

Together we create
the electromobility
of the future.



SWEDISH ELECTROMOBILITY CENTRE, STAGE IV

Annual Report 2019



This is the Swedish Electromobility Centre

The Swedish Electromobility Centre (SEC) is a national Centre of Excellence for e-mobility. We unite Sweden's expertise and function as a node for interaction between academia, industry and society.

Our driving force is the development of sustainable and energy efficient transportation. We perform industry relevant research and study different e-mobility technologies to assess their potential. We give courses, arrange workshops and conferences, manage a doctoral student network and host an extensive analysis of energy efficient vehicles. Through our wide network of researchers and engineers at Sweden's leading vehicle manufacturers and technical universities, we provide valuable connections and strategic knowledge.

An eventful year

2019 was an eventful year within the Swedish Electromobility Centre. Completing stage 3 and kick-starting stage 4 has demanded much effort and time, but more than anything all the hard work have generated valuable insights, new connections, innovative ideas and important results. A new management team, new partners, new Thematic Leaders, a new theme area and increased financial support from the Swedish Energy Agency have made it possible for us to almost double in size.

Although the interest in electromobility is probably greater than ever before, it is also a field lined with challenges – how do we produce lighter, more efficient and sustainable batteries? How do we avoid using rare earth metals in vehicle production? And how do we incorporate the system perspective into the value chain? These are some of the issues that the skilled researchers connected to the centre dedicate much time to resolve.

Our role is as much about finding the answers as formulating the right questions. It is not an easy task to undertake, but by sharing the responsibility and working together we are certainly equipped to succeed.

We would like to give a special thanks to the Swedish Energy Agency and our partners, old and new, who have provided vital financial support to our projects. We are eager to continue achieving great things together, and look forward to creating new knowledge, experience, ideas and solutions within the vast field of emobility.



*Linda Olofsson,
Director, Swedish Electromobility Centre*



Photo: Jonathan Bean, Unsplash

They make it possible

The theme areas are the backbone of the Swedish Electromobility Centre, and the engagement from our partners in the thematic areas is essential. Over the course of 2019, SEC have grown significantly. VTI, Epiroc, TitanX, PowerCell, ABB, SAAB, Bombardier and University West all became new partners of the centre during the year.

Their involvement hold many new opportunities. As our new partners are not solely working within the automotive sector, SEC have expanded its working field from the roads to the air and seas. We are very happy to have broadened our network further and are eager to see what we can accomplish together. Because together is truly how we create the electromobility of the future.





Host collaboration, nourish curiosity and be the change

The Swedish Electromobility Centre is an engine, fueled by collaboration, curiosity and a will to make a change. Our aim is to generate knowledge within the field of electromobility that builds the foundation for a sustainable society, where it is possible to stay mobile and at the same time make environmentally conscious choices. By investing in high quality research today, we gain the knowledge needed to enable a systematic change of society tomorrow.

We have set our course, because we truly believe that working together and doing it right from the start provide for the best conditions to achieve success. Together we create the electromobility of the future. Together we create sustainmobility.



How it works

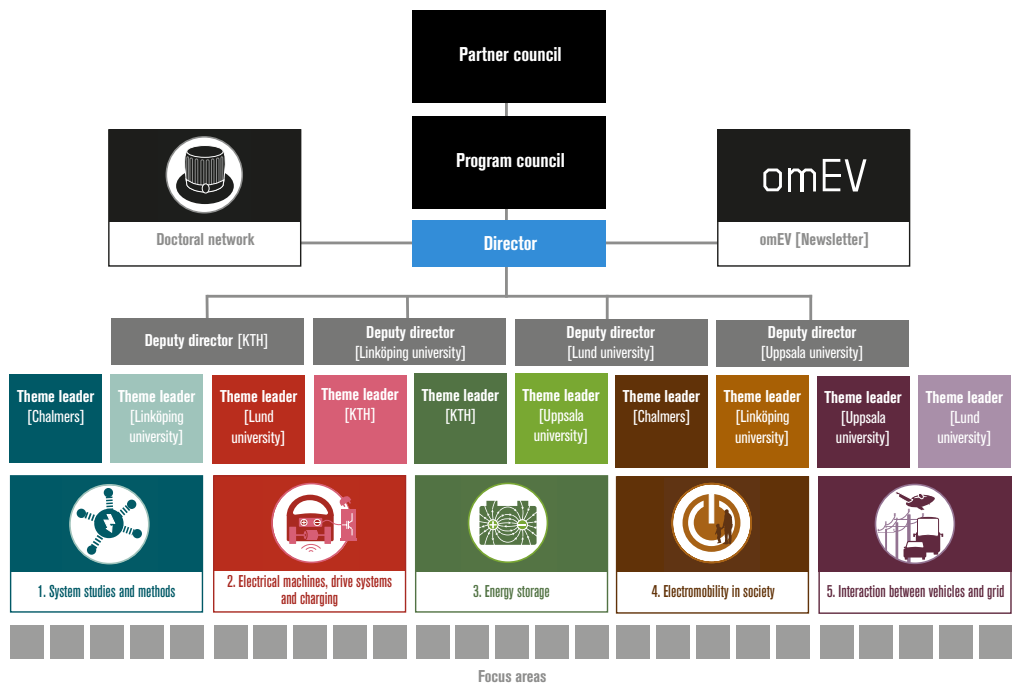
SEC is a national centre of competence that also functions as a network platform. Our work is based on collaboration and covers a wide range of scientific disciplines, where several universities work in the same research area.

Our field of activity touches on all additional technology areas in an electric or hybrid vehicle, the vehicle as a whole and its charging infrastructure.

The Swedish Electromobility Centre is funded by the Swedish Energy Agency. We operate through our Management Team, Program Council and our partners.

