Survey: Atmosphere Impact of Eco-friendly Automobile System with Specifications

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Abstract— *Electric vehicles have been identified as being a key technology in reducing future emissions and energy consumption in the mobility sector. The focus of this article is to review and assess the energy efficiency and the environmental impact of battery electric cars (BEV), which is the only technical alternative on the market available today to vehicles with internal combustion engine (ICEV). Electricity onboard a car can be provided either by a battery or a fuel cell (FCV).The technical structure of BEV is described, clarifying that it is relatively simple compared to ICEV. Following that, ICEV can be 'e-converted' by experienced personnel. Such an e-conversion project generated reality-close data reported here.*

Keywords— Battery electric vehicles, Sustainable mobility, Traffic emissions, CO2, Internal combustion engine vehicle, Plug-in hybrid electric vehicle, Fuel cell vehicles.

I. INTRODUCTION

On a worldwide scale, 26% of primary energy is consumed for transport purposes, and 23% of greenhouse gas emissions is energy-related. Automobiles play a particular role for three reasons: First, cars are dominating the street traffic in most countries. Second, car sales exhibit the greatest growth rates in the world. Third, there are alternative technologies for the drivetrain available unlike, e. g., for trucks.

While small trucks may also be operated electrically within a limited range, big trucks are dependent on diesel fuel, which can be shifted to a mixture of 80%. methane (either fossil or biogenic) in the future. Buses can also be driven electrically on limited distances; buses driven by compressed natural gas (methane) are routinely used. While fuel cell-driven buses are already on the streets, small trucks driven by fuel cells and H2 are still concepts.

In order to meet future mobility needs, reduce climate as well as health relevant emissions, and phase out dependence on oil ('peak oil'), today's propulsion technologies. have to be replaced by more efficient and environmentally.friendly alternatives. On the transition to a sustainable society, particularly efficient mobility technologies are needed worldwide. Electric vehicles have been identified as being such a technology [1]. In parallel, a couple of countries (like Germany, Denmark, and Sweden) have decided to switch electricity production from fossil fuel to renewable sources, further improving sustainability of electric cars when compared with ICEV.

II. TECHNOLOGY

A. Concept of Electrical Car:

At the beginning of the automobile's history, two main competing approaches to engine-driven vehicles existed: one with internal combustion engine (ICE) and another one with an electric drive train. Already in 1834, the American inventor Thomas Davenport built The first electric car. The first ICEV was developed in 1886 by Benz and Daimler in Germany.

Around the year 1900, electric cars had a significant share of all engine driven cars. At the same time, F. Porsche already invented a hybrid electric car equipped with an ICE range extender and wheel hub electric engines. The two different drive trains were competing until Henry Ford, in 1908, chose an ICEV for the first mass production of a car in history (summarized in [2]). This way, ICEV won the race early in the twentieth century and displaced the battery electric vehicles (BEV). From an environmental perspective, this may have been one of the biggest mistakes in the history of technology.

B. Technical Component of Electrical Car:

The main components of a BEV can be divided into the electric battery, the electric motor, and a motor controller. The technical structure of a BEV is simpler compared to ICEV since no starting, exhaust or lubrication system, mostly no gearbox, and sometimes, not even a cooling system are needed. The battery charges with electricity either when plugged in the electricity grid via a charging device or during braking through recuperation. The charger is a crucial component since its efficiency can vary today between 60% and 97%, wasting 3% to 40% of the grid energy as heat. The motor controller supplies the electric motor with variable power depending on the load situation. The electric motor converts the electric energy into mechanical energy and, when used within a drive train, to torque. In series BEV produced so far, central engines have been used; however, hub wheel electric engines are also possible and would be available for mass production (summarized in [2]).

However, the enormous increase in energy density offered by Li-ion batteries is the prerequisite for the expected widespread electrification of cars. Nickel metal hydride batteries were used in the interim time when the re-electrification of the automobile started in the 1990s. However, they do not offer enough power and have a worse environmental impact compared to Li-ion batteries (see below). The only alternative to Li-ion batteries with comparable power, the Zebra cell (Table 2), is based on molten salt and, thus, only useful for continuous everyday use. Today, a lot of different Li chemistries are available, and prices are continuously decreasing for Liion batteries (e.g., summarized in [12]). However, the price for a complete Li-ion cell set offering 14 kWh capacity, allowing a 100-km electrical range of a small-size car (like a Smart, see below), is still in the order of 5,000 Euro including taxes. Life cycle impacts of the various Li-ion chemistries differ significantly.

