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Automotive the Future of Mobility

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Executive summery

Will the Automotive era come to an end in the 21th century? Looking at today's environmental and economic challenges of the use of last century technology cars and listening to some trend watchers one could think so. Cars can be regarded, as an old school status product indeed, for which there is no use, no place, no money and no interest in our modern society. On de other hand, auto-mobility is still growing, both in developed as in developing counties. The current worldwide road travel by motorbikes, cars, trucks and busses will probably double to 80 trillion kilometers in 2050 [1]. In terms of total mobility demand this is also the expected growth in the Dutch Port City area of Rotterdam.

Facing these identical mobility growth figures in the Dutch Port City areas of Rotterdam this paper describes the research of the Rotterdam University of Applied Science, the motivation and developments in automotive, and our first living lab experiments. In our vision we believe that respecting the traditional automotive values '*individual freedom and flexibility'* and using new disruptive technologies, the automobile will very likely consolidate its position as preferred choice for mobility of persons and goods during the 21th century. Meanwhile one should focus on tempting goals, the Six Zero's, which will guide us towards a road map to a new sustainable economy and ecology.

Keywords: Automotive, Rotterdam, Electric Vehicle, Smart e-Mobility, Sustainability, Disruptive Technologies, Zero Emission, Zero Energy, Zero Congestion, Zero Accident, Zero Empty, Zero Cost

1 Introduction

Many people believe that the heyday of automotive mobility were in the 20th century. Evidently during this past century automotive as an industry and as a mean of transport was very dominant for the prosperity and the way of life. The pioneer days of the automobile during the first half of the century up to the early sixties are regarded as the romantic age for classic motoring enthusiasts. At the end of the century automotive mobility became the number one and preferred mean of transport for persons and goods worldwide. Will this era come to an end in the 21th century? Looking at today's environmental and economic challenges of the use of last century technology cars and listening to some trend watchers one could think so. Cars can be regarded, as an old school status product indeed, for which there is no use, no place, no money and no interest in our modern society. On de other hand, auto-mobility is still growing. The current worldwide road travel by motorbikes, cars, trucks and busses will probably double to 80 trillion kilometers in 2050 [1].

The Dutch Port City area of Rotterdam is facing identical mobility growth figures [2]. Moreover, transport and logistics are the key factors for the regional economy. The fast majority of persons and freight is traveling respectively transported over the very well developed road infrastructure. About 60% of the regional business is related to this road transport [2]. The Port of Rotterdam is one of the European gateways to the world economy, and meanwhile making the Netherlands one of the leading distribution countries in Western Europe. Because of this future sustainability of mobility in logistics is a top priority for our regional and national economic development. With 60% reduction in 2025 compared to 2005, the local policy directive by the Rotterdam Climate Initiative has set the most ambitious goal for transport related CO_2 emission reduction in the Netherlands [3]. Moreover, to protect the health of its citizens, the clean air and low noise rules are now among the toughest in Europe. Continuing the current state of high intensive automotive mobility, with internal combustion engines and 99% dependence on oil could lead to a catastrophic situation for the economy and ecology, and, of course for mankind.

2 Electrification of Automotive

For this reasons the Rotterdam University of Applied Sciences started together with the municipality and local companies the first practice oriented research regarding the application of different electric vehicles, which we already have on the roads at Rotterdam. In 2009 this 'living lab' called eMobility-Lab has been rewarded by a Sia Raak Pro research subsidy. The goal was to provide education, government and business partners new knowledge and promising practice based insights about crucial aspects like energy saving capabilities including the recuperation through regenerative braking, best practices on safety measures and standards, total cost of ownership or operation, specific maintenance issues and not to forget user satisfaction [4]. This research work was done on a variety of urban electric vehicles (EV's), like automated shuttles, garbage trucks, city busses, passenger cars, distribution vans and scooters. In some cases these EV's were prototypes or early production models, but most of them are still driving. A nice example is the e-Busz used by the public transport operator the RET. All the above-mentioned aspects are researched from the very beginning of the deployment of the newly co-developed range extended electric city bus, from 2009 up to today. Empiric research through energy measurements of the unique e-Traction wheel motors led to design based research with the goal to optimize energy savings and cost efficiency [5]. Thanks to a study on electrical safety and the close co-operation with the Dutch road safety authority RDW, the e-Busz was the first electric city bus that was safe enough to be allowed on the Dutch roads in a commercial service [6]. Aspects like maintenance and driving instructions are developed and published in workshops and user manuals. Today the busses are fully monitored with advanced telematics, an on–line system from a start-up company Viricity. The data is analyzed to find-out the best driving conditions for chauffeurs, and to define a fast charging strategy to make it possible to drive the whole service with zero emissions.