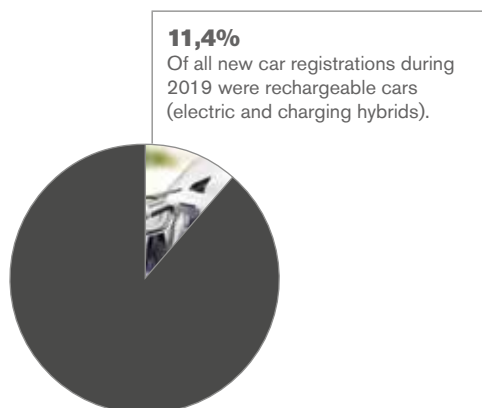
Our mission

The Swedish Electromobility Centre brings together the Swedish automotive industry and technical universities with a range of different research disciplines. All are connected through their relevance for electromobility and technology for electrification of vehicles. We promote both deep, narrow technical studies and cross-discipline and cross-institution research.



Our organisation

The research conducted at Swedish Electromobility Centre is divided into five separate theme areas. Each theme area has two theme leaders, responsible for managing the theme to serve as a platform for research collaboration and knowledge transfer within the specific theme area. Each theme has a theme group associated with it, company's specialists in each area and research participants from participating parties. All theme areas carry out SEC-funded research projects whose development and results are followed up at the theme group meetings.



Contributing to a sustainable society

The United Nations Global goals constitutes the most ambitious agenda for sustainable development on a global scale. Contributing to building a society where everything from the smallest component and batteries to the most complex systems are sustainable in every aspect is what truly lies at the heart of SEC's mission. Hence, our activities directly or indirectly affect several of the global goals for sustainable development.



No. 7: Affordable and clean energy

Electromobility makes it possible to decouple from direct emissions. The energy that fuels electrified vehicles can be generated from largely domestically produced sources, which unlike today's dependence on fossil fuels, has a low carbon footprint. Hydropower, windpower, biofuel cogeneration or solar power are a few examples. Using several different energy sources in the vehicle fleet also lower the risk of disruptions in energy supply. At the same time, the vehicle's energy storage can work as an important back-up in an energy system with a high proportion of intermittent renewable energy.


No. 8: Decent work and economic growth

Since the establishment of the SEC in 2007, industrial activity in the field of electromobility has increased greatly. At the start, a few vehicle manufacturers offered electric and hybrid vehicles for commercial purposes. Today, many offer hybrid vehicles, rechargeable hybrid ones or fully electrified vehicles in their model port-

folio. Subcontractors to vehicle manufacturers produce technically mature components and systems for energy storage, energy distribution, electric machines, power electronics, and subsystems. Continued investment in the SEC research thus improves the opportunities for Swedish automotive companies and companies in the generation, distribution and storage of electrical energy to assert themselves in the international competition.

No. 9: Industry, innovation and infrastructure

In the development of electromobility, research, innovation and technological advances are key in developing sustainable solutions to economic and environmental challenges. This applies nationally as well as internationally. A transition from fossil-based vehicle operations enables new markets and jobs, which can contribute to more efficient and fair use of resources globally. There is also a risk that some jobs will disappear. This in turn requires increased knowledge of resource extraction and environmental impact with a broad system perspective.



No. 11: Sustainable cities and communities

Sustainable urban development encompasses sustainable construction and sustainable planning of housing, infrastructure, public places, transport and recycling. A very important part of the quest for sustainable cities is high utilization of the city's surface through densification, and efficient transport systems for both goods and people. Here, electromobility plays several roles. At lower speeds, electric buses and cars are quiet and do not produce local exhaust gases, which is a very important prerequisite for combining efficient transport with dense buildings. In public transport, both rail-bound electric vehicles such as trains and trams, as well as internal combustion-driven buses, have challenges with noise. Vehicles that are fueled by electricity however are silent at lower speeds and can for the same reason deliver goods and collect waste at night, without disturbing the night's sleep in surrounding homes.

No. 13: Climate action

Climate change is a real and undeniable threat to our entire civilization. Greenhouse gas emissions continue to rise. As a result, we risk reaching an average global warming exceeding two degrees. This would have severe global impacts on the Earth's ecosystem, leading to increased ocean acidification and the risk of more extensive natural disasters, as well as increased threats to human health and security, food production and water supply. The effects are already visible. In 2016, the global road vehicle fleet consisted of 1.2 billion vehicles, which in turn accounted for 17% of the world's carbon dioxide emissions. Electrification of a larger proportion of these vehicles, in combination with renewable electricity or electricity production with low carbon dioxide emissions, has the potential to greatly reduce its contribution to the total carbon dioxide emissions globally.

Our thematic areas

The Swedish Electromobility Centre brings together the Swedish automotive industry and technical universities with a range of different research disciplines. All are connected through their relevance for electric and hybrid vehicle technology. We promote both deep, narrow technical studies, cross-discipline and cross-institution research.



Our Thematic leaders of the Swedish Electromobility Centre, from the left: Fransisco Márquez-Fernández [2], Mikael Lantz [5], Linda Olofsson (Director), Göran Lindbergh [3], Anders Nordelöf [4], Cecilia Boström [5], Daniel Brandell [3], Magnus Blinge [4], Oskar Wallmark [2] and Jonas Fredriksson [1]. Absent: Lars Eriksson (Looking at us from the board above) [1]. [Within the parenthesis is the Theme Leader's area]



Theme 1: System studies and methods

System studies and methods develops methods and algorithms, which are adopted and utilized in a hybrid and electric vehicle setting by exploiting dynamic models, computational methods and simulation techniques. The main topics are mathematical modelling, dynamic simulation, performance analysis, control design and optimization.

Focus and objective

Analysing the functionality of the vehicle, on its own or as part of the transport system, with respect to environmental aspects and cost.

