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## **New Task on Life Cycle Assessment of Electric Vehicles in IEA IA-HEV (Hybrid and Electric Vehicles)**

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### **Abstract**

Electric vehicles have the potential to substitute conventional vehicles to contribute to the sustainable development of the transportation sector worldwide, e.g. reduction of greenhouse gas and particle emissions. There is international consensus that the improvement of the sustainability of electric vehicles can only be analysed on the basis of life cycle assessment (LCA) including the production, operation and the end of life treatment of the vehicles. For example, about 90% of the greenhouse gas emissions of a vehicle running on renewable electricity from hydro power derive from the production and end of life treatment of the vehicle, and only 10% stems from vehicle operation. Based on LCA activities in its 15 member countries, the IEA Implementing Agreement on Hybrid and Electric Vehicles (IA-HEV) starts a new Task on the LCA of electric vehicles. The main topics to be addressed are: 1) LCA methodology, 2) frequently asked questions, 3) overview of international LCA studies, 4) parameters influencing the energy demand of vehicles, 5) LCA aspects of battery and vehicle production, 6) end of vehicle life management, 7) LCA aspects of electricity production, distribution and vehicle battery charging, 8) R&D demand. A Research Platform for Life Cycle Assessment and End of Life Management for Electric Vehicles is established in IA-HEV, to further augment the benefits and competitiveness of electric vehicles. The new IA-HEV Task “Life Cycle Assessment of Electric Vehicles - From raw material resources to waste management of vehicles with an electric drivetrain” started in November 2011 with three participating countries: Austria, United States and Switzerland. The operating agent is Gerfried Jungmeier from JOANNEUM RESEARCH in Austria. The Task will end in 2015.

*Keywords: LCA (Life Cycle Assessment), EV (electric vehicle), recycling, second-life battery, ZEV (zero emission vehicle)*

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# 1 Introduction

Electric vehicles have the potential to substitute conventional vehicles to contribute to the sustainable development of the transportation sector worldwide, e.g. reduction of greenhouse gas and particle emissions. There is international consensus that the improvement of the sustainability of electric vehicles can only be analyzed on the basis of life cycle assessment (LCA) including the production, operation and the end of life treatment of the vehicles (Figure 1). For example, about 90% of the greenhouse gas emissions of a vehicle running on renewable electricity from hydro power derive from the production and end of life treatment of the vehicle, and only 10% stems from vehicle operation. In addition all environmental impacts must also include the whole value chain and - if relevant – interactions from recycling in the dismantling phase to the production phase, if recycled material is used to produce new vehicles (Figure 2).

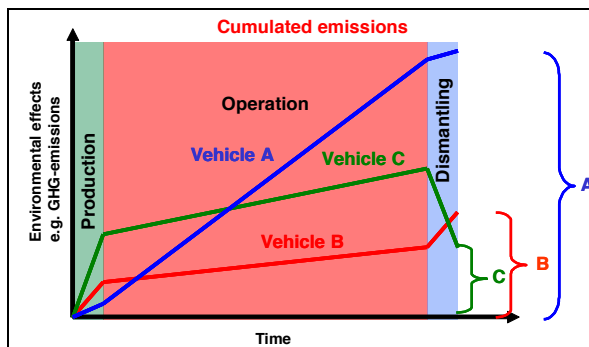


Figure 1: Life cycle assessment of the three phases in the life cycle of a vehicle – production, operation and dismantling

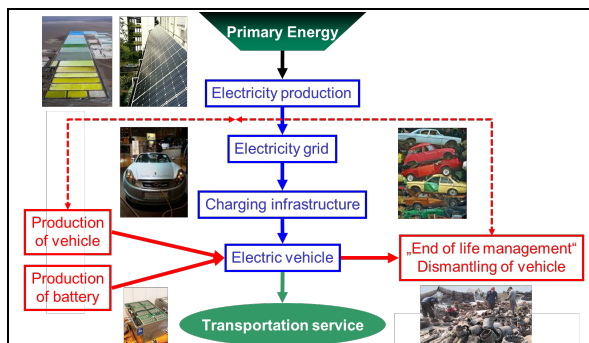


Figure 2: Assessment of LCA-aspects over full value chain

Based on the LCA activities in its 15 member countries, the IEA Implementing Agreement on Hybrid and Electric Vehicles (IA-HEV) starts a new Task on the LCA of electric vehicles. The main goals of this Task are

- provide policy and decision makers with FACTS for decisions on EV related issues
- improve “END OF LIFE MANAGEMENT” by promotion of best available technologies and practices
- improve DESIGN for optimal recyclability and minimal resource consumption
- establish "RESEARCH PLATFORM for life cycle assessment including end of life management for electric vehicles“ to augment the benefits and competitiveness of vehicles with an electric drive train.

## 2 Materials and Methods

The Task is a networking activity, which means that the experiences from the national projects are fed into the IA-HEV LCA Platform and discussed on an international level. Each participant contributes to the different topics in the Task based on a work sharing principle. The main topics to be addressed in the three year working period are:

- 1) LCA methodology, e.g. system boundaries, allocation
- 2) frequently asked questions
- 3) overview of international LCA studies
- 4) parameters influencing the energy demand of vehicles
- 5) LCA aspects of battery and vehicle production
- 6) end of vehicle life management
- 7) LCA aspects of electricity production, distribution and vehicle battery charging
- 8) summarizing further R&D demand.

A research platform for life cycle assessment including end of life management for electric vehicles is established in IA-HEV, to further augment the benefits and competitiveness of electric vehicles. The Task started in November 2011 with three participating countries: Austria, United States and Switzerland.

