Photo: MAN Truck & Bus AG

klima+ energie fonds

ZERO EMISSION MOBILITY

Innovations for the mobility transformation – "Made in Austria"

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EMISSION-FREE TECHNOLOGIES POINT THE WAY TOWARDS THE FUTURE OF MOBILITY

Photo: Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Plans for Austria to achieve climate neutrality by 2040 are a shared goal within the extensive areas of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology. This goal will be the foundation for the countless decisions that must be made in steering the country over the coming years. For the mobility sector in particular, it means that the system needs to become fossil-free and decarbonised 10 years earlier than previously planned. This is necessary to ensure that Austria's path for reducing CO_2 will allow it to achieve the Paris climate targets.

Positioning Austria as a pioneer in climate protection and achieving climate neutrality by 2040 must become a joint project, and this is undoubtedly a **project that involves many opportunities** for Austria's numerous innovative companies. There is hardly any other support programme that demonstrates this more strikingly than "Zero Emission Mobility" and its predecessor programme "Flagship Projects for E-Mobility". For more than 10 years, the Climate and Energy Fund has been subsidising a large number of projects from the ministry's funds, which makes one thing clear: not only do emission-free technologies point the way to the future of mobility, as illustrated by the **CROSSING BORDERS** project aimed at developing cross-border solutions for electric mobility in the areas of charging infrastructure, roaming and routing, they also offer new opportunities to create added value and jobs. One example of this is the **MEGAWATT-LOGISTICS** project which, together with a large number of partners and using electric HGVs produced in Steyr, is testing emission-free logistics of the future.

The "Zero Emission Mobility" programme is a key tool for us in building a bridge between mobility and innovation policy. It gives us a glimpse of what will be possible with emission-free technologies today, tomorrow and farther in the future. The **systemic approach** forms the core of this programme, from the vehicle to the infrastructure and the actual application. We are also using it to answer strategic questions. For example, in the **E-MAPP 2** study currently underway, we are examining the requirements that emission-free technologies and digitalisation will impose on training for skilled workers in the future. By estimating now what future training requirements will be, we are laying the foundation for companies to be sustainable and successful and for securing jobs in regions that specialise in automotive added value.

This brochure documents the many success stories of recent years and aims to motivate entrepreneurs, start-ups and SMEs as well as established players in the automotive industry to join us on this path towards a **climate-neutral Austria 2040**.

Leonore Gewessler
Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology

INNOVATIONS FOR MOBILITY TRANSFORMATION – ZERO EMISSION MOBILITY

Electric mobility is on the fast track in Europe and forms an important building block for the sustainable mobility transformation, as promoted by the Climate and Energy Fund. It not only contributes towards achieving climate targets in an industrialised country such as Austria, but also opens up major opportunities for the region as a business location. This will require research, development and innovation in the mobility industry with respect to all aspects of electric mobility. The Climate and Energy Fund has successfully supported this objective since 2009 with a set of targeted measures.

E-mobility is not only the order of the day; it also has great potential for creating new jobs and providing added value. Experts believe that an expansion in electric mobility will **create around 34,000 new jobs** and generate around **EUR 3.1 billion** of extra added value in Austria by 2030. These are the findings of the "E-MAPP: E-Mobility and the Austrian Production Potential" study that we commissioned.

Our "Zero Emission Mobility" support programme allows us to support innovative and **implementation-oriented research projects** that contribute to new, more efficient, powerful and cost-effective electric mobility solutions and highlight on Austrian knowledge and expertise. This means that together with the federal government, we are strengthening the Austrian automotive industry and supporting it in the necessary transformation.

We are addressing **the overall system of electric mobility** with our funding programme rather than just individual vehicle components: Zero Emission Mobility projects cover areas such as applications, users and infrastructure. There are also scientific studies that deal with current issues related to electrified mobility and provide a basis on which policy-makers can base their decisions. The two positive assessments of our support programme to date show that concentrating strategically on this unique setting of "user – vehicle – infrastructure" and focusing on system integration is the right approach. This is because ultimately the issue does not mean a 1:1 exchange of vehicles, but instead involves a smart mobility system in which individual driving is only one of numerous ways to get from A to B.

So far, we have supported a total of **35 forward-looking projects** with over **EUR 68 million in subsidies**, thereby sparking **more than EUR 127 million of investment** by private companies. **More than 310 project partners** have been able to develop their ideas and demonstrator models as a result, taking them closer to market readiness. We are very proud of the fact that some of these innovative solutions can already be found on Austria's roads and are being successfully exported.

This validates our approach in continuing to make mobility more climate-friendly and to harness the opportunities for Austria as a key centre for technology.

