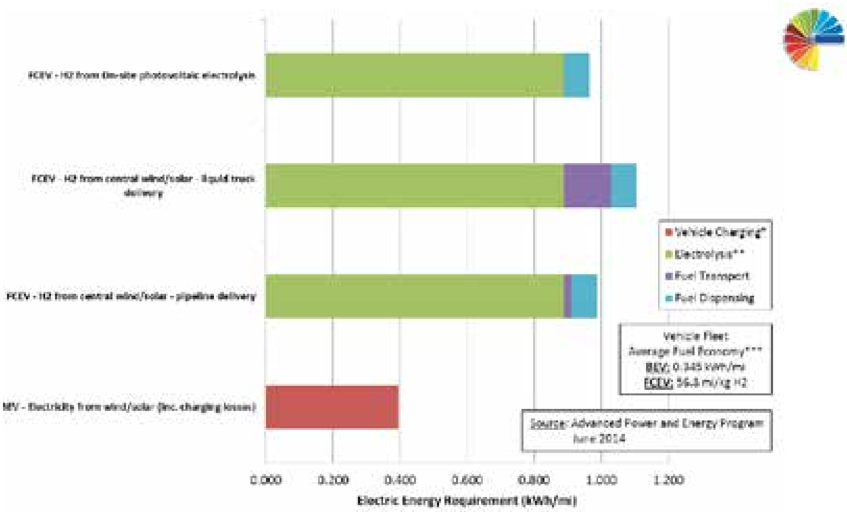
The scientific approach is definitely impressive when the fuel cell vehicles are subject to debate. Like battery electric vehicles, fuel-cell vehicles are using electricity for propulsion but the primary electricity is made by using a fuel cell powered by hydrogen, rather than drawing electricity from a battery. The fuel cell vehicle power is set by the fuel cell and the hydrogen tank sizes. The most common types of fuel cell for vehicle applications are using polymer electrolyte membrane (PEM). Inside the PEM fuel cell the electrolyte membrane is sandwiched between a positive electrode (the cathode) and a negative electrode (the anode). The hydrogen is introduced to the anode and the oxygen (from air) to the cathode. The hydrogen molecule break apart into protons and electrons because of an electrochemical reaction in the fuel cell catalyst. Protons travel through the membrane to the cathode (www, FCEV 1, 2016).

But, the reality on buying and using the fuel cell vehicle daily is not close because the fuel cell vehicles are the most difficult and expensive alternative fuel vehicles even if, as an advantage, they are the most environmental protective vehicles. Several researchers notified that the fuel-cell vehicles are not as environmental friendly as the battery electric vehicles (and some plug-in hybrids) are. Dr Joe Romm (who used to oversee and promote hydrogen funding in the US Department of Energy) mentioned: "Put in more basic terms, the plug-in or EV 'should be able to travel three to four times farther on a kilowatt-hour of renewable electricity than a hydrogen fuel-cell vehicle could'!" (Shahan, 2015). Dr. Joe Romm also mentioned: "The two best cases for FCEVs in the chart (figure 14) – a hydrogen pipeline system from central station renewable generation and onsite renewable generation and electrolysis — are wildly implausible for many decades to come, if ever." (Shahan, 2015)

In 2017, the World's First Plug-in Fuel-Cell Car goes into series production. The vehicle will be a Mercedes-Benz that will start selling a plug-in fuel-cell version of its GLC compact crossover from 2017. The model's fuel-cell stack was developed in Vancouver with a Ford joint venture. The automakers managed to shrink the size of its fuel-cell stack by about 30 percent so that fits within "conventional engine compartments." More importantly, the stack uses 90 percent less platinum. The vehicle will have a combined range of about 500 kilometers, including an all-electric range of about 50 kilometers (King, 2016).

On July 2016, this year, the standard regarding the fuel-cell and the hydrogen distribution, is awaited, under the Technical Specification ISO/TS 19880-1 (ISO-TS 1), Gaseous hydrogen — fuelling stations — Part 1: General requirements, which is a key document for the building of hydrogen fuelling stations worldwide. The Technical Specification are prepared by ISO/TC 197 WG 24, led by co-conveners Jesse Schneider (from BMW) and Guy Dang-Nhu (from Air Liquide), along with Nick Hart (from ITM Power) as secretary. The publication is important also in view of the relevant fuel-cell standards that the EU Alternative Fuels Infrastructure Directive will refer to in the future. The scope of the Technical Specifications` covers the processes from hydrogen production and delivery to compression, storage and fuelling of a hydrogen vehicle. A safety and performance guideline for hydrogen stations is essentially, including the interface to fuel vehicles. The level of safety specified in the technical specification is similar to the level of safety of stations fuelling with conventional fuels (ISO-TS 1, 2016).

