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International Cooperation on Hybrid & Electric Vehicles under the International Energy Agency's Energy Technology Network

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Summary

The International Energy Agency (IEA) established a Technology Collaboration Program (formerly called Implementing Agreement) on "Hybrid and Electric Vehicles" in 1994. Today 17 member countries participate in sixteen working groups related to electric vehicles, components, deployment, infrastructure, and environmental/economic issues. Recent activities and key results from these working groups are described.

Keywords: HEV (hybrid electric vehicle), EV (electric vehicle), PHEV (plug in hybrid electric vehicle), federal government, deployment

1 Introduction

The International Energy Agency (IEA) is made up of 29 member countries and runs 39 collaborative research programs, designated as the Technology Collaboration Programs (formerly called Implementing Agreements) as part of the IEA's Energy Technology Network. These programs foster the collaboration of government organizations, national laboratories, research institutes, universities and industrial companies. The aim is to speed up the technical and non-technical problem solving in the field of technologies for energy efficiency, more efficient use of resources, and the use of renewable energies. The goal is a broader and more stable energy supply and a limitation of CO_2 emissions. One of the key technologies is the motorized traffic. It is one of the major sources of CO_2 emissions, it actually relies mainly on fossil energies and it is very energy-inefficient.

The IEA Implementing Agreement for co-operation on Hybrid and Electric Vehicle Technologies and Programmes (IA-HEV) was set up in 1993 as a basis for collaboration on pre-competitive research and the production and dissemination of information. In 2016 the name of the agreement changed to Hybrid and Electric Vehicles Technology Collaboration Programme (HEV-TCP). Today, the HEV-TCP has 17 participating member countries. The HEV-TCP member countries are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

2 Activities

Every five years the Implementing Agreement prepares and delivers a new five-year work plan to the IEA headquarters. The work plan for 2015-2019 has been completed and approved. Under the new rules, participation of non-IEA countries is possible. This allows important countries in the production and the use of hybrid and electric cars to participate and to contribute to the international research activities.

The actual activities are carried out under working groups, or Tasks [1]. Countries join various Tasks depending upon their particular interests. An individual Task typically has about 3-8 participating countries.

The sixteen current working groups are:

- Task 1: "Information exchange" - Activities include country experts meetings, an annual report, a newsletter, and a web site (www.ieahev.org)

- Task 23: "Light electric vehicle parking and charging infrastructure" -- Objectives are to document existing solutions for best practice, create turnkey guidelines for local governments, and conduct workshops for interested communities.

- Task 25: "Plug-in Electric Vehicles" -- Objectives are to compare full-function HEVs, PHEVs, and EREVs with advanced conventional powertrains (clean diesel, turbocharged direct injection petrol, CNG, other); to conduct a systematic cost methodology comparison (i.e. battery, multiple TCO models), and to conduct a systematic market penetration methodology comparison to evaluate policy alternatives to increase market size.

- Task 26: "Wireless power transfer for electric vehicles" – Objectives are to promote interoperability and standards development; discuss safety issues of misalignment, leakage fields, and debris tolerance; and begin cataloguing potential grid impacts.

- Task 27: "Electrification of transport logistic vehicles (eLogV)" – Objectives are to produce a summary of the status of technologies, implementations and hurdles; identify early niche markets and commercialization opportunities; and provide policy recommendations for further RD&D activities.

- Task 28: "Home grids and V2X technologies" – Objectives are to analyze the technical and economic viability of vehicle to grid technology, produce a policy-making toolbox, and define a technology roadmap.

- Task 29: "Electrified, connected, and automated vehicles" – Objectives are to analyze the potential technological synergies of electrification, connectivity and automation of road vehicles and derive research, development and standardization needs; study the business models combining electrification and connectivity /automation of road vehicles and identify the need for action by companies and/or governments; and to assess the impact of user/driver behavior on the combination of electrification, connectivity and automation and conclude on needs for measures in awareness and legislation.

