E-mobility: Chances and Challenges

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SDU

Centre for Industrial Electronics cie

E-mobility: Not just cars

Provision of Energy for e-mobile

3 mega trends:

- Battery based concepts
  - Battery stores the complete propulsion energy
  - Electric motors convert the energy into motion
- Hydrogen based concepts
  - Energy is stored in pure hydrogen or hydrogen based gases or liquids
  - Fuel cells and e-motors or combustion engines convert the energy into motion
- Trolley system
  - Energy is continuously provided by overhead contact wires

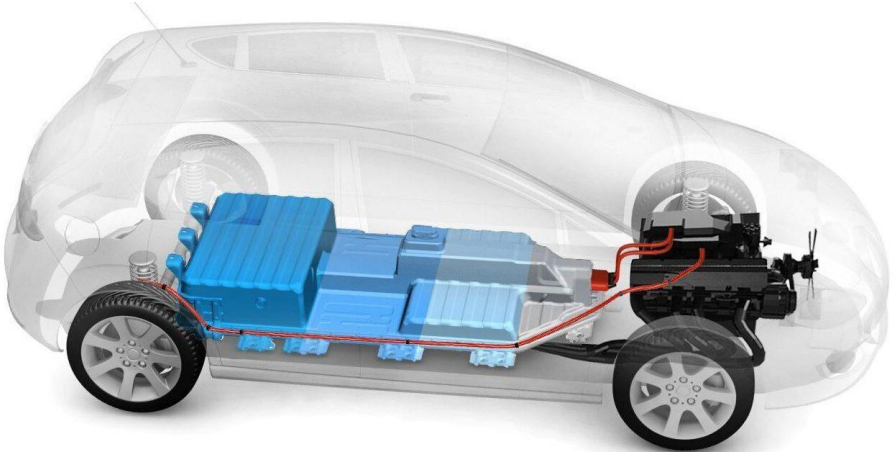
Battery based concepts

Challenges

- Batteries are heavy and bulky
- Battery lifetime is limited
- High kWh cost
- Charging infrastructure not sufficient
- Electricity network not ready for high EV share

Chances

- Breaking energy recuperation (Flywheel, super caps)
- Efficient drives and motors
- Intelligent battery management systems
- Intelligent battery charging systems
- Smart grids



Electric vehicles are part of the smart grid

High speed motors and drives

Why high speed motors in EV?

- Increased power density and efficiency
- Reduction of weight
- Elimination of gear change

Challenges:

- New drive topologies and/ or new components to facilitate high motor frequencies
- New control strategies
- Reliability issues with new fast switching components
- Compact and reliable drive and motor design

SDU/CIE contribution to e-mobility

Formula Student

- Students build autonomous electrical race car
- Competences in interdisciplinary team work
- Knowledge about future concepts and components

New Power Devices: SiC/GaN

- Performance improvement
- Reliability investigation
- Life time prediction
- Failure Analysis
- Control optimisation

Capacitors

- New material development
- Performance improvement
- Reliability investigation
- Life time prediction
- Failure Analysis
- Super Capacitors

High speed drives

- Elimination of gearbox
- Efficiency improvement
- Reliability improvement
- New topologies

Energy production

- Renewables
- Smart Grid
- (inductive) charging

CIE – Services

Consulting

- Technology radar and clarification

Test & measurement

- Characterisation of power semiconductors*
- Characterisation of passive devices*
- Reliability of power semiconductors/ passive devices (power cycles)*
- EMC*

Simulation

- Thermal-mechanical simulations
- Electrical-circuit simulation
- EMC*

Demonstrators

Prototyping & product development

Failure analysis (imaging, electrical test*)

- Power semiconductors
- Passive devices*
- EMC*

Reverse engineering

- Topologies
- Devices
- Thermal concept

Acoustics

- 3D sound simulation, sound design
- Acoustic analysis of machines
- Interfacing human-machine