Figure 14. Electric energy requirements for electricity-based fuelling pathways



Source: (www, WTW 1, 2014)

Autonomous Vehicles

The autonomous vehicles types are defined based on the level of autonomy the vehicle is able to support. Following the standard J3016, "Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems", a harmonised classification system and supporting definitions are set. Six different levels of driving automation from "no automation" to "full automation" are defined (Figure 15), including the base definitions and levels on functional aspects of technology for eliminating the confusion and covering numerous disciplines, from engineering, to legislation and public disputes. The clear definition for the automation driving levels is able to educate wider communities by clarifying the driver's role for each level, while the automated driving system is engaged (SAE International, 2014).

Each level of automated driving has several particular performances to be achieved. Other definitions are used, like “the dynamic driving tasks” which refers to the operational and tactical aspect, like steering, acceleration, deceleration, monitoring the vehicle and the roadway and responding to the events, determining when to change the lanes, to brake, to use signals etc. The “driving mode” refers to the driving scenario type. The “request to intervene” sent to the driver by the driving assistance systems refers to every notification that the systems expect to be received by the driver and the driver have to promptly begin or resume performance of the dynamic driving tasks.

The definition of the “0” level, named “no automation”, refers to that the human-driver is taking care for all the dynamic driving tasks, even when enhanced by warning or intervention system, being in charge for steering, accelerating and decelerating, braking, monitoring all the driving environment, the next level is defined. No automation road vehicles are already equipped with different systems that help drivers to keep to their lane (the lane change assist and the lane departure warning) and to monitor the vehicle surrounding areas, like the blind spot detection system, that warn the driver to avoid unwanted situations. Other systems included already in the no automation vehicles are the park distance control, the front collision warning systems that only announce the driver of an imminent danger.

The level “1”, named “driver assistance”, corresponds to some driving modes automated achieved, when several activities are made by the driving assistance systems, without human driver intervention, like steering, acceleration, deceleration using the information from the driving environment and with the expectation that the human driver will be able to react and to perform for the other all remaining aspects of the dynamic driving tasks, based on human driver monitoring of the driving environment. The already existing systems that act on level “1” automated vehicles are the adaptive cruise control and the adaptive cruise control stop-and-go that use radar sensors to detect the distance to the vehicle in front and reduce the vehicle’s speed in case of emergency and for keeping a safe distance and accelerating to the vehicle in front by automatically applying brakes, the park assist system that steers the car and make the parking possible without human driver intervention for steering, the human driver being in charge only for accelerating and decelerating, the lane keeping assist system that becomes active from specific speed, normally from 50 km/h, takes corrective actions or warns the driver.

The level “2”, named “partial automation”, corresponds to the driving mode when the driving assistance systems are in charge for complete steering, acceleration, deceleration using information about the driving environment, while expecting that the human driver will perform all the remaining driving tasks. The park assistance system is part of this level of automation and consists in achieving the parking feature into public and/or private parking areas without human intervention from inside the vehicle, the human driver being able to initiate the parking via a smartphone for example, and the vehicle will accomplish the manoeuvre by itself, under the human driver monitoring. The traffic jam assist is another system corresponding to the level "2" of automation, being in charge with following the traffic flow in low speeds, in urban areas or on highways.

The level "3", named "conditional automation", corresponds to the driving mode when the driving assistance systems are in charge to steer, accelerate, decelerate, monitor the driving environment, with the expectation that the human driver will intervene only by request. The traffic jam chauffeur and highway chauffeur are level "3" automated driving systems that detects the slow driving of the vehicle in front on highways and similar roads and handle the vehicle both on longitudinal and lateral, while the human driver has to activate the system and any time can switch it off and to take the command, or under the system request if automation gets its own limits to take over the specific driving task.