Theresia Vogel
Managing Director
of the Climate and Energy Fund

Photo: Climate and Energy Fund

ELECTRIC MOBILITY – EUROPEAN AND NATIONAL STRATEGIES

Photos: Climate and Energy Fund / Hans Ringhofer

SOURCES

[1] Proportion of greenhouse gas emissions in Austria that are attributable to transport, Environment Agency Austria, www.umweltbundesamt.at/umweltsituation/luft/treibhausgase/ www.umweltbundesamt.at/umweltsituation/verkehr/auswirkungen_verkehr/verk_treibhausgase/

[2] www.oesterreich.gv.at/themen/bauen_wohnen_und_umwelt/klimaschutz/1/Seite.1000325.html

[3] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_de

[4] https://ec.europa.eu/clima/news/clean-mobility-new-co2-emission-standards-cars-and-vans-adopted_en

Mobility is a basic human need. The extent to which our quality of life depends on being fully mobile is revealed, not least, by the increase in traffic volumes that can be seen all over the world, particularly in the main conurbations. However, mobility is also a key factor for our economic system, which now operates on a global scale. The other side of the coin is well known: transport is one of the main causes of climate change. In Austria, transport accounts for approximately 29% of greenhouse gas emissions. Since 1990, transport emissions have increased by approximately 74% within the country. In 2017, greenhouse gas emissions from transport increased by around 3.2% (or 0.75 tonnes of carbon dioxide equivalent) in comparison to 2016.[1]

If we want our future to be one where we remain mobile – in both our private and business lives – a massive rethink will be required. For this, we will need mobility systems that are not only efficient, affordable and comfortable but that also use our resources sparingly at the same time. Electric mobility is one of the key technologies for shaping the mobility system of the future. As well as offering an opportunity to achieve significant reductions in greenhouse gas emissions from transport – and help create a sustainable mobility system – it also holds massive potential for generating added value and creating new jobs.

The framework for developing electric mobility in Austria is provided by climate and energy strategies at both a national and an international level.

INTERNATIONAL TARGETS

On 12 December 2015, 197 nations agreed in Paris to limit anthropogenic global warming to well below 2 °C compared to pre-industrial levels. The Paris Agreement entered into force on 4 November 2016 and was ratified by Austria before the end of 2016.

The European Council has set binding CO_2 reduction targets up to the year 2020 (a reduction of 16% by 2020 compared to 2005 is planned for emissions in Austria that are not subject to EU emissions trading). In addition, goals for the use of renewable energy sources are being set to combat climate change in a sustainable way.

For the period up to 2030, the EU has agreed on further targets ("EU climate and energy package 2030"). These provide for an EU-wide goal to reduce greenhouse gas emissions at least by 40% by 2030 compared to 1990. Global greenhouse gas emissions should also peak as soon as possible and then be reduced to (net) zero by the middle of the 21st century. This EU goal was also included as the EU's contribution (NDC) to the Paris Agreement.[2]

With the "Green Deal", the EU is going one step further and setting itself the goal of becoming the first continent to become climate-neutral by 2050. The European Green Deal is an ambitious package of measures aimed at ensuring sustainable ecological change that will benefit both the people and the economies of Europe. The measures are planned in phases and range from drastic reductions in emissions, investments in cutting-edge research and innovations, to conservation of our natural environment. The European Commission plans to mobilise investments amounting to EUR 1 trillion for climate protection by 2030.[3]

Reduction in CO_2 emissions of new passenger cars

In 2017, the European Commission proposed a set of new CO_2 emission reduction targets for car fleets. These stipulate that the average CO_2 emissions for passenger cars will have to be 37.5% lower in 2030 than in 2021 and for vans 31% lower.[4]

Reduction in CO_2 emissions of trucks
In 2018, the European Commission approved a set of new CO_2 emission reduction targets for heavy-duty vehicles. These stipulate that the average CO_2 emissions will have to be 30% lower in 2030 than in 2019.[5]

Alternative fuels infrastructure
Environmentally-friendly alternative fuels are set to become more prevalent in the future. The necessary infrastructure to support this will have to be set up in accordance with EU Directive 2014/94/EU. Among other things, this includes the infrastructure for partially and fully electric vehicles. The Directive stipulates that an "appropriate number" of charging points are to be established by 2020. Each Member State was required to devise its own national policy framework for this purpose.[6] An initial progress report on the Austrian National Policy Framework "Saubere Energie im Verkehr" (Clean Energy in Transportation)[7] was already sent to the Commission in November 2019. It shows that the country has achieved its most crucial targets in the area of infrastructure.

AUSTRIA'S POSITION ON ELECTRIC MOBILITY

In its government programme for 2020-2024, the new Austrian federal government has set out a number of measures for reducing emissions from road transportation while, at the same time, enabling and promoting innovation.