Advancements and achievements during 2019

The main activities for the year have been to finalize projects within the area, as stage III ended, and initiate project and workshop discussions for stage IV. ABB, Epiroc, Powercell and TitanX were welcomed as new partners to the theme. Their knowledge, as well as their role as active project partners, is and will be vital for the thematic area discussions.

During the year, the theme has witnessed how national and international attention has drawn from optimizing components to optimizing complete systems. Therefore, a lot of effort has been put into helping the automotive industry and its suppliers in this transition, for example by developing effective methods for model-based systems engineering that specifically address the needs for hybrid and electric vehicles.



Thematic Leaders:

Jonas Fredriksson (Linköping University) and Lars Eriksson (Linköping University)

Researchers from:

Chalmers University of Technology: Electrical Engineering

Mechanics and Maritime Sciences

KTH Royal Institute of Technology: Aeronautical and Vehicle Engineering,
Machine Design, Mechatronics

Linköping University: Electrical Engineering

Lund University: Automatic Control

Uppsala University: Electrical Engineering (stage IV)



Specialists from:

Stage III: AB Volvo, Volvo Cars, Scania, Vattenfall, CEVT, VTI

Stage IV: AB Volvo, Volvo Cars, Scania, CEVT, Powercell, ABB, VTI, TitanX, Epiroc



Theme 2: Electrical machines, drive systems and charging

Theme Electrical machines, drive systems and charging is a competence base for technologies related to electric energy transfer and conversion between the electric utility grid and the wheels of electric vehicles. This includes charging equipment, the traction system, and auxiliary systems on board the vehicles.

Focus and objective

Focus lies on cost efficiency on a component or sub-system level in a transport system perspective, including manufacturing, installation, operation, energy consumption, and recycling. The overarching objective is minimized environmental impact.

Advancements and achievements during 2019

Electrical machines, drive systems and charging have hosted several events, workshops and conferences during 2019. Research in the field of electric machinery continues to stay relevant much motivated by the electrification of the transport sector. Considerable work has been spent on preparing and formulating project applications for the coming call for projects during early 2020. These activities were successful. Several applications were developed and submitted, in which actors from both universities and industry plan to collaborate. In June, the theme got two new Theme Leaders and the theme name was changed to Electrical machines, drive systems and charging to further emphasize that technologies related to charging of electric vehicles is covered by the theme.



Theme Leaders:

Francisco J. Márquez-Fernández (Lund University) and Oskar Wallmark (KTH)

Researchers from:

Chalmers University of Technology: Electrical Engineering

KTH Royal Institute of Technology: Electric Power & Energy Systems

Lund University: Industrial Electrical Engineering & Automation

Uppsala University: Engineering Sciences



Specialists from:

ABB, AB Volvo, Bombardier, BorgWarner, CEVT, Epiroc, Powercell Sweden, Saab,

Scania CV, TitanX, Vattenfall, Volvo Cars Corporation, VTI.



Theme 3: Energy storage

The primary function of Energy storage is to deepen the understanding of energy storage units, electrochemical cells, materials, and performance limiting processes, to exploit this knowledge for better performing electric vehicles.

Focus and objective

Optimizing key factors behind ageing and health of the energy storage devices, focusing on present and next-generation lithium-ion battery technologies including fuel cell systems. The objective is to maximize the driving range, facilitate fast and flexible charging, improve storage diagnostics and minimize cost and environmental impact.

Advancements and achievements during 2019

Energy storage now includes fuel cells and monitor research concerning fuel cells as an important part of the theme's core topics. Energy storage still monitor research concerning fuel cells which is an important part of the theme's core topics. During 2019, prolific researchers within Theme 3 received plenty of attention in the media. The launch of Batteries Sweden (Vinnova competence center) generated further attention around Energy storage and SEC's activities. The fact that the Nobel prize in Chemistry went to researchers involved in Li-ion battery development inevitably generated extensive media interest for SEC researchers as well. Throughout the year, theme 3 have arranged several successful workshops. The year started off with Multi-scale modelling of batteries in Uppsala, followed by a workshop on polymer electrolytes for batteries which was organised in Uppsala as well. In April theme 3 hosted a battery meeting in Gothenburg, and in November they arranged a much appreciated Battery Crash Course in Landskrona with approximately 60 participants.



Thematic leaders:

Göran Lindbergh (KTH) and Daniel Brandell (Uppsala University)

Researchers from:

Kristina Edström, Uppsala University
Patrik Johansson, Chalmers
Rakel Wreland-Lindström, KTH Royal Institute of Technology
Reza Younesi, Uppsala University
Torbjörn Thiringer, Chalmers
Torsten Wik, Chalmers
Erik Berg, Uppsala University



Specialists from:

ABB, AB Volvo, CEVT, Epiroc, Powercell, Scania, Volvo Cars.



Photo: Claudio Schwarz, Unsplash

**“It is not always about delivering the answers.
It is also about finding the questions.”**

Mikael Lantz, Thematic Leader of theme 5

Theme 4:

Electromobility in society

Electromobility in society investigates the electrified vehicle from a societal and environmental perspective. The research gather data and analyzes drive patterns and requirements for vehicles and infrastructure, for different types of mobility and transport services. The work also covers aspects relating to policy and the gradually more important role of electromobility in the transportation system. This is done through studies of how different actors influence ongoing development, and the mechanisms that govern how they interact.

Focus and objective

The objective is to support development and governance throughout the whole value chain, from how vehicles and components are produced to how they are used, reused and recycled. By applying a system perspective on all its research, theme 4 aims to provide pathways towards more sustainable electrification technologies and vehicle use.