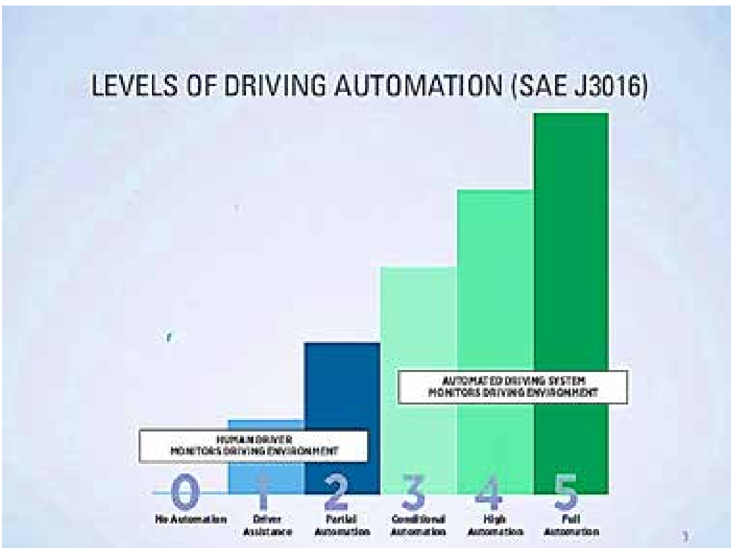
The level "4", named "high automation", corresponds to the driving mode when the steering, the acceleration, deceleration, monitoring the driving environment as well as the all aspect of the dynamic driving tasks, even the human driver does not respond appropriately to a request to intervene. The parking garage pilot is the system that includes manoeuvring to and from the parking place as a driverless valet parking without any monitoring from the human driver. The highway pilot is suitable for driving on highways or similar road types, where the speed is up to 130 km/h and is having the possibility to change the lane, to overtake other vehicles, but the system will not issue any requests to the human driver and the human driver can switch it off.

The level "5', named "full automation, corresponds to the driving mode when the vehicle's performance is completely made automatic, under all roadway and environmental conditions that can be managed by the human driver. The fully automated vehicles are able to handle all driving between two destinations, without any intervention from the human driver and the human driver presence inside the vehicle is optional.

Starting from the "high automation" level, the responsibility is to keep the vehicles and the traffic safe even in abnormal conditions. Indeed, the costs for such systems are increasing when new additional systems are introduced in order to check for failures and to verify the behavioural responses during the development phases.

Since 2005, several entities initiated project, some of them public funded, to support the development of automated vehicles. Public authorities are defining the action plans for facilitating the development and the introduction of automated vehicles. While in the United States all five levels of automation are able to be met on roads, in Canada the testing automated vehicle on public roads is already started. In Japan and in South Korea the development of automated vehicles reached a high level of knowledge and testing, some dedicated competitions promoting the relevance of automated driving. In China, the government sees the automated driving as the 2020 reality, because they already tested and used automated vehicles. In Australia the automated trucks are taking the lead and their strategic plans include more than 200 self-driving trucks on the current public roads. In Europe, many countries has automated driving projects already implemented or under implementation, that confirms the validity state for the unmanned vehicles for the next years.

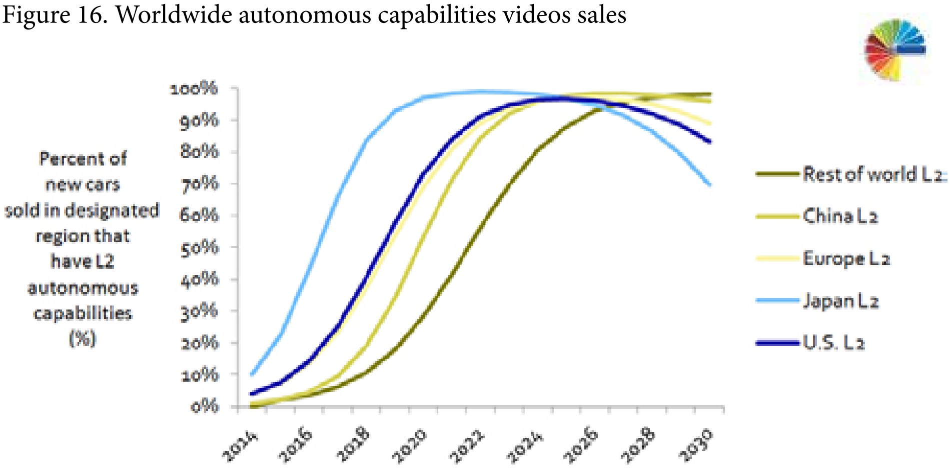
Figure 15. Levels for road vehicles' automation driving systems according to SAE J3016 standard



Source: (SAE International, 2014)

Based on the sales during the last years and the predictions for the next years, the automated driving vehicles having the level "2" autonomous capabilities will continuous grow on international markets, with a fast growth during 2014 and 2024 (Figure 16).

Figure 16. Worldwide autonomous capabilities videos sales



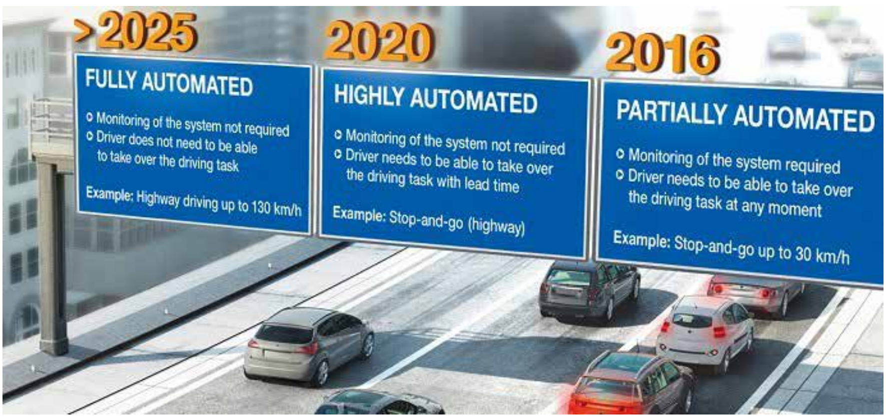
Source: (Laslau et al, 2014) (www, AW 1, 2014)