The starting point is the federal government's target of achieving climate neutrality in Austria by 2040. To this end, a CO_2 budget compatible with the Paris Agreement and corresponding routes towards reduction are planned. Binding sectoral targets are also planned within the framework of a climate protection law by 2040 with an interim target for 2030. According to this ambitious new target, the transport sector will also have to make its contribution to a climate-neutral Austria by 2040.

Road traffic is by far the biggest source of CO_2 emissions in Austria. Conventional diesel and petrol consumption must therefore be significantly reduced. In addition to making use of sustainable first and second/third-generation biofuels, the shift in transport and electric mobility to alternative fuels based on renewable energy sources is seen as a very important step.

Accordingly, a strategy will be developed to use alternative energy sources in mobility with a focus on the overall climate balance and energy efficiency, together with a hydrogen strategy which is also aimed at the transport sector and other industries.

Particularly in the area of public procurement, it is important to set a good example. As of 2022, the purchase of emission-free passenger cars will be standard, and from 2027 it will generally no longer be possible to buy new vehicles with combustion engines. The same applies, for example, to taxis, hire cars and cars used for car-sharing: as of 2025 all such newly registered vehicles will be emission-free.

Photo: Climate and Energy Fund / Hans Ringhofer

SOURCES

[5] www.europarl.europa.eu/news/de/press-room/20190321IPR32112/neue-co2-emissionsgrenzwerte-fur-pkw-und-transporter-gefordert

[6] Directive 2014/94/EU on the deployment of alternative fuels infrastructure http://eur-lex.europa.eu/eli/dir/2014/94/oj

[7] National Strategic Framework "Saubere Energie im Verkehr" (Clean Energy in Transport) www.bmvit.gv.at/verkehr/elektromobilitaet/downloads/strategierahmen.pdf

move2zero – Decarbonisation of the Graz bus system, photo: Lupi Spuma

RESEARCH AND DEVELOPMENT FOR THE MOBILITY SOLUTIONS OF THE FUTURE

Photo: Climate and Energy Fund / Astrid Bartl

Sustainable mobility concepts rely on having a multimodal transport mix, whereby different forms of mobility (private and public plus motorised and non-motorised) are combined to create one low-carbon system. Electric mobility is regarded as a key building block for creating the mobility system of the future. However, the transition to electric mobility is about much more than simply introducing new vehicles. And it does not just affect the automotive industry and its suppliers. Rather, the actual implementation process brings various new players into the market. In the first instance, this naturally means the power industry, whose task it is to provide the power (preferably from renewable sources) and set up the appropriate charging infrastructure. In addition, information and communication technologies (ICT) are coming to play an increasingly important role. Intelligent concepts are required to enable the networking of users, vehicles, charging stations and power companies. The degree of complexity involved in setting up the necessary data links is considerably greater than has traditionally been the case, all the more so because Austria – in particular – thinks that getting on board with electric mobility is a powerful force for promoting intermodal traffic concepts.

Given the many factors and stakeholders involved, a multitude of research fields associated with electric mobility are beginning to emerge. In addition to technological concepts and development activities relating to vehicle and infrastructure components, these also encompass system-related, political, economic and social aspects as well.

Photo: IV / Kurt Prinz

A sustainable transition to decarbonised mobility can only be achieved with a forward-looking industrial policy at both the national and the European level. This calls for persistent research and innovation in technical as well as socio-economic terms. If we want to continue to see Austrian industry active in areas of strategic added value and to enable new innovative mobility solutions in the future, it is essential that we offer supportive structures.

These include the European Research Framework Programme and the IPCEI (Important Projects of Common European Interest) instrument at the EU level, as well as the programmes of the Climate and Energy Fund in Austria. They can make a significant contribution to successfully standing by Austrian companies in the transformation process and thus positioning Austria as a frontrunner in key technologies.