Advancements and achievements during 2019

The research areas within theme 4 were brought to attention in Swedish media many times during 2019. There is an increasing trust that electrification of the transport sector is the way forward for the society to tackle a large-scale transition, from the use of liquid fossil fuels, and to achieve significant climate change mitigation. This shift to electrification is also motivated at a local level from issues concerning public health and air quality, and at a national level from considerations such as energy security and energy independence. But there are challenges in terms of resource extraction and resource availability, as well as a risk for societal rebound effects in the case of

**Thematic leaders:**

Anders Nordelöf (Chalmers) and Magnus Blinge (Linköping University).

Researchers from:

Anders Nordelöf, Chalmers
Magnus Blinge, Linköpings Universitet
Anna Kramers, KTH
Frances Sprei, Chalmers
Gyözö Gidofalvi, KTH
Jan Sundberg, Uppsala Universitet
Thomas Magnusson, Linköpings Universitet
Öivind Andersson, Lunds Universitet

**Specialists from:**

Martin Weiderstrand, CEVT, Wolfgang Wenzel, Borgwarner, Hanna Persson, Volvo Car Corporation, Henrik Engdahl, Volvo Group, Jana Wignell, Volvo Group, Linnea Petersson, Volvo Car Corporation, Johan Hellsing, CEVT, Fernanda Marzano, Scania, Arnaud Contet, Titanx, Erik Svedlund, Epiroc



Theme 5: Interaction between vehicles and grid

Interaction between vehicles and grid works with issues concerning the collaboration between an extensive electric road vehicle fleet, the electricity production system and other electric consumption in the community. Within the theme, various requirements will be explored, such as requirements for charging solutions, requirements that regulate the interaction between the vehicle fleet and the electricity grid, including requirements for vehicle battery.

Focus and objective

The purpose of the theme is to answer the question on how the interaction between vehicle and power systems should be carried out in order to maintain a stable power system, and at the same time make sure that all vehicles can be provided with the intended function. The objective of the theme is to identify different requirements/demands necessary to fulfil its scope.

Advancements and achievements during 2019

Interaction between vehicles and grid is our newest theme that started during fall when Cecilia Boström and Mikael Lantz were appointed its Theme Leaders. Since then, time has been invested in getting to know the center's activities and planning how the theme should be run. A theme group meeting in Solna was arranged, including several Skype meetings where the participants presented their activities and their visions for the theme. An important part of the work has been identifying what activities and projects should be included in the theme, and how it should be defined.



Thematic leaders:

Cecilia Boström (Uppsala University) and Mikael Lantz (Lund University).

Reseachers from:

Chalmers University of Technology,
KTH, Uppsala University,
Dep. of Electrical Engineering,
LTH faculty of engineering



Specialists from:

Alexander Berggren, CEVT, Andreas Bodén, Power Cell, Jakob Edvinsson, Volvo Cars, Christian Gruffman, Vattenfall, Andreas Käck, VTI, Erik Svedlund, Epiroc, Karin Thomas, Uppsala University, Christopher Watts, Scania, Reno Filla, Scania, Filip Johnson, Chalmers, Massimo Bongiorno, Chalmers, Olof Samuelsson, LTH, Lennart Söder, KTH, Gyözö Gidofalvi, KTH, Anders Grauers, Chalmers, Niklas Thulin, Volvo Penta, Peter Mellberg, Bombardier, Erik von Essen, Scania, Maria Taljegård, Chalmers

“Electromobility is an area that affect and will be affected by almost all actors in the society.”

Cecilia Boström, Thematic Leader of theme 5

Interview: Cecilia Boström, Thematic Leader of theme 5, Interaction between vehicles and grid

What is it like to be a Thematic Leader?

– The work as a Thematic Leader has been very exciting and sometimes also challenging. Me and Mikael Lantz are both new to the centre and are working on starting up this new theme. So far I have had the opportunity to get to know many people who possess different skills and who are from different organisations, this is really inspiring and meaningful.

You are in charge of our newest thematic area. What do you want to contribute with? How do you want to develop your theme?

– I think that this new theme is very important for the centre and will add another dimension to the ongoing activities within it. Our hope is to contribute with world class research within the field of vehicle-grid interaction. We are also hoping to gather experts from the automotive industry and power system operators and identify further needs of development and research, and also to understand their approach to electromobility.

Why is it important to work towards a sustainable future?

– We all have a responsibility to work towards a sustainable future and look for long term solutions. As we all know, the world has limited resources and it is our obligation to use them wisely and make sure that we create tools and solutions for future generations to develop further.

How can other companies, research organisations and other actors join in on this mission?

– Electromobility is an area that affect and will be affected by almost all actors in the society. I cannot see any reasons to not join this mission!

What is the most important thing you have learned by working within the SEC?

– Our mission is not something that an individual organization could do itself, this is something that we all need to work on together. SEC has created a perfect platform for this.

“It is about research and innovation at the highest level possible.”

Mikael Lantz, Thematic Leader theme 5

PASSION LED US HERE

Photo: Ian Schneider, Unsplash

Our project portfolio

SEC host projects within our five thematic areas. This is a glimpse of the projects that were on-going during 2019.



Thematic area:
System studies and methods

Modelling, system analysis and control of a hybrid powertrain and after-treatment system

Powertrain and exhaust after-treatment systems for heavy-duty hybrid vehicles are designed and developed according to the same principles as conventional heavy vehicles. They are often designed and developed separately – the powertrain for good fuel economy and the exhaust after-treatment system to meet current emission legislation. This mode of procedure leads to fuel inefficiency, since the motor has to be used more than necessary in order to get a sufficiently high temperature of the exhaust after-treatment system for good efficiency.

Sophisticated methods that take into account the entire system and optimize system performance are needed to improve the efficiency of the system. Model-based methods are often used for this,

as they provide both flexibility and customizability to the configuration, in this case the hybrid vehicle and its exhaust after-treatment system.