Google-self-driving-car is famous through its operation in California, for private and public transport, not reaching yet the maturity and is being used to raise awareness of the potential benefits of automated driving among all traffic participants. But Google isn't the only outfit puttering around United States roads with its hands off the wheel. The German automotive supplier Continental received granting for testing and adorning its vehicles in some states in United States, but Continental's autonomous vehicles aren't exactly direct competitors to Google's fare. The company's "highly automated vehicles" are more of an advanced cruise control system than a self-driving vehicle, being capable of navigating stop and go traffic on a freeway, for example, but still requiring the driver to take control as their exit draws near. Continental sees the partially autonomous vehicle as a stepping stone to fully automated cars, and plans to offer the partial solution between 2016 and 2020, switching up to fully automated driving systems by 2025 (Buckley, 2012).

Partially automated driving starting in 2016 (Figure 17) consists in assisting the driver in certain situations, in the first step, which will be technically possible for partially automated systems to support drivers in stop-and-go traffic situations on the freeway traveling at up to 30 km/h. The car takes over steering as well. The driver is relieved of the physical and mental task of driving, but still needs to monitor the driving situation constantly. The highly automated driving from 2020 (Gigure 16) corresponds to the alternative use of the driver's time and refers to the driver who will be able to hand over responsibility for driving on the freeway at varying speeds. For example, in slow-moving traffic, drivers can simply be chauffeured and turn their attention to another activity. They must however be able to resume control again at any time.

The fully automated driving from 2025 (Figure 16) sets the comfort and convenience for the driver, as the third stage, the vehicle being possible to drive whole sections of a trip fully automatically without any human intervention. In other words, the vehicle would be able to be controlled automatically on the freeway at up to 130 km/h. When the vehicle is in fully automated mode, drivers will no longer need to be able to take over, which will increase their freedom enormously and allow them to turn their travel time into leisure time (www, Conti 1, 2016) (Buchholz, 2015).

Figure 17. Automated vehicles prediction



Source: (Buchholz, 2015)

At the European level, high automation driving vehicles are able to be met only when low vehicles' speed and dedicated infrastructure are available. Several funded programs supported the automated driving projects from the early days, the radar technologies being able to gain innovations, the sensors information combined with the communications and positioning services being improved, many automation modes being tested, the platooning between automated driving vehicles being optimised also for daily persons public transport and for light freight transport, intelligent networks for using the communication facilities between vehicles, vehicles and infrastructure, vehicles and everything being implemented, other related driving advanced assistance systems.

Some examples of automated driving vehicles are presented below. The Cybercars are small automated vehicles for individual and collective transport, both for people and goods that can run without human drivers' intervention and can continuously communicate with the traffic control centre. The necessity of using intelligent transport systems in protected environments was achieved and the automated driving vehicles are able to operate on roads where no other vehicles are allowed on low speeds. The High-Tech Buses are operating more like trams, using dedicated infrastructure and always have a human driver who is able to take the control anytime. The Advanced City Cars are integrating zero or ultra-low pollution powertrain and several driving assistance systems which are using the intelligent transport communication systems, including the car-sharing option (ERTRAC, 2015). Overall, the driving safety have to increase whilst the robot vehicle is being introduced.

Approaches, Initiatives and Responses on Autonomous Driving

Intelligent mobility is seen as major opportunity, including the connected vehicles, the vehicle to everything communications, the increasing safety, the decongestion and the access to mobility advantages. All vehicles' manufacturers already produced and tested different automated driving vehicle solutions, being able to have clear plans for the next decades following their experiences. The energy efficiency is one of the targeted objective achieved by using automated driving vehicles equipped with hybrid or electric powertrain. The automated driving systems will choose the proper functional mode for the powertrain in order to have the minimum consumption and emissions.

Action plans regarding the introduction of automated vehicles were presented by public authorities all around the world following the continuous development of the automation technologies and the tendencies to move the driving tasks from the human drivers to the smart systems and machines.