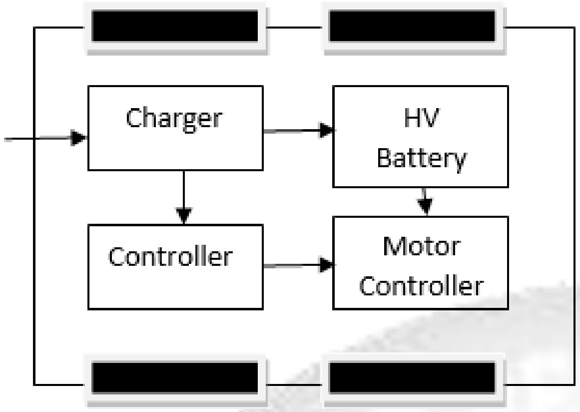

Fig. 1: Components of Electrical Automobile System

The greenhouse gas emissions of the BEV can easily be calculated based on its electricity consumption and following the GHG emission associated with the local electricity production [1,5]. In the literature, there are plenty of data quantifying greenhouse gas emissions of electric cars in operation.

On the contrary, we assume that, in the next few years,electric cars will be mostly small or mid-size cars (see above). An e-conversion project, performed in the laboratory of the authors in 2011, may illustrate weight data exemplarily: A Smart built in the year 2000 has been e-converted from combustion engine to an electric car. A 25-kW electric engine and a 14-kWh LiFePO4 battery were installed, allowing a range of up to 120 km. The curb weight grew by 161 kg to 880 kg, which is little more than half of the car weight assumed by Helms. A Mitsubishi I-MiEV weighs 1,110 kg and is equipped with a 16-kWh Li-ion battery. The Nissan Leaf, however, the first high-volume mid-size electric car, weighs 1,525 kg and operates a 24-kWh lithium battery.

C. Life Cycle Impact:

Life cycle categories further than GWP implemented in LCA reports on electric cars published so far are abiotic depletion potential and non-renewable cumulative energy demand. however, pointed out additionally that BEV charged with electricity with a significant portion of nuclear energy will be associated with a backpack of nuclear waste production. Also, he identified disadvantages of BEV compared to ICEV in the land use category and, particularly noticeable, in the human toxicity potential category, both due to the production of the lithium battery.

On the other hand, there are advantages of BEV over ICEV in the impact criterions resource damage and photochemical oxidation potential [3]. This is due to the sulfur emissions during the smelting of metals like Cu and Ni and may also be due to associated SO2 emissions when components are produced in countries like China, where electricity production is dominated by coal-fired power plants. However, there are differences within the batteries: LiFePO4 batteries have a lower acidification potential since they contain no nickel [4].

III. CONCLUSIONS

The electric car seems to be a suitable instrument and a sustaining measure towards a more sustainable mobility future since it is four times more energy efficient compared to ICEV. Therefore, it is seen as a milestone towards a ‘Great Transformation’. The TTW efficiency advantage of BEV over ICEV, together with the efficiency jump by Li-ion batteries, enable the electrification of the automobile as long as it is moved in regional ranges of up to 100 km per day. However, WTW efficiency of electric cars can reach exemplary figures only when electricity is provided by very efficient power plants and infrastructure, best with renewable energy production. Also, electric cars should be incorporated into a variety of modern mobility concepts.

Life cycle impact of BEV in categories other than the global warming potential reveals a complex picture, although BEV demonstrates advantages over ICEV in most categories. One disadvantage of BEV is the acidification potential associated with the smelting processes of Cu, Ni, and Co since a lot of Cu and, in some battery types, Ni and Co also are essential elements of electrical components. Additionally, there are acidifying emissions of coal-fired power plants depending on the local value of this type of power production.

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