Model-based methods need, as the name indicates, system models. The project goal is therefore to develop mathematical models that can be used to support the design of the powertrain system and the exhaust after-treatment system. The models will also be used in projects at Linköping University and Chalmers, both of which have acknowledged academic experience in model-based development.

The focus of the project is research and a need for knowledge in the following three themes has been identified: development of new models, knowledge of interaction between hybrid powertrain and aftertreatment system, and systematic control design methods.



Thematic area:
System studies and methods

SCOPE – Service optimization of charging stations for electrified vehicles

Electric and plug in hybrid vehicles will most likely become predominant in several EU countries in the future, approximately after 2025. These vehicles will need energy from the power grid.

Fast-charging Electric Vehicle Charging Stations (EVCSs) will have a limited amount of charging slots, and a limited total charging power dictated by the strength of their connection to the grid and by their rated power. Electric Vehicles (EVs) will therefore have to share the utilization of EVCSs. This is a resource allocation problem where the shared resources are time slots and charging power. Once electric mobility will be highly developed, EVCSs will differ from conventional gas stations, where the problem of resource allocation is non-existent.

This project aims at improving this situation by trying to answer the following questions: (Q1) how should the locations of charging stations be determined?; (Q2) how can policies for charging stations be designed, and what information ought to be exchanged between the vehicles and the charging stations?; (Q3) which are the probable future stakeholders and applications in a future where vehicles extensively are harvesting grid electricity?

The results so far show that (A1) the optimal locations of fast-charging EVCSs should consider the perspective of customers, an algorithm has been proposed by SCOPE to account for that dimension of the problem; (A2) SCOPE is investigating several AI-based algorithm to design charging policies; the sharing of information (e.g. state of charge) between the EVs and fast-charging EVCSs has an impact on the interaction EV-EVCS, and measures to avoid a detrimental effect on the development of electric mobility are currently under investigation; (A3) the conclusions from (A2) will help us providing answers to (A3).



Photo: Saketh Garuda, Unsplash



**Thematic area: Electrical machines,
drive systems and charging**

Power Conversion Challenges with an All-Electric Land Transport System

This project is the Theme Researcher project for Electrical machines, drive systems and charging during SEC stage III. Power Conversion Challenges with an All-Electric Land Transport System focuses on the interface between the electric vehicle and the energy source, which in most cases is the electric utility grid. Based on the results from a round of interviews with SEC industrial partners, three topics were selected:

- Cost comparison of different charging system configurations: the necessary cost models have been developed and used to assess the societal cost of electrifying the Swedish fleet under different hypothetical scenarios.
- Management of chassis potential with a conductive dynamic charging solutions: electric models of the vehicle and the infrastructure have been created for the case of conductive ERS, and potential fault scenarios have been analysed, studying the influence of different system parameters in the overall safety.
- Impact of a high power, highly dynamic load on a weak power grid. The impact of electromobility related power loads in the existing grid will be analysed, and grid-support measurements will be proposed when needed (this part is currently in progress).

Although the scope of the project may seem too broad at first, the idea of the project is to start exploring these areas, building up the necessary competence within the Swedish Electromobility Centre and initiating research activities that could lead to new projects in the future.



Thematic area:
Electromobility in society

Charging behaviour and infrastructure need for plug-in electric vehicles

The project is a collaboration between Physical Resource Theory at Chalmers, the PH&EV Center at UC Davis, and Volvo Cars. The overall objective of the project is to analyse the relationship between charging infrastructure and vehicle development departing from the user perspective. The research is based on user experiences, driving data and actual charging behaviour.

Results from our studies show that long range PHEVs (at least 50 km) have the potential to electrify a large share of the households driving, equal to that of a smaller range BEV (range of roughly 120 km). When it comes to fast charging need we find that the ratio of battery electric vehicles to public fast charging points can be similar to other alternative fuels in the future (close to one fast charging point per 1000 vehicles for high power rates of 150 kW). In a review of existing studies on charging infrastructure we find that more research is especially needed to determine how much infrastructure is needed to support the rollout of PEVs.

The first phase of the project has taken place between June 2017 and June 2019. The project will continue until June 2021. So far the project has been financed with 2 182 000 SEK.

Researcher from the PH&EV Center have contributed with data and input to one of the research articles and will continue to contribute to work being done with the PhD-student Ahmet Mandev. Frances Sprei has also had collaboration with researchers at Fraunhofer ISI on the subject. The results have been useful for policy support and are of interest for Volvo cars as well as other stakeholders in the field related to the development of charging infrastructure.



Clean electricity

In recent years, the charging hybrids have dominated the market, but according to BIL Sweden the clean electric cars will outnumber the charging hybrids in a few years.

Source: BIL Sweden

Collaboration with other research organisations

SEC provide several different kinds of possibilities to collaborate. We work within and across our thematic areas, with other research organisations and internationally with PhD students and organisations outside of Sweden.

SEEL

Owned by RISE and Chalmers, the company was created to establish and operate a test center with the aim of supporting research and development in the field of electromobility. In December 2019, the government received the EU's approval to support the investment with SEK 575 million. SEEL will establish operations in Gothenburg, Borås and Mälardalen. The establishment will include testing capacity for all different parts relevant to electrified transportation such as battery, power electronics, charging systems, powertrains and complete vehicles.

SAFER

SAFER Vehicle and Traffic Safety Centre at Chalmers is a joint research unit where partners from the Swedish automotive industry, academia and authorities cooperate to make a centre of excellence within the field of vehicle and traffic safety. During the year, SEC and SAFER have had discussions on possible safety related research on electric vehicles.

f3

f3 is a research centre that conducts system-oriented and interdisciplinary research linked to all stages of the renewable fuel value chain. Alongside the Swedish Electromobility Centre, they play an important role in creating CO₂-neutral transportation. The importance of collaboration with combustion centres increases as hybrids become the normative choice of vehicle.

SICEC

SICEC is a research cooperation between three Swedish Internal Combustion Engine competence centers: KCFP at Lund University, CERC at Chalmers University of Technology and CCGEx at Royal Institute of Technology. SICEC play an important role in creating CO₂-neutral transportation.

KCK

KCK (Kompetenscentrum katalys) is a four-year research program with a vision to contribute to a sustainable energy and transport system with new and advanced catalytic technology. KCK play an important role in creating CO₂-neutral transportation.

ECO2 Vehicle Design

ECO2 Vehicle Design is a research centre that conduct research within vehicle design, targeting environmentally friendly and economically competitive rail and road vehicles in a sustainable transport system.

ITRL

ITRL (Integrated Transport Research Lab) is a multidisciplinary and multi-stakeholder arena. It is focused on sustainable mobility solutions through research and demo.

RISE

SEC have regular meetings and communications with RISE. SEC is also involved in the research and innovation platform Research and innovation platform for electric roads led by RISE.

BASE

BASE (Batteries Sweden) is a newly established competence centre which we have the intention to collaborate with, mainly within our Thematic area Energy storage.

The SEC also engages in and supports interesting initiatives such as the European Union's initiative Battery 2030+, led by Kristina Edström at Uppsala University. In addition, the centre supports project applications that lie within the scope of our roadmap.

A portrait of Magnus Karlström, a middle-aged man with light brown hair and a slight beard, wearing a dark suit jacket over a white shirt. He is looking directly at the camera with a neutral expression. The background is a dark, solid color.

Global Watch

OmEV, our global news watch project led by editor in chief Magnus Karlström, has continued to grow over the course of 2019. Since 2018, the number of subscribers has increased from less than 2000 to a total of 2325 subscribers. On a daily basis, OmEV provides subscribers with the latest information regarding the hottest topics within the field of energy efficient vehicles.

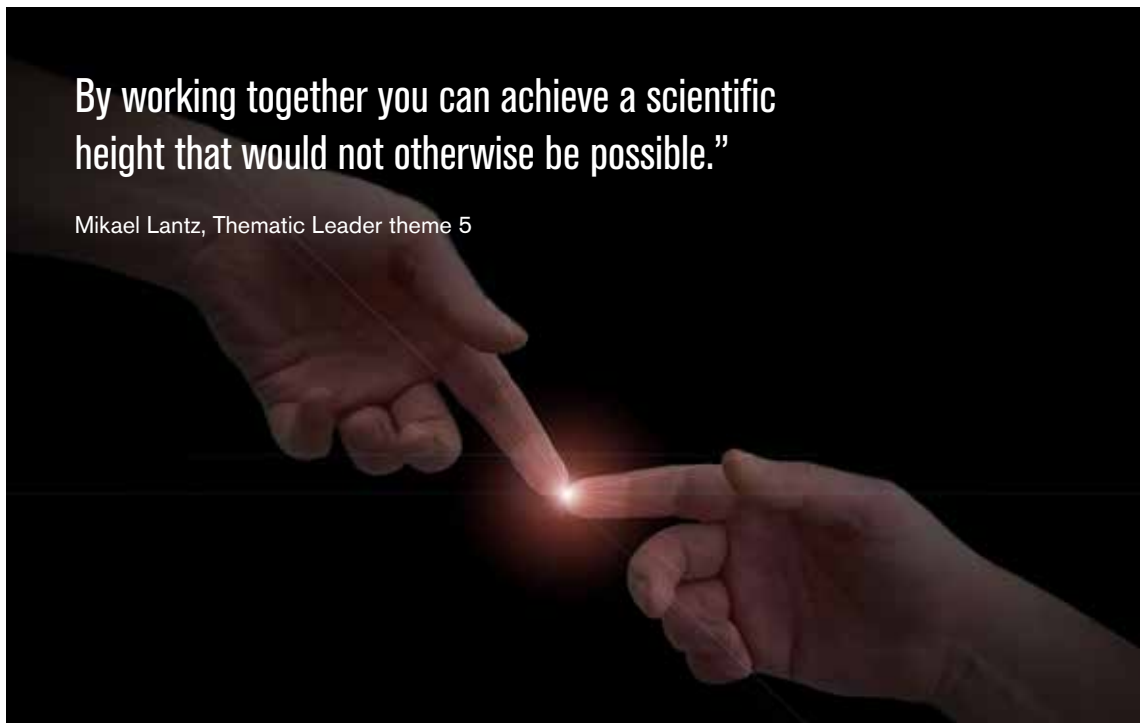
During 2019, the role of the city in shaping tomorrow's emobility has been a prioritized topic, as well as news regarding electrical trucks and inevitably the many questions regarding battery resources.

An important trend during the year was that emobility technology is spreading to other vehicles apart from the private car. Emobility has started to influence the boat industry, marine vessels and other vehicles, which means that the global watch is expanding its area of coverage as well.

OmEV is run together with the editorial board consisting of Helena Berg (Libergreen) and Jens Hagman (KTH). OmEV is funded by the Swedish Energy Agency and hosted by the Swedish Electromobility Centre.

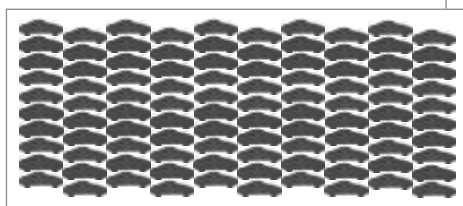
By working together you can achieve a scientific height that would not otherwise be possible.”

Mikael Lantz, Thematic Leader theme 5










Building knowledge

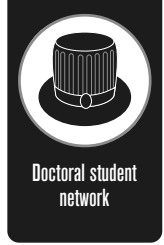
The Swedish Electromobility Centre continues to create future competence by interacting with young professionals and spreading knowledge generated within the centre. During 2019 more than 600 people attended our educational workshops, conferences and seminars.



In the next two years...

About 100 new electric car models and about 100 charging hybrid models will be on the market. This means that there will be more models in more segments and in different price ranges.

<p>24 January</p> 	<p>18 February</p>	<p>24 March</p> 	<p>17 April</p> 
<p>Multi-scale modelling of batteries in Uppsala.</p> <p>33 Participants</p>	<p>VeHICLe, Virtual Hybrid Cooling Seminar.</p> <p>71 Participants</p>	<p>Polymer electrolytes for batteries in Uppsala.</p> <p>20 Participants</p>	<p>Thematic Conference at Chalmers in Gothenburg.</p> <p>29 Participants</p>
<p>23-24 April</p> 		<p>7 May</p>	
<p>E-mobilit Days in Linköping.</p> <p>77 Participants</p>		<p>Workshop on Dynamic Optimization for Electromobility Applications.</p> <p>19 Participants</p>	
<p>15 May</p>  	<p>20-24 May</p> 		
<p>Cross-thematic workshop on developments in components and systems for electromobility at KTH, Stockholm.</p> <p>60 Participants</p>	<p>SEC Summer School in Jönköping.</p> <p>19 Participants</p>		
	<p>29 May</p>		<p>12 June</p> 
	<p>Towards a Holistic Assessment of Electric Vehicles and Hybrid Technologies.</p> <p>12 Participants</p>	<p>Workshop on Thermal Management of Electrical Machines.</p> <p>60 Participants</p>	
<p>26-27 June</p> 		<p>1-2 October</p> 	
<p>Workshop SEC Stage 3 to 4 at St Jörgen Park, Gothenburg.</p> <p>95 Participants</p>		<p>Kick-off with our theme leaders in Gräna.</p> <p>9 Participants</p>	
<p>6 November</p> 	<p>6 November</p> 	<p>13 November</p> 	
<p>Battery Crash Course together with BorgWarner.</p> <p>60 Participants</p>	<p>Kick-off with our new theme Interaction between vehicles and grid, at Vattenfall.</p> <p>10 Participants</p>	<p>Cross-thematic workshop at Chalmerska Huset, Gothenburg.</p> <p>55 Participants</p>	



Doctoral Student Network

The Swedish Electromobility Centre's doctoral student network is open for all PhD students in Sweden who study aspects of electrification and hybridisation of vehicles. The network is an arena for collaboration for PhD students and stimulates their interaction with Swedish automotive industry.

The Doctoral Student Network provides:

- Access to Swedish Electromobility Centre's activities and network
- Contact with PhD students from different fields
- Knowledge building through PhD courses, seminars and workshops
- Equipment for future work and research challenges

All PhD students in Sweden working with different approaches, methods and focus in the area of e-mobility are welcome.

SEC Summer School

SEC arranges a yearly Summer School, a course for PhD students who want to deepen their knowledge and discuss their ideas concerning electromobility. The event hosts approximately 20 students yearly and ends with a presentation of the participants assignments. During 2019, SEC Summer School was located in Jönköping between May 20-24th. The focus of the course was components and system studies for electromobility, with emphasis on electric battery and fuel cell vehicles.



“Electromobility is the future trend.”

Qian Xun, PhD student theme Energy Storage

Interview: Qian Xun, PhD student, theme Energy Storage

What does the job market look like for an almost completed PhD student in the field of emobility?

– I think the job market is quite promising, there are many large mobility companies in Sweden, for example Volvo and CEVT, as well as companies in other countries. Electromobility is the future trend, and many companies are active in this area.

What do you do as a PhD student?

– I am part of the theme Energy Storage where I'm dealing with the modelling and simulation of each component as well as the vehicle system. I also work with the energy management and power control for the hybrid energy storage with fuel cells and supercapacitors.

Have you worked in the industry or had any international collaborations?

– I am collaborating with China Automotive Technology and Research Center Co. Ltd and Universitat Politècnica de Catalunya. I visited China Automotive Technology one year ago and stayed there one week. I was in Universitat Politècnica de Catalunya for five months and conducted some experiments on fuel cells and supercapacitor hybrid systems.

What is your dream to work with in the future?

– I would like to remain in the academic world and continue to do research related to emobility.

How can we solve climate challenges using emobility tools and methods?

– To reduce CO₂ emissions, transportation and electrification is one promising solution. The vehicle manufactures are also designing and producing battery-electric vehicles and fuel cell electric vehicles. I think the climate problem will be solved as the knowledge around emobility increases.

“The interaction between our Sweden based industry, academia and society is unique in the world.”

Nils-Gunnar Vågstedt, Chairman of SEC's Program Council

Interview: Nils-Gunnar Vågstedt, Chairman of SEC's Program Council

What words do you associate with the SEC?

– I would say triple helix. Industry, academia and society are needed together when making a change. In Sweden we are quite good at addressing issues using this dialogue, and we benefit from that in a Swedish centre. The interaction between our Sweden-based industry, academia and society is unique in the world.

How would you describe the SEC's role in society?

– A sustainable electrified society is the keyword for society in the future. Sustainability turns out to be linked to electrification, it just gets clearer and clearer. This applies to all dialects of electrification. The transition and everything that we at the centre are working to strengthen becomes more and more important. Of course, the vehicles themselves; cars, trucks and buses, but also the electrical systems. In the centre, we work broadly to stimulate sustainable electrification.

How would you describe the SEC's mission and vision?

– To make sure that this happens, that we achieve electrification that is sustainable, and to reach for the larger effects. Because SEC exist, we are able to achieve these changes that would not have been possible otherwise.

How would you describe the development of the centre over time?

– I have been active in the SEC since 2008. We have gone from being an initiative, a small attempt, to establishing ourselves and responding with really sharp research and good projects. We are growing more or less cubically, which is a huge challenge in itself. The centre has also gone from being vehicle system oriented to becoming more community oriented.





”Sharing is the key”

*Francisco J. Márquez-Fernández,
Thematic Leader theme 2*

Outreach and communication

SEC continue to use our many channels to present research, meet with actors within the mobility field, arrange and participate at seminars and conferences, as well as providing our followers and members with the latest knowledge.

Over the course of 2019, we have taken an active role in participating in several public events, workshops, conferences and meetings. We have hosted a cross-thematic workshop, gained increased financial support from the Swedish Energy Agency, gotten new partners, increased the number of subscribers to our newsletter and gained publicity through articles, radio programs and podcasts.

Media coverage and publicity

In September, Sveriges Radio published an article on the vast environmental consequences of earth metal extraction. Anders Nordelöf, thematic leader of Electromobility in Society, responded to the critique and suggested ways to make the production of batteries more sustainable. “There are possibilities to radically decrease these emissions.”

The same month, SEC submitted a debate article to Göteborgs-Posten which was published at their website. It was a reply to an earlier article where representatives from universities, municipality and large companies called for increased cooperation between academia and industry. In the article, on behalf of the centre, we argued that this is exactly what SEC was built to do, and put emphasis on the

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wise words of our thematic leader Francisco J. Márquez-Fernández - “Sharing is the key”.

On October 2nd, our director Linda Olofsson was interviewed by Dagens Industri where she shared her thoughts on the future on emobility. “The whole chain must be sustainable, from the battery manufacturing to the power used to fuel the vehicle.”

Later the same month, Sveriges Radio interviewed Linda Olofsson about the impact of the conversion from fossil fueled to fossil free. She put pressure on the fact that Sweden has a unique opportunity to set an international example of electromobility, partly because of the country’s built-in culture of collaboration: “Sweden is well equipped.”

November 28th Linda Olofsson participated in a panel at Ekocentrum’s Ecar Day together with Anders Nordelöf, thematic leader of Electromobility in Society.

December was a busy month. SEC participated in the panel at Di Stora Emobilietsdagen on December 10th. Our director Linda Olofsson participated in DEFAs emobility podcast during the eCar Day at Svenska Mässan in Gothenburg. We introduced our new team in the December newsletter and launched our new concept Meet our theme leaders, a series of short videos where we present our theme leaders and the work that they do within the centre. First to present his perspective is Oskar Wallmark, theme leader of Electrical machines, drive systems and charging.

On December 11th we published an article on batteries and graphene where Daniel Brandell, thematic leader of Energy Storage, presented his perspective on the potential possibilities and challenges of batteries and graphene. New partners joined our centre and we signed our main agreement.

“If we get it right, we can use research findings within mobility for new innovations and manage our society in a better way without damaging the environment.”

Rebecka Andersson, Administration Officer, SEC



Meet the Core Team of SEC

Rebecka Andersson
Administrator Officer

The reason I work in the field of research and innovation:

I previously worked for American Express in England as a Team Leader. I eventually ended up at Chalmers and SEC, probably because I value the opportunities that comes with working for a bigger company. What is so great about research is that it enables people to follow the changes in society and make a difference.

Why I want to create a sustainable future:

If we are to live on earth, we need to somehow make it work. If we get it right, we can use research findings within mobility for new innovations and manage our society in a better way without damaging the environment. But the development must not go too fast, we need balance in order to handle .

Anna Karlsson
Project Coordinator

The reason I work in the field of research and innovation:

I am driven by a curiosity to get answers to the questions I have, and to feel that I am doing something meaningful that is of benefit to society.

Why I want to create a sustainable future:

As a dedicated genealogist the historical perspective, which it appears many people lack today, has become very clear to me. For instance, due to war, pandemics or climate change conditions can change swiftly. We must take history into account in order to develop a more sustainable society for future generations.

Linda Olofsson
Director of SEC

The reason I work in the field of research and innovation:

It's so exciting and I'm so curious. I want to understand how everything works, and I see opportunities in what I learn.

Why I want to create a sustainable future:

I see it as my responsibility towards future generations, and to my children.

Astrid Hedenström
Communication Officer

The reason I work in the field of research and innovation:

It's about creating a good and positive future for all of us. Where the world gets better. It is a privilege to be part of the research world that is driven by solving problems rather than despair.

Why I want to create a sustainable future:

Because it is the only way forward.



Together we create sustainmobility

From the beginning, SEC gathered a few people convinced of the potential of the technology. Almost 13 years later, we have grown and learned many things. One of the more important lessons is that if you put really hard work in something you truly believe in, things will start to happen. And if you work together, that small attempt will eventually end up becoming something great.

With the assignment to initiate technology development, we aim to be the co-creators of tomorrow's renewable and sustainable transport society. We have gone far from where we started, but the road to reach our destination is still long.

It is through our research that we are able to paint the bigger picture of how we are all interconnected – through our society, technology, our movement patterns and our curiosity. We are all facing the consequences of climate change, but together we have the means to do something about it.

In this ever so fast changing society, we dare to be a little old school and stick to core values. Our most important one is collaboration. It is what our centre was built upon, and what we believe will be demanded from us today and in the future.

Join us on our journey. Let's get to the future together.

Network
Creativity
Commitment
Experts
Sustainable electrified society
Electromobility
Research focus
Rewarding
Areas of strength
Electrification
Exciting
Development
Collaboration
Network of competence
Innovation and curiosity
Education
Utilization
Community benefit
Competence center
Knowledge building
Visionary
Sustainable change
Driving force
Holistic approach
Triple helix
Cross-disciplinary problem solving



Do you want to become part of our network or our Doctoral student network? Contact us at phd@emobilitycentre.se

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If you want to know more about the Swedish Electromobility Center, you are welcome to contact us at www.emobilitycentre.se