Initiatives and responses

The initiatives and the responses in various countries and regions are following the same goals, to introduce the automated driving vehicles at large scale, at least form level "3" upward. American auto-manufacturers enhanced their plans by implementing the level "2" solutions, while different states allowed higher level driverless vehicles to operate on public roads. In Europe, most of the auto manufacturers and systems developers are launching different programs and are implementing different projects, some of them only demonstration projects, for making people aware of the necessity for the automated vehicles and to emphasize the incisive requests for introducing them. In addition, the traffic infrastructure is under massive changes for allowing the detailed communication with the vehicles and the humans inside them, to present the location, the intended destinations, the road traffic environment and flow, the vehicle control stability in order to high precision usage of digital maps and other issues that may be addressed in the future.

The high automation vehicles are taking into account the already existing driving scenarios, including traffic accidents and the road vehicles' operation. Based on how realistic the vehicles is driven without human intervention, the driving assistance systems are offering the alternative solutions when the human driver is able to take control if necessary. The goal is to deliver and use an extended and personal mobility that is safer, economic, comfortable and less time consuming for humans during driving. Several scenarios are taken into account by both vehicle manufacturers and companies that are proving the intelligent systems for achieving the automated driving and operating on public and private roads, when the human driver no longer monitor the vehicle and is able to have different activities during the trip besides operating the vehicle.

The extended mobility that can be offered is continuously being improved by introducing scenarios for the future vision when the functionality of the automated driving systems no longer accepts the intervention of the human driver even in an emergency situation with defined or unforeseen circumstances. Personal mobility is following revolutionary scenarios for preventing accidents and reduce harmful emissions, without following the driving assistance systems upgrades, but using both traffic and drivers patterns, when the automated driving system is taking completely the control. This approach is possible to be implemented by learning algorithms and artificial intelligence, when the automated driving systems are operating near the limits by mimicking human behaviour, using digital mapping and online services (Beiker, 2016).

Infrastructure

The digital maps that are used for tactical driving and the update using the automated driving vehicles are necessary, taking into account the work zones, the weather any accidents, lane closures, or other dynamic factors. (WP-AD, 2015) The position of the vehicles are reported in real time and the automated driving vehicles are able to use the information regarding the road state immediately.

Communications between the vehicles and infrastructure are needed for the introduction of automated driving vehicles and the intelligent transport systems technologies that are enabling the information and warnings on traffic for combining the keeping the lane assistance system, the adaptive cruise control and other at least level "3' automation systems with the safety technologies in transport sector regarding the infrastructure current state. The automated driving vehicles will contribute to the considerable reduction of traffic fatalities and congestion using the new generation for urban and extra-urban transport. Different types of automated vehicles are able to demonstrate the abilities such vehicles offer on road obstacles avoidance, passenger recognition, strategical escape in case of accident and economical operation by receiving information in a combined manner form the vehicles' sensors, radar, GPS and from the road infrastructure. The continuous growth of automated driving vehicles are defining the decision criteria for the non-human driver tasks. The difficulty appears when understanding the danger is subject to debate also for different human-drivers when defining and combining the driving scenarios with the driving tasks in different situations.

The infrastructure plays an important role in transport efficiency, on bus and freight transport, on private vehicles, helping the vehicles to be informed about the closest charging points, available parking places, reducing the congestion, the traffic volumes and the emissions by critical analysis on the current reported state (FFI, 2015). In addition, the infrastructure is responsible for informing the automated driving special vehicles used on maintenance and services (Croitorescu and Ruichek, 2015) about the current state of the factors under investigation.

Safety, security and liability

Data security represent one stage for ensuring the social acceptance of automated vehicles. This stage consists in different parts, from processing the large amount of data, store the data and make the data accessible for the future scenarios, communication and identification, to the data evaluation and interpretation. One major boundary is the data ownership approach. In addition, the automation systems liability and the applied solutions are problems that must be solved. The data protection is absolutely necessary, being not only a concern for automated driving vehicles, but also to road infrastructures. The data protection and security have to be as transparent as possible to the user, but have to be secured in order not to be modified by anybody. But, the "online data security" is anytime under the possible attacks danger. While automation does not fundamentally bring new cybersecurity vulnerabilities, the level of risk for any malicious attack certainly increases at the higher levels of automation in which the driver role is decreased or non-existent (WP-AD, 2015).

Anyhow, the adequate security measures were taken into account for the beginning and the updating and optimising steps are continuous. The liability and safety are introducing concerns considering the responsibilities in case of accidents starting from level "3" upward. The discussions include the human driver, the vehicle manufacturer and the vehicle's owner. The balance between these three potential responsibilities has to be established. In addition to the three responsible solutions, another person can be consider responsible for the accident if that person is considered guilty and it is outside the automated driving vehicle, as pedestrian or is driving a normal vehicle.