* planned for end 2019

CIE – Collaboration Variants

Education*	Costs and commitment	Contract	Results
Semester Projects / Experts in teams Companies suggest a topic to student teams and co-supervise the progress. The topic shall match the curriculum. "Experts in teams" consists of 5th semester students teaming up from different engineering programmes. Duration: 15 weeks	Free of charge, sponsorship of materials or travel, supervising in various amounts is expected	Optional Non-disclosure / IPR agreement	E.g. technology concepts, business models, prototypes, demonstrators
Bachelor and Master Thesis Companies define with a student and academic supervisor a topic for a thesis. The topic shall have academic relevance. Duration: 15 weeks	Free of charge, sponsorship of materials or travel	Contract with SDU, optional Non-disclosure /IPR agreement	Thesis e.g. incl. prototypes, demonstrators, business models
Internship Companies offer a) students (6th semester, Diploma/B.Eng.) an Internship in their company: full-time, duration 20 weeks. Requires an Engineer supporting the intern in the company.	Internship: suggested monthly salary ≈ 14.000 kr. Salary is not a demand for the internship.	Contract with SDU, optional Non-disclosure /IPR agreement	According to internship agreement
In-company project Companies offer students (3rd semester, M.Sc.) an In-company project related to academic topics: 2 days per week in the company, duration 15 weeks. Requires an Engineer or staff with adequate education (M.Sc. level) supervising the student in the company.	Free of charge	Contract with SDU, optional Non-disclosure /IPR agreement	According to project description approved by the academic study board
Guest lectures, site visits and others Companies offer guest lectures, company visits or other formats such as innovation camps or presentations contributing to the education of engineering students.	Free of charge, sponsorship of travel	n/a	n/a
Student jobs Companies offer student jobs (e.g. 8-10 hours per week) or full-time jobs in the SDU database www.sdu.dk/jobbank	Salary agreement between company and student	Employment contract	According to contract

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Spring Semester	Oct - Dec	Jan	Feb	Mar	Apr	May	Jun
Semester projects	Proposal by 01/12		Project execution				
Thesis	Contract by 01/02		Project execution				
Internship	Contract by 01/01		Project execution				

Autumn Semester	Mar - May	Jun - Aug	Sep	Oct	Nov	Dec
Semester projects / Experts in teams	Proposal by 15/05		Project execution			
Thesis(only B.Eng.) /In-company project	Contract by 01/09		Project execution			

CIE – Collaboration Variants

Research Collaboration	Costs	Contract	Results
Public co-funding Companies apply with SDU and eventually more partners for public funding (e.g. Innovationsfonden) to run a joint project. SDU supports the application writing.	Partners bear own costs which are co-funded.	Grant agreement, optional Non-disclosure /IPR agreement	Partners keep own results, IPR and publication rights. Licensing can be agreed.
Private co-funding Companies co-finance a research project with the university, which is in the scientific interest and is relevant for both.	Co-financing based on individual agreement	Collaboration agreement, optional Non-disclosure /IPR agreement	Partners keep own results, IPR and publication rights. Licensing can be agreed.
Industrial PhD / Postdoc Companies employee an Industrial PhD student or Postdoc as a full-time employee for three years supervised by SDU and the company. Subsidies from the Innovationsfonden may be available.	Salary agreed between the company and the PhD student /Postdoc	Employment contract, PhD agreement with SDU	Companies own the results, PhD Student has to publish them (partly)

CIE – Collaboration Variants

Service	Costs	Contract	Results
Consulting Companies commission researchers who provide their specialist opinion and technology expertise on a specific topic.	Based on working hours and hourly rates	Service agreement	Companies own the results
Testing and analysis Companies commission researchers who test technical components, devices and systems regarding failures or specifications.	Based on working hours and hourly rates	Service agreement	Companies own the results
Rent of equipment Companies rent the university's lab space and analytical instruments which are run by the company's staff after a technical instruction.	Based on working hours and hourly rates	Service agreement	Companies own the results
R&D and product development Companies commission researchers who contribute with feasibility concepts, simulation, prototypes, demonstrators etc	Based on working hours and hourly rates	Service agreement	Companies own the results
Continuing education Companies commission researchers to develop and teach tailored seminars to their staff.	Based on working hours and hourly rates	Service agreement	Companies own the results


Thank you for attention!
Prof. Dr. Toke Franke
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