The Task considers the following vehicles and propulsion systems:

- Propulsion systems:
  - battery electric vehicle (BEV)
  - hybrid electric vehicle (HEV)
  - plug-in hybrid electric vehicle (PHEV)
  - range extender vehicle (REV)
  - hydrogen fuel cell electric vehicle (FCV) (incl. hydrogen production)
  - in comparison to ICE vehicle with gasoline, diesel and natural gas using current and future technology
- Road vehicles:
  - passenger cars
  - (light) utility vehicles
  - busses
  - 2-wheelers and
  - fork-lift trucks.

13) Documentation: proceedings, reports, papers, notes, presentations

14) Management and operation of the Task.

The time planning of the task activities during the three years is shown in Figure 3, the most important networking activity in this LCA platform is the organisation of the five workshops.

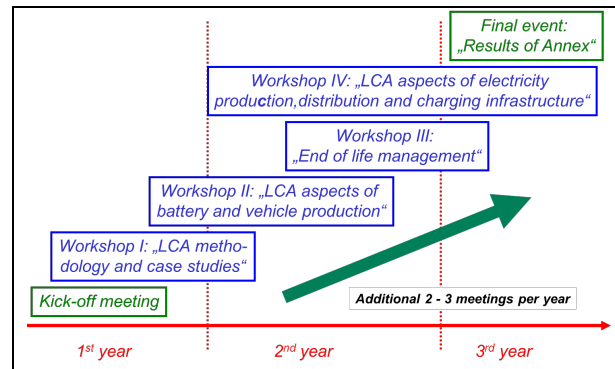


Figure 3: Time planning of the Task work

The work packages that are covered by the members from the participating organizations are

- 1) LCA methodology e.g. system boundaries
- 2) Frequently asked questions
- 3) Overview on international studies
- 4) Influences on the energy demand of vehicles
- 5) LCA aspects of battery and vehicle production
- 6) End of life management
- 7) LCA aspects of electricity production, distribution and charging infrastructure
- 8) Necessary and available data
- 9) Overview of key actors and stakeholders
- 10) R&D demand
- 11) Workshops
  - I. Workshop I: „LCA methodology and case studies“
  - II. Workshop II: „LCA aspects of battery and vehicle production“
  - III. Workshop III: „End of life management“
  - IV. Workshop IV: „LCA aspects of electricity production and infrastructure“
  - V. Final event: „Results of Task“
- 12) Conclusions and outlook

### 3 Results and Discussion

The expected results of this international networking activity in IA-HEV are summarized in Figure 4. Inputs and results from national projects will be collected and discussed in the Task. Examples of possible national inputs are shown in Figure 5 giving a comparison of greenhouse gas emissions of vehicle production, and in Figure 6 giving the life cycle based greenhouse gas emissions of electric vehicles.

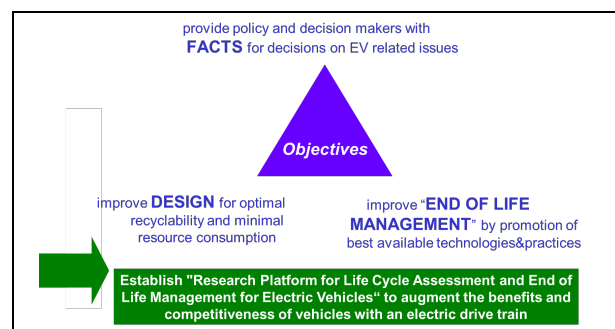


Figure 4: Expected results

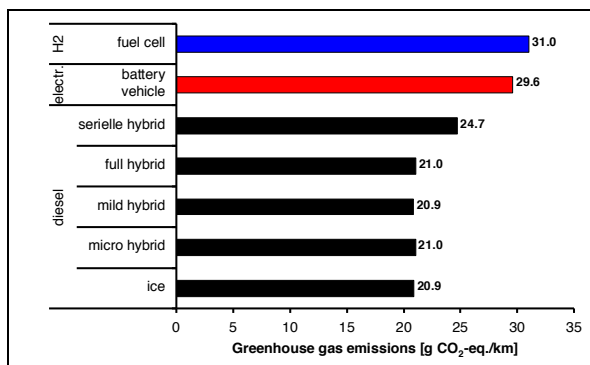


Figure 5 : Greenhouse gas emissions of vehicle production

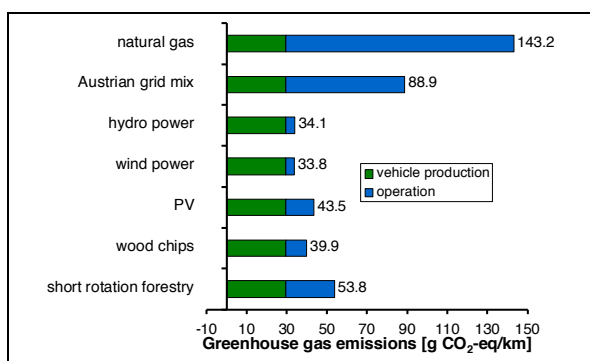


Figure 6: Life cycle based greenhouse gas emissions of electric vehicles

The countries participating since January 1<sup>st</sup>, 2012 are

1. Austria
2. Germany
3. Switzerland
4. USA

## Acknowledgments

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## Author

Highlights of professional experiences:

- life cycle assessment of bioenergy for transport, electricity, heat and biorefineries
- greenhouse gas assessment of products and services
- sustainability assessment and future scenarios for transportation fuels of the future – biofuels, e-mobility and hydrogen.

Present Positions:

- Area Manager at JOANNEUM RESEARCH “Energy Systems and Strategies”
- Lecturer: Vienna University of Technology; University of Graz; University of Applied Science, University of Applied Science Kapfenberg, Danube University Krems
- Austrian Team Leader in IEA Bioenergy Task 42 “Biorefinery”