The automated driving vehicles' liability is subject of three major challenges, first, the communication cannot be established between a high-tech automated vehicle and a no modern technologies vehicle, second, the limits of the monitoring surrounding equipment, not all angles and spots are able to be captured and processed, and third, the adaptability to all traffic modes and types, from one country to another.

The automated driving vehicles safe state is ambiguous and depend on the individual perception for each human driver. The acceptable definition for safety refers to a risk level that depends on the vehicles' situation. The automated driving vehicles are taking the decision based on the stationary and dynamic objects, the intention of the dynamic objects, the legal conditions, received mission that consists in the final destination and the current energy performances of the vehicle. The automation systems may be switched off by request, but the human driver will monitor both lateral and longitudinal motion. But, safety may suffer and the safety requirements may be different. While designing the automated driving vehicles' guidance, the environment recognition and the vehicle operations are meant to be fully available as examples. The vehicle's redundant sensors cover the control decision factors indicating the handling, acceleration/deceleration and braking.

The safety features are also integrated in the infrastructure, being able to prevent all the vehicles from a certain route or road and also to track all their behavior (Reschka, 2016). Monitoring the vehicles behavior by the infrastructure considers already defined scenarios, described, tested and implemented in a safety environment. The tracked vehicles are able to be control via the infrastructure information in terms of processing the information and choosing the best decisions according to the situations met. The robotics involved on automated driving vehicles are safety-oriented and their control is following the most efficient, the most economic and the higher comfort driving style according to the legislation and the traffic criteria about avoiding any action with low level of trust. In transferring control situation, the robotics are considered under the command of the human driver, but when no human driver is controlling the vehicles' operations, no humans are inside the vehicles and no remote control operator is available, the vehicle will choose the best solution by applying the functional limits of the system and it will control all the vehicles' motion in the same time with signaling all the other vehicles and informing the infrastructure.

The full automated driving vehicles are using human drivers for extending their capabilities, especially on non-marked roads or on off-road routes, without any existing maps. Military applications were already tested using these constrains and the successful results demonstrated that the possibilities exist and the necessary maneuvers are practically achieved by the vehicle automation systems and guidance without using predefined maps.

The predictions and the automated driving vehicles' actions are bringing together smart systems to achieve the demands in terms of safety, security, functionality, efficiency and robustness and to support the comfort, the fuel efficiency, the decreasing emissions and the prices.

The automated vehicles smart components and systems integration will be on long term and will contribute to social wellbeing, increase social inclusion, bring added value on energy efficiency and reduce road fatalities. The excellent knowledge involved in automated driving vehicles represents a promising application of internet of things in the mobility sector. The controlling functions are allowing the human driver to partially or fully dedicate his attention to something else instead driving, but the human driver reactions for levels from "0" to "3" have less than one second from warning to action. Therefore, only when the human driver is not needed to monitor the driving process, the automated driving vehicles using non-human driver will decide all the safety and security situations (FIA, 2015).

The automated driving vehicles are very complex systems that contain large number of sensors that should communicate also between them and the vehicle's dedicated electronic control unit and to the infrastructure using algorithms, evaluate the driving state and using processed data to deal with the traffic, store and understand the data from the environment and human-drivers own reactions and interventions.

The automation systems are designed to prevent all critical situations by monitoring the drivers' responsiveness in automation levels up to "3" and the human drivers should be periodically warned about vehicle's monitoring state. All the technical measures have to prevent predictable and dangerous misuse of automation systems like sleepiness, or leaving the driver's seat, amongst other actions. The communication between the vehicle and the human driver is done using the human machine interface that is capable to provide the needed information in time to keep the human-driver active all during the route. The automation systems implication has limitation that the drivers should be aware of. The combination of the human drivers' performances and the automation systems represent the achievement for the successful automated driving vehicle design. The safety of traffic is depending on this combination and the human drivers' tasks should be easier.

Human-driver

The possible confusion that may be met currently refers to the definition of the "driver". The human driver is expected to take control whenever necessary, with or without the vehicle's warning, the control resuming being as fast as possible, in sufficient time, to avoid any unwanted situations and to take the operational decision. The human driver's vigilance represent the central aspect, which may decrease immediately after the control is taken by the vehicle, in addition to the distraction that may occur after not more than five minutes of assistance. According to (Box and Wengraf, 2013), distraction, the root cause of 25 to 55% of all accidents, will be growing in a world of automated driving.

The human drivers differs especially on age and gender, due to their decisional operations during different driving scenarios situations. Different education and training about driving performances define the demands for the automation systems, together with the realistic scenarios and the drivers' expectations. Each automation system has its own boundaries and the human driver should understand this. The automation systems are reliable as they are available as equipment on vehicles. Therefore, any failure that may appear will be possible to avoid any accidents by the human drivers' intervention (FIA, 2015).