GEORG KAPSCH
President of the Federation of Austrian Industry

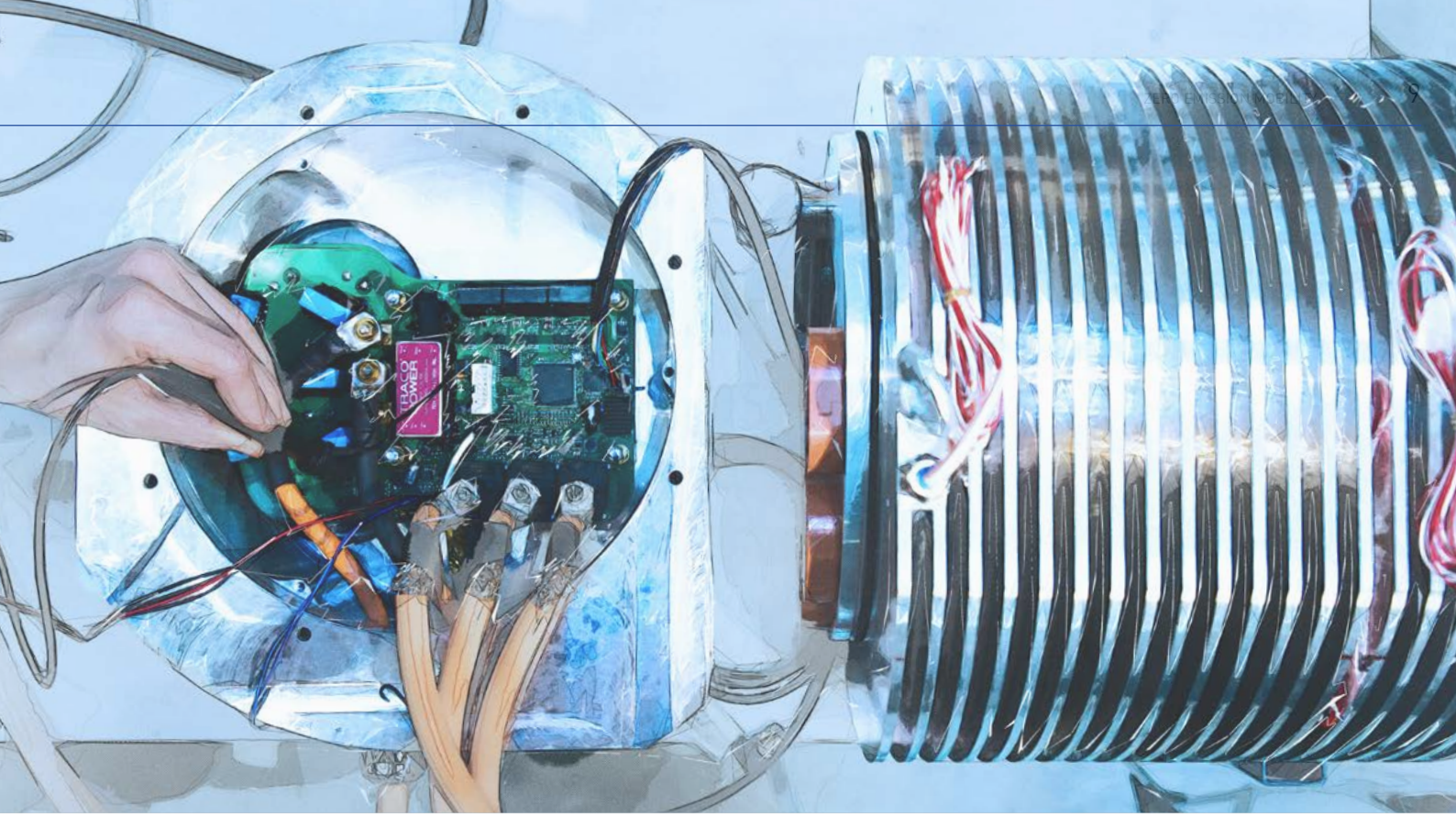


Photo: Climate and Energy Fund / Astrid Bartl

AUTOMOTIVE TECHNOLOGY FIELDS

In the area of vehicle technology, one of the main focuses is on developing alternative power trains. Firstly, this is a question of devising "complete system" concepts and operating strategies. Secondly, it entails developing and enhancing various components, such as electric engines, high-performance electronics and control technology. Today's modern vehicles have to respond to external conditions in real time and are expected to optimise all operating parameters continually. For this, they need information from advanced sensor components and high-performance electronics of the same calibre to process this information.