In 2012, 100 years after electric vehicles dominated the car market for short period of time and 30 years after the first 'Californian' revival, automotive e-Mobility started booming again. The Netherlands is now together with California, Norway, and China a frontrunner in the electrification of road transport. From a historical viewpoint this can been seen as the realization of the idea of the Dutch professor Sibrandus Stratingh (1785-1841), who made in 1835 a first working battery powered scale model that is regarded as the forerunner of the electric vehicle (EV).

We are still finding new way's to electrify road transport. Different electric urban-distribution trucks are now in the testing phase in Rotterdam and other cities. Large heavy trucks transporting freight are usually diesel-powered tractors towing a trailer behind it on which the load is transported. Battery electric trucks for the long haul transport are not very feasible in the short term, because of the enormous driving range that is required. In the long term, hydrogen-electric trucks like the recently shown Nicola 1 prototype can offer a solution [7]. For the shorter term we are researching the feasibility of an active e-trailer concept. It will have two electrical direct-drive motors on one of the rear axles of the trailer, along with a battery pack to store and to provide energy. The active e-trailer will be able to provide extra propulsion and regeneration

of brake energy for the whole combination. Acting as a plug-in hybrid the combination saves fuel by peak shaving the load of the diesel engine and can drive last miles in zero emission EV mode.

Based on our research experiences it can be concluded that electrification is the technical master key for all forms of automotive mobility in terms of emissions reduction and energy saving. Meanwhile, the future developments in electric energy storage and renewable electric energy production electric mobility will become proven technologies as well which will lead to a future proof solution (Figure 1).

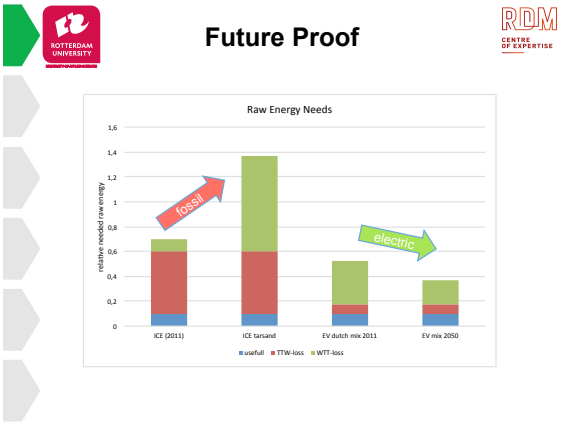

Figure 1: Future proof energy efficiency of e-Mobility in the Netherlands [13]

2.1 The step to Smart e-Mobility

The eMobility-Lab research led to crucial changes in the content of our education Automotive Engineering but also led to a new multi-disciplinary approach together with logistics, economics and other technical faculties in our institution and with other Universities. From a technical viewpoint, the understanding grew that there is strong synergy and synchronization between electrification and digitization of vehicle technology. Together, they form the basis for Smart e-Mobility. Like Diarmuid O'Connell of Tesla said 'EV's are the step-up function to rolling computers' [8]. For electric vehicles the step to automated self-driving capabilities or even autonomous vehicles is relatively small.

The electric Rivium Park Shuttle, which is already in operation since 2002, is a good example. It was the first vehicle researched in eMobility-Lab and is still revolutionary, because it drove zero emission electric and fully automatically without a driver [9]. From 2015 we started a research project of another Universities of Applied Science the HAN addressing Intelligent Truck Applications in Logistics [10]. This project is mainly focused on the application of full electric AGV's and automated electric trucks in the Port of Rotterdam. More recent in 2016, we have joined the Surf STAD (Spatial and Transport impacts of Automated Driving) a research project started by the Delft University [11]. In this joint research we study the existing and emerging Demonstrators and Cases of Autonomous Driving in and around the cities.

3 Adopting three sustainable disruptions

Tony Seba, Professor Entrepreneurship, Disruption and Clean Energy at Stanford University, is one of the first scientist who puts an automotive vision of sustainable disruptions forward. He points out that major disruptive transitions, electrification, renewable solar energy, automation and the sharing economy will completely change the face of the automotive industry in the coming decade. His conclusion, due to total electrification and a renewable electric energy society, we will be able to move in a post fossil energy age. Additional developments such as automation and data sharing will contribute to the development that we will only need 1/3 of the vehicles for the same mobility needs [12].