The human-drivers are aware all the time of the vehicles' automation level and about their responsibility to react and monitor the vehicle. When the human-driver is not able to intervene, only at level "4" for some situations and at level "5', the automation systems are reacting for all the tasks. During the levels "0" to "3" the human-drivers have to permanently monitor the vehicle, not being allowed to take their eyes from the road. The minimum requirements of automated driving vehicles for level "4" and "5" include the possibility to the human drivers to engage different non-driving tasks, without assuming the driving tasks. The human-drivers intervention have to be recorded in order to decide who may be responsible for any incident (FIA, 2015). A possible example can be the level "4" automated valet parking for passenger vehicles that is an interesting application which will be realised in the near term because it is low speed and may operate also off the public road. The idea is that the human driver steps out of the car at the entrance to a parking facility and uses the smartphone to instruct the car to park. The vehicle autonomously drives away empty, without any humans inside, and finds a space, returning to the entrance when called by the driver (WP-AD, 2015).

Definitely, the next revolution in mobility will the automated driving electric vehicles. Therefore, as human errors are still the major reason for road accidents, the automated driving vehicles' equipment is expected to make future transport safer. The potential is huge while its introduction on large scale for daily public use is environmental friendly, efficient and should be accessible (UNECE, 2016). The electric mobility is continuously growing and the support services are adequate for the current use, but for sure will need to grow accordingly in the future.

Legal Overview for Autonomous Driving Mobility Solutions

Both electrification and automation in road vehicles are two spectacular attractions and the predictions to fully electrified automated road vehicles from 2025 are following the intelligent transport systems evolution and the continuously tested automation solutions levels, from partial automation, already met on roads, to fully automation. The automated electrified driving can be applied to different means of transport, from bikes, scooters, light vehicles, light trucks, but the passenger vehicles automation represent the main target. The extension to other vehicle, for example to agricultural machines, to luggage carriers inside airport etc. are concepts to whom the knowledge transfer and replication will be made.

The current existing automated vehicles are worldwide spread but the legislation differs from each continent, country or state to another. Social and legal challenges are taking into account the responsibilities of the human drivers and the automation systems as well as the ability to understand the decisions independently processed and achieved during driving.

The legislative boundaries are challenges that can only bridge the further development of environment monitoring, driver assistance systems implementation and control role.

The current regulations in Europe regarding road vehicles automated driving are following the Vienna Convention of 1968 (VC, 1968), which, according to Article 8 "Every moving vehicle or combination of vehicles shall have a driver" and Article 13 "Every driver of a vehicle shall in all circumstances have his vehicle under control…", referring to the driver's necessity of possessing the physical and mental ability and being physically and mentally fit when driving, and possessing all the knowledge and skills to drive and to control the vehicle at all the time. The Vienna Convention is able to facilitate international road traffic and to increase road safety by establishing standard traffic rules among the contracting parties. The Vienna Convention has been ratified by 70 countries, but those who have not ratified the convention may still be parties to the 1949 Convention on Road Traffic.

The Geneva Convention of 1949 had similar text and approach, probably does not prohibit automated driving, but promoted road safety by establishing uniform rules, including the requirement that each vehicle should have a human driver able to control or to intervene at all times in the automated vehicle's operation. The Geneva Convention on Road Traffic is accepted by 95 states. The 1949 Convention's description of a Driving Permit and International Driving Permit are located in Annexes 9 and 10. Switzerland signed but did not ratify the Convention. There is a European Agreement supplementing the 1949 Convention on road traffic, in addition to the 1949 Protocol on road signs and signals, concluded in Geneva on 16 September 1950.

Comparing both conventions, the Vienna Convention imposes somewhat more extensive obligations on the driver of a vehicle (Csepinszky et al, 2014). In March 2014 an amendment on Article 8 of the Vienna Convention mentioned that the driver still has to be present and also be able to take over the steering wheel at any time, but the car can be driven by itself as long as "the system can be overridden or switched off by the driver" (Dokic et al, 2015). In March 2016 another amendment will be introduced to the Vienna Convention and automated driving technologies transferring driving tasks to the vehicle will be explicitly allowed in traffic, provided that these technologies are in conformity with the United Nations vehicle regulations or can be overridden or switched off by the driver (UNECE, 2016).

Regarding the two conventions, other regulations are sharing the legal progresses, like the ECE Regulation 79, which contains requirements for the steering configuration that is problematic for automated driving vehicles. An "Advanced Driver Assistance Steering System" is only allowed to control the steering as long as the driver remains in primary control of the vehicle at all times, according to paragraph 2.3.4. In addition, such systems "shall be designed such that the driver may, at any time and by deliberate action, override the function" (Lutz, 2016) (paragraph 5.1.6.1 "Whenever the Automatically Commanded Steering function becomes operational, this shall be indicated to the driver and the control action shall be automatically disabled if the vehicle speed exceeds the set limit of 10 km/h by more than 20 per cent or the signals to be evaluated are no longer being received…".) (ACSF, 2015).