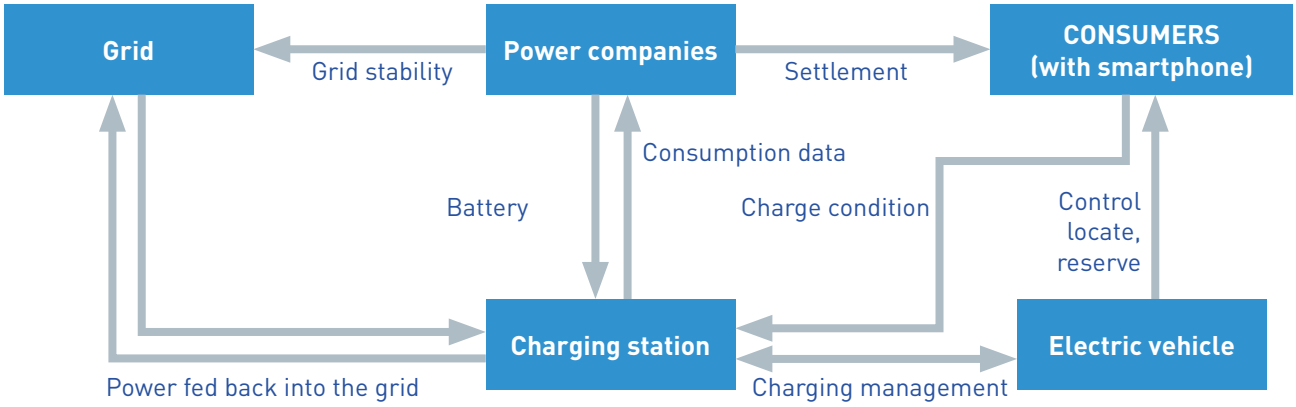
The psychological barriers preventing the spread of electric vehicles remain the same as before, namely the short driving range and the high cost of the batteries. The performance and cost of the rechargeable batteries will be crucial to the success of electric mobility. Enhancement of the battery technology is mainly concerned with energy density, safety during use, deep-cycle resistance and service life. Research and development in this area is heading in several different directions, e.g. how to combine batteries with high-performance capacitors or how to develop batteries in combination with fuel cell range extenders.

Within this context, life cycle analyses are another important element, i.e. the process of considering the total ecological and economic costs of the battery from the availability of the raw materials right through to recycling.

The integration of energy storage systems into the vehicle is also imposing new requirements in terms of the bodywork. By using new lightweight materials such as carbon fibre reinforced plastics, you can keep the total weight of the vehicle to a minimum, thereby extending the range. >>>

Photo: Climate and Energy Fund / Astrid Bartl

In order to develop a complete system of electric mobility, vehicle manufacturers, power companies and ICT specialists will all have to cooperate with one another.



Source: Fraunhofer IAO (institute for work management and organisation), graphic: Waldhör KG

ELECTRIC MOBILITY SYSTEM COMPONENTS

Research and development in the field of electric mobility must be geared towards creating a fully integrated complete system. Vehicle technology, infrastructure, energy supply and intelligent services for users must all link up if the electric mobility system is to work and become accepted.

Photo: Climate and Energy Fund / Astrid Bartl

SOURCES

[1] https://de.statista.com/themen/581/smartphones/

TECHNOLOGY FIELDS RELATING TO ENERGY AND INFRASTRUCTURE

Anyone who relies on a battery-powered vehicle to get around needs the corresponding infrastructure to be in place so that they can charge up their car reliably and conveniently. Along with access to an extensive network of charging stations, user-friendly technologies are also required to enable easy operation.

Without a sustainable energy supply, there is no prospect of creating an environmentally-friendly form of mobility that is fit for the future. If the use of electric vehicles leads to increased demand for power from the public grid, solutions will have to be found to facilitate intelligent grid integration and incorporate renewable energy sources. The key research areas here are: central or decentralised storage management, the power demand associated with an increase in the number of electric cars, charging control and storage management in general. On the other hand, the process of incorporating electric vehicles into the grid introduces new storage capacity because the vehicle batteries can be used as external power storage systems. As part of "vehicle-to-grid" concepts (V2G), intelligent technologies are being developed for controlling charging and discharging processes in the smart grid. The idea is to use the batteries of electric vehicles as small incoming and outgoing feeders that can be connected as required.

NEW PERSPECTIVES THANKS TO INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

The overall system will only function if the users, vehicles, charging station and power companies are all connected to one another in the future via communication technology. Vehicle manufacturers, power companies and ICT firms must work together to develop integrated solutions. Users need to know where they can charge up their car, when their battery is full and how to pay for what they consume. The power companies need the consumption data to ensure the stability of the grid through skilful charging management. The information and communication technologies will form the interface between the users and the operating companies.

If data from public transport operators and other providers of mobility services can be integrated into a single system, this will create some of the most important conditions for "integrated mobility". Users who are able to get around flexibly and conveniently by relying on various interconnected mobility services (public transport, e-car sharing, e-bikes, hire bikes, etc.) will barely miss having their own car. The key to setting up such networks already exists: more than 1.4 billion smartphones are sold worldwide every year. [1]

Technological innovations are a very important component of the mobility transformation to a climate-friendly and thus Paris-compliant transport system. It is precisely the systemic approach of the "Zero Emission Mobility" programme and the consistent focus on emission-free drives that make a decisive contribution to developing and testing in Austria today the sustainable and climate-friendly solutions of tomorrow.

One decisive factor for the success of the mobility transformation is that as many Austrian companies and research institutions as possible make use of the huge potential that the mobility transformation offers. This will sustainably secure Austria's competitiveness as a business location. With this programme, the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology is pleased to support the process of achieving both sustainable economic development and the complete decarbonisation of the transport system by 2040 at the latest.