- Task 30: "Assessment of the environmental effects of electric vehicles" – Objectives are to analyze the environmental effects of electric vehicles (EVs) based on life cycle assessment (LCA), including the production, operation and the end of life treatment of the vehicles, and in comparison to conventional vehicles. Assessment will include effects of EVs on water, air, land use (resource consumption, waste management), and overall environmental effects and their assessment.

- Task 31: "Fuels and energy carriers for transport" – Objectives are to provide policy makers with up-to-date insight in environmental and energy impacts of (PH)EVs compared to ICEVs (petrol and diesel); to assessing potential impacts of future developments in vehicle technology and energy systems (up to 2030); and to focus on life cycle GHG emissions and local pollutants, with noise and energy security.

- Task 32: "Small Electric Vehicles" -- The objective is to promote a broader commercialization, acceptance, and a further development of small electric vehicles (SEVs) by collecting and sharing pre-competitive information, exchanging framing conditions, best practices and ideas, how to further develop the market conditions and mobility concepts. Specifically, the objectives are twofold: Increased safety, comfort and usability at lower costs for SEVs due to technological progress, and better market perspectives for SEVs due to a change in surrounding conditions like e.g. regulations, transport policies and mobility concepts.

- Task 33: “Battery Electric Buses” – The objective is to analyze the current state of technology and demonstration experience, analyze future perspectives and technology developments, identify critical success factors, and analyze sustainability issues.

- Task 34: “Batteries” – Objective is to exchange information to advance battery technology in focused working groups and workshops. Topics may include response to battery fires, internal short circuits, and second use or disposal of vehicle batteries.

- Task 35: “Fuel Cell Electric Vehicles” – Objective is to analyze the current technology, future prospects and research needs for fuel cell electric vehicles (FCEVs), including hydrogen station concepts and market conditions for FCEVs and hydrogen stations. The task will document international differences and best practices.

- Task 36: “Electric Vehicle Purchase and Use Patterns” – Objective is to provide a platform to connect stakeholders with researchers working on consumer adoption and use of EVs, and to distill a set of policy-relevant messages from the research findings and related discussions.

- Task 37: “Extreme Fast Charging” -- Objective is to understand impacts, requirements, standards, and benefits for charging rates up to 350 kW. Task will investigate station siting factors, quantify cost of installation, document power supply and grid connection, understand implications of extreme fast charging on battery design and cost, understand pay structure, and study consumer education.

- Task 38: “Marine Applications of Hybrid and Electric Systems (e-Ships)” – Objectives are to provide a leading platform on e-Ships, bridging “blue” maritime, “green” energy, e-mobility and automation perspectives; to characterize and showcase the technology, economics, energy and environmental aspects, applications and market potential of e-Ships; and to provide data and recommendations to policymakers to accelerate adoption and market acceptance of e-Ships.

3 Key Results

Some key results from the various working groups include, among others, the following:

- *Electric Vehicle Business Models -- Global Perspectives*. This volume collects insights from industry professionals, policy makers and researchers on new and profitable business models in the field of electric vehicles (EV) for the mass market. This book includes approaches that address the optimization of total cost of ownership. Moreover, it presents alternative models of ownership, financing and leasing. The editors present state-of-the-art insights from international experts, including real-world case studies. [2]

- *EV Ecosystems project*. The HEV-TCP held workshops on creating EV Cities of the Future in Newcastle, London, Istanbul, Barcelona, and Los Angeles. Good timing related to all aspects of electric vehicle deployment and infrastructure, involving all stakeholders, taking away uncertainties, and making electric vehicles financially attractive are necessary and powerful tools to foster the deployment of electric mobility. The actual level of deployment depends on a wide range of other factors as well, such as governmental priorities, population density and spread, availability of (renewable and clean) electricity, and the overall economic situation. [3]