Until now ECE Regulation 79 has been the primary regulatory hurdle for the type approval of automated vehicles in Europe, being in charge with setting the operation for the steering systems. The major regulatory aspect is to introduce technical background and provisions for the steering system control, based on corrective measures and safety while driving on highways. The current limitation of automatic steering functions below 10 km/h have to be removed and, since 2014, the experts ran several research activities to evaluate the technical requirements for safer operation, the results being expected to be publish during September 2016 and the adoption in 2017 (UNECE, 2016).

Public Acceptance and Authorities' Involvement for Electric Autonomous Vehicles on Improving Mobility

The electric and the autonomous vehicles are subject to debate by many people. The trust in electric vehicles is limited by the missing charging infrastructures and by the batteries costs. Indeed, the dynamic performances, the less emissions during operation and the energy consumption prices are better than for the conventional vehicles. However, the hybrid electric vehicles are more common, being a viable alternative for both diving range and fuel consumption.

The leak of trust in automated driving vehicles comes from the insufficient information that people received during last years and the failure rates people meet while using different home equipment and machines because not all manufacturers payed the necessary attention during the development phases. More on that, the driving pleasure represent another boundary between the limits the interest for the automated driving vehicles.

Safety of automated vehicles will also impact on the level of social acceptance and uptake. Acceptance will depend on the likely deployment scenarios and feelings towards it may be very different for example towards truck platoons on the motorway or low speed delivery vehicles on separate infrastructure in urban areas. The role of consumer information programmes will also be important to explain and build confidence and drive best practice in safety (ADP, 2016). At this stage, user acceptance poses a challenge indicating that they "would not trust manufacturers and government assurance that driverless cars were safe (FIA, 2015). The technology should also be accessible to all categories of the population. It is not acceptable that only a certain group can acquire such vehicles even if the technology is regulated. New financing models (with the support of the insurance sector) could also be developed.

One topic related to safety that represent an important boundary for the public refers to the vulnerability the road users have in front of the automated driving vehicles. The pedestrian and the cyclist represent dynamic objects to be identified and protected by the automated driving vehicles and the particularity of "non-vehicles" roads may be accepted only for human-driven vehicles while the automated driving vehicles will operate on that kind of roads at low speeds using visual and audible warnings.

Even if the people may continue to act suspicious towards the new technologies, the information campaigns and special education and training classes are expected, including demonstrations at virtual and real-life levels to feel the technologies. On European level, the citizens have to think in terms of behavioral changes. The cities can be maintained as attractive places, with less pollution and wellbeing by introducing innovative mobility solution. The education and training have the major role in raising the citizens' awareness about the environment and about their needs regarding better efficiency in transport and services. The urban mobility offers different options, but the future options include a better lifestyle, more solutions to choose, new knowledge involved and new culture. But, the cities are not able to face all these challenges alone, only at local level.

Harmonised regulations should be taken, and the taken solutions should involve all Europe's resources. Meanwhile, the European Commission is presenting options without any clear solutions and all already launched debates included challenges on environmental friendly transport only applicable on local levels. The local administration are in charge of defining and implementing the urban mobility policies, but the European Commission have to support their actions and encourage the development of the new culture, for urban mobility in Europe, without imposing solutions that are not adapted to local circumstances. European Commissions should encourage the sharing of good practices across Europe and should better promote the cooperation, the interoperability, the financial support, the legislation and the advantages that come with the new innovative solutions in urban mobility.

Conclusions

Still, electric vehicles and e-mobility services have low usage among communities. One of the aims to be reached is to increase the awareness of needed zero-emission vehicles. The new technologies and solutions are meant to increase the users' confidence on e-mobility. The aims include the possibility to show what positive impact will have the integration of light autonomous electric vehicle inside and through communities.

The potential of replication of the transport solution is high: it can be replicated to small cities transport system, community service intelligent vehicles, city centers tours transport or exhibition transport.The risks are also high. The possibility that these vehicles will not be accepted by the potential users is a strong debated subject. Being new concepts, the light autonomous electric vehicles might not be trustworthy, and the population will not want to rely on a vehicle that has autonomous driving capabilities. From this point of view, a new risk appears that the programming dedicated to the autonomous driving system will be hacked by bad intended people and an accident may occur, which will be a major problem for the project.

Several boundaries regarding the available roads for the testing and implementation phases can be taken into account. Technological boundaries can be also met.

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