Photo: Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

HANS JÜRGEN SALMHOFER

Strategic Coordinator Mobility Transformation & Transport Decarbonisation
Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Photo: Climate and Energy Fund / Astrid Bartl

MORE KNOWLEDGE ABOUT FUTURE USERS

The introduction of electric mobility calls for new traffic concepts and a new approach to mobility management. Alongside the economic and ecological aspects, the general political framework also has a role to play in this regard. However, the ability of electric mobility to spread ultimately comes down to whether it is sufficiently accepted by the population. In this sense, it is extremely important to analyse user behaviour, user acceptance and any barriers.

What ranges are required, how reliable do electric vehicles have to be, how much can they cost and under what conditions will users be prepared to change their mobility behaviour? Consequently, demonstrations and test runs involving the new technologies and concepts, and the systematic evaluation of empirical user data obtained from pilot projects will be vital when it comes to the further development of electric mobility.

GETTING ELECTRIC MOBILITY MOVING – INTERNATIONAL TRENDS

SOURCES

[1] IEA Global EV Outlook 2019
www.iea.org/publications/reports/globalevoutlook2019/

[2] Press Release E-Mobility: Current Sales Trends in Major Global Automotive Markets, Prof. Stefan Bratzel, Center of Automotive Management (CAM), Bergisch Gladbach, 11 July 2019, www.auto-institut.de
https://auto-institut.de/index_htm_files/Pressemitteilung%20Elektro_1.Halbjahr_2019_v2.3_SB_Engl.pdf

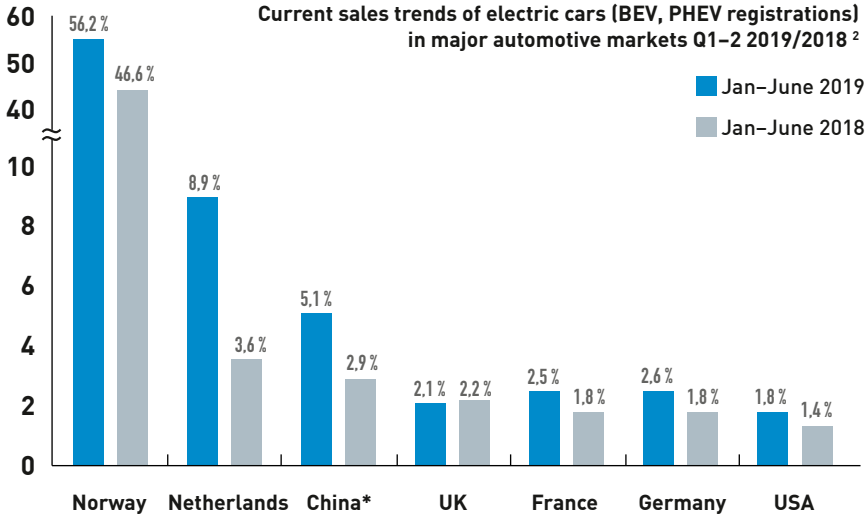
Electric mobility is growing rapidly. In 2018, the global electric car fleet exceeded 5.1 million, an increase of 2 million over the previous year. This means that the number of new registrations in 2017 almost doubled.

The People's Republic of China is the largest electric car market in the world. Around 45% of electric cars on the road in 2018 were in China – a total of 2.3 million – up from 39% in 2017.

In comparison, Europe accounted for 24% of the world fleet and the USA for 22%.

Norway continues to be a pioneer, leading the way in terms of market share of electric cars (BEV, PHEV) with 56.2% of new registrations. This is due to significant tax breaks and numerous accompanying measures, such as exemptions from parking fees. Norway has set itself the goal that all new vehicle registrations after 2025 will be for electric vehicles.[1]

In the great automotive nations, the registration figures for battery electric vehicles (BEV) and plug-in hybrid vehicles (PHEV) are still fairly insignificant.



*rounded, incl. commercial vehicles;
China, USA and Norway incl. fuel cell; Manufacturers in the USA partially appreciated

Photo: WKO / Marek Knopp

Electric mobility is one of the possibilities already available today for renewable and CO_2-saving mobility. It is attractive for companies that use e-fleets to position themselves as pioneers of sustainability or meet the needs of the market with new business models. How can we get more e-cars on Austria's roads? For example, by giving everyone who parks in a communal garage the right to a charging station. Research and development play a decisive role in the expansion of electric mobility. In this way we can increase the value added in Austria and increase export opportunities.

HARALD MAHRER
President of the Austrian Economic Chambers (WKO)

Photo: Climate and Energy Fund / Astrid Bartl

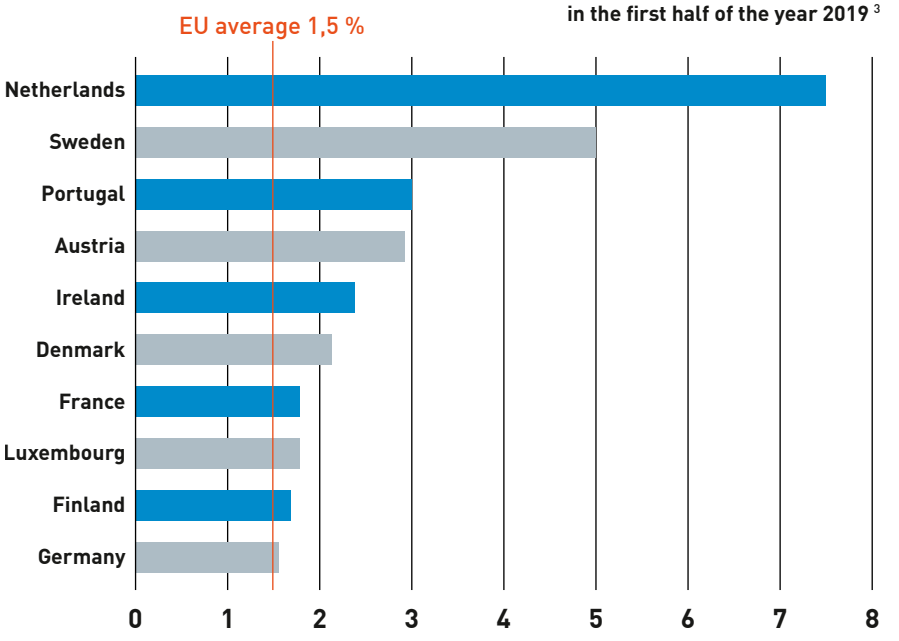
In the EU, the share of all-electric cars that are being newly registered is only slowly increasing. In 2018, just 1% of new cars were powered purely by electricity, and in the first half of 2019 a mere 1.5% were all-electric.

Although Austria is above the EU average (with a 2.8% share of cars powered purely by electricity among the new registrations in the first half of 2019), in contrast to 2016 and 2017 the country's performance in this area is no longer among the best in the EU.

The front-runner is the Netherlands. In 2018, 5.4% of new cars there were already electric, and in the first half of 2019 this number rose to 7.5%.[3]

In terms of public charging stations, Austria is among the top 10 in Europe with 56 per 100,000 inhabitants. Norway is still in the lead with 237 charging stations per 100,000 inhabitants.[4]

Share of battery-electric cars in new registrations in the first half of the year 2019 [3]



Source: VCÖ

SOURCES

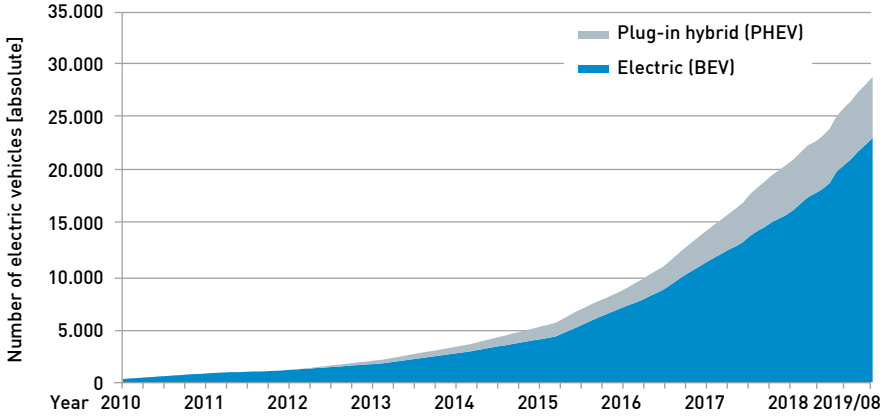
[3] www.vcoe.at/presse/presseaussendungen/detail/oesterreich-verliert-bei-e-autos-anschluss-zur-eu-spitze
[4] www.ots.at/presseaussendung/OTS_20190516_OTS0114/meilenstein-fuer-e-mobilitaet-oesterreichweit-laden-an-3500-ladepunkten-mit-nur-einer-karte
www.bmnt.gv.at/umwelt/luft-laerm-verkehr/verkehr/meilenstein-für-E-Mobilitaet.html (figures according to EAFO, VCÖ 04/2019)

ELECTRIC MOBILITY IN AUSTRIA – OPPORTUNITIES AND OUTLOOK

Photo: Climate and Energy Fund / Hans Ringhofer

In Austria, the high proportion of renewables within the energy mix provides a solid foundation for creating a sustainable and environmentally sound mobility system. As a key technology, electric mobility holds massive potential for generating high levels of added value and employment in Austria in the long run. Austrian industry and a large number of innovative companies are supplying cutting-edge technology for vehicles, infrastructure and smart mobility solutions.

Vehicle inventory of electric vehicles (Class M1)
(passenger cars - M1, Electric and Plug-in hybrid vehicles)[1]



[1] Source: Statistics Austria; data as of 31 December of the respective year and 31 August 2019; hydrogen vehicles are not included in this figure for technical reasons; representation: AustriaTech

The acceptance of electric mobility has been increasing in Austria for years. Public transport in many of the main conurbations is already being enhanced thanks to the introduction of environmentally-friendly hybrid and electric buses. E-taxi and e-car sharing concepts are being refined and trialled in various regions.

The number of electric cars in Austria is rising continuously. Back in 2011, there were 989 electric and plug-in vehicles on Austria's roads but by August 2019, this figure had climbed to a staggering 33,757 vehicles. This corresponds to a share of 0.67% of all vehicles. Between January and August 2019, 6,414 BEVs and 1,043 PHEVs were newly registered. Compared to August 2018, new BEV registrations have increased by 105%.[1]

Nevertheless, electric vehicles remain a niche product within the private transport sector. For this reason, research facilities and companies are working on new solutions to break down the psychological barriers that are known to put people off (driving range is too short, high purchase costs and inadequate charging infrastructure).

Photo: Fronius International GmbH

At Fronius we support our customers with modern charging systems, intelligent battery management and comprehensive services. This helps bring down the energy consumption for the operation of electric forklifts in the long run, reducing both costs and environmental pollution. We are currently running several pilot projects to test how battery charging technology can be combined with the use of photovoltaic power plants.

Yet these alternative non-fossil drive solutions are just one part of a bigger picture for us: a comprehensive energy supply based on the use of renewable energy sources. The Fronius vision is called "24 hours of sun". Thus, in future everyone will be able to charge up their electric vehicle at home easily and conveniently – using electricity produced by their very own photovoltaic power plants. Companies will also be able to offer their employees and customers a suitable smart charging infrastructure in the future that relies on networked photovoltaic systems. In addition, they will be able to generate green hydrogen remotely for their own vehicle fleets, to use for long-distance journeys.

ELISABETH ENGELBRECHTSMÜLLER-STRAUSS
CEO of Fronius International GmbH

E-MAPP STUDY
E-MOBILITY AND THE AUSTRIAN PRODUCTION POTENTIAL

This study was carried out in 2016 by Fraunhofer Austria, Austrian Mobile Power and the Virtual Vehicle Research Center on behalf of the Climate and Energy Fund. It examined the added-value and employment potential that Austria could unlock as a result of the transition to electric mobility. The automotive industry is currently in the process of transitioning to pure electrically powered vehicles. One of the key bridging technologies during this phase are hybrid electric propulsion systems.

Renowned OEMs hold development and production sites in Austria which belong to the most efficient ones globally developing and producing state-of-the-art and future engine and transmission concepts. Austria has a strong electrical and electronics industry, which produces important components required by the electric mobility sector. The focus of this study lies on passenger car components, charging infrastructure concepts as well as associated production technologies and processes of selected components within the e-mobility value chains.

A new study, E-MAPP 2, is currently being commissioned, which will show how electric mobility and the associated value added and employment effects have developed in Austria since 2016.

SOURCE

E-MAPP,
E-Mobility and the Austrian Production Potential, Fraunhofer Austria, Austrian Mobile Power and the Virtual Vehicle Research Center on behalf of the Climate and Energy Fund, 2016

www.klimafonds.gv.at/assets/Uploads/Presseaussendungen/2016/eMapp/E-MAPPStudie.pdf

FUTURE MARKET
FOR ELECTRIC MOBILITY

As a technology field, electric mobility holds massive potential for generating added value and creating new jobs. There are excellent opportunities here for Austrian companies to position themselves internationally with new products and technologies.

The 2016 E-MAPP study found that electric mobility held enough potential for Austria to create 33,900 jobs and generate around EUR 3.1 billion of extra added value by the year 2030.

The greatest potential for Austrian-based producers lies in the manufacturing of electric vehicle components and subcomponents, at both the infrastructure solution and production technology levels. >>>

33,900 jobs
EUR 3.1 billion added value by 2030

KEBA Wallbox for charging electric cars, photo: KEBA AG

Photo: Martin Rumersdorfer

Schachinger Logistik is investing heavily in the development of modern sector-specific logistics with a view to creating proactive and sustainable solutions – primarily for smart city logistics, last-mile logistics and a rapid transition to post-fossil mobility. The ambitious cooperative research projects EMILIA, LEEFF and, as