- *EV City Casebook*. This report documents the results to share experiences on EV demonstration and deployment, identify challenges and opportunities, and highlight best practices for creating thriving EV ecosystems. The EV City Casebook presents informative case studies on city and regional EV deployment efforts around the world. These case studies are illustrative examples of how pioneering cities are preparing the ground for mass-market EV deployment. They offer both qualitative and quantitative information on cities’ EV goals, progress, policies, incentives, and lessons learned to date. These studies enhance the understanding of the most effective policy measures to foster the uptake of electric vehicles in urban areas. [4]

- *Advanced Hybrid and Electric Vehicles: System Optimization and Vehicle Integration*. This book contains the results of the research program "Agreement for Hybrid and Electric Vehicles", developed in the framework of the Energy Technology Network of the International Energy Agency. The topical focus lies on technology options for the system optimization of hybrid and electric vehicle components and drive train configurations that enhance the energy efficiency of the vehicle. The approach to the topic is genuinely interdisciplinary. [5]

- *Economic Impact Assessment of E-Mobility.* Eight countries participated in this task from May 2014 until the end of 2016. The study focused on the economic impact of the introduction of electric mobility. It examined the ways in which electric mobility can strengthen the economic position of a country, and what kind of economic growth can be expected in the electric mobility sector. Key economic indicators were identified as the number of jobs in e-mobility, the annual revenues related to e-mobility, and the exports related to e-mobility. Common value chains for the manufacturing of electric vehicles, charging infrastructure, energy and mobility services were developed. Each participant produced a country report on the economic perspective in their own country, and a final report summarizes and analyzes the work. [6]

- *Disrupting Mobility: Impacts of Sharing Economy and Innovative Transportation on Cities.* This book contains results from the HEV-TCP task on electrified, connected, and automated vehicles. The book, part of the series on Lecture Notes in Mobility 2017, describes the best ideas from the sharing economy and smart systems integration that could truly disrupt mobility. One of the major insights of the book is that truly disruptive innovation potential can be unlocked if technologies like electric cars and self-driving pods are combined with game-changing business and operational models like ride-sourcing and car-sharing. [7]

- *Quick Charging Technology for Plug-in Electric Vehicles.* A report on the current status of quick charging technology describes quick charging technology deployment developments and trends, discusses objectively how quick charging technology can contribute to the deployment of electric vehicles, and provides recommendations for setting up a roadmap for quick charging technology development and implementation. [8]

- *Life Cycle Assessment (LCA) of Electric Vehicles (EVs).* The working group identified how electric drivetrain vehicles should be designed for optimal recyclability and minimal resource consumption. It also identified the best available technologies and practices for managing the materials in EVs at the end of their useful life, when the vehicle is dismantled. Country-specific factsheets on the environmental impacts of hybrid and electric vehicle sales were quantified. The analysis takes into account the electricity generation mix specific for each country. Environmental effects depend strongly on the national electricity generation. For HEV-TCP countries, the greenhouse gas emissions of electricity supply at the charging point ranges from a low of 50 g CO2eq/kWh in Sweden, to a high of about 700 g CO2eq/kWh in Ireland and the United States. The estimated reduction in greenhouse gas emissions per average EV/PHEV ranges from a 8-76% reduction, depending on the country-specific electricity generation mix.

- *Workshops on Battery Safety*. Internal short circuits were the focus of two workshops because they are of great concern to anyone using lithium-ion batteries. A short can result in thermal runaway with significant safety issues. Internal short circuits remain one of the most challenging issues for battery developers and users. Experienced designers believe that they can address failures such as overcharging, over discharge, and unbalanced cells through appropriate electrical controls. In a similar manner, they believe that an appropriate battery housing can protect against reasonable crush and penetration incidents. But they are concerned that they do not yet have a practical, cost effective way of insuring that an internal short will never result in a cell or battery failing.

4 Conclusions

The International Energy Agency's Hybrid and Electric Vehicle Technology Collaboration Program (HEV-TCP) enables member countries to discuss their respective needs, share key information, and learn from an ever-growing pool of experience from the development and deployment of hybrid and electric vehicles.

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