Our Research Centre Port Cities at the Rotterdam University of Applied Science also takes multi level sustainable disruptions as the staring point for big transitions. In the research program Moving@Rotterdam three professors are joining forces and research together, sharing their disciplines regarding Smart Logistics, Future Mobility and Sustainable Transition. Based on our practical know-how of the fruitful cross over between electrification and automation we support the view of Seba. Technically it's already possible and also politics and regulation are more and more demanding for a sustainable change. We believe that based on the 'traditional' automotive values of individual freedom and flexibility and thanks to disruptive technologies the automobile can not only consolidate its position as preferred choice for mobility of persons and goods, but can also positively develop in a sustainable way, in terms of economy and ecology during the 21th century. However, we also strongly believe that the 'willingness to chance' is by far the strongest factor in this transition, in other words, the social part of the innovation process of new technologies. This calls for a closer look at the underpinning desirable targets of our will to change to sustainable automotive mobility. That's why we defined Six Zero's, as targets that are hard to refuse.

3.1 The Six Zero's

The following Six Zero's will be worked out and illustrated in the full paper:

- Zero Emission: Why should we still want and accept air pollution, climate change and noise produced by our automotive mobility while we can do without by using electric vehicles?
- Zero Energy: Why should we still want to spill energy or risk the depletion of energy supply by our automotive mobility if we can drive EV's on renewable electricity from sun, wind and water?
- Zero Congestion: Why would we still want and like to get stuck in traffic jams while using cars and trucks if connected and automated vehicles and roads can avoid or by-pass them?
- Zero Accident: Why should we still want or risk of possibly fatal accidents due to unsafe driving and lack of control by human drivers while automated or autonomous vehicles will be much safer?
- Zero Empty: Why should we still want or accept that cars are on average on 25% utilize the passenger space and truck are on average less than 50% filled with freight, while sharing them by electronic travel data exchange and internet of things could fully use them to full capacity?
- Zero Cost: Why would we still want pay for owning our own vehicle and spending a lot of money on vehicles that are more parked than moving, while though sharing, using big data and Internet of Things vehicles can cover their own cost?

To conclude, we should question ourselves; do we want to reach the following goals in a foreseeable timeframe or not? If the answer is positive, automotive will indeed be the future of mobility.
To summarize, Figure 2 shows the relation between the three disruptions and six zero's.

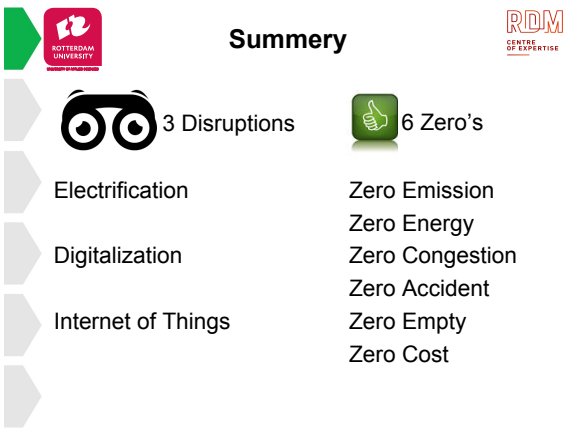

Figure 2. Relation between the three disruptions and six zero's [13]

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References

[1] J. Dulac, Global Transport Outlook 2050, International Energy Agency, 2014
[2] Port Vision 2030, Port of Rotterdam, 2011
[3] L.F. Verheij, Nulmeting RCI, Uitstoot CO_2 Rotterdam, RCI, 2005
[4] F.G. Rieck, SIA Raak PRO-1-248, Inhoudelijke eindrapportage eMobility-Lab, Hogeschool Rotterdam, 2014
[5] Technisch verslag pilotproject openbaar vervoer per bus in de regio Rotterdam, e-Busz, Stichting NEMS, 2013
[6] Verkenning elektrisch rijden, Deel 1: Technologische onzekerheden en uitdagingen rondom elektrisch rijden in Nederland, hoofdstuk 2.5 Veiligheid en Milieu, Dutch-INCERT, 2010
[7] Nicola One, Motor Company, https://nikolamotor.com/, accessed on 2017-02-14
[8] D. O'Connell, Tesla, Keynote speech presentation at Nordic EV Summit, Drammen, Norway, 2017-02-07
[9] S. van Sterkenburg, Analysis of regenerative braking efficiency - A case study of two electric vehicles operating in the Rotterdam area, VPPC paper, USA, 2011
[10] B. Veenhuizen, "INTRALOG - Intelligent Truck Applications in Logistics", HAN University of Applied Sciences, 2014
[11] B. van Aram, STAD: Spatial and Transport Impacts of Automated Driving Project proposal, NWO Sustainable Urban regions of the Future (SURF) TU-Delft, 2015
[12] T. Seba, Clean disruption of energy & transportation, ISBN 9780692210536, 2014
[13] F.G. Rieck, Inspiration session at Research Centre Sustainable Port Cities, Rotterdam University, The Netherlands, 2016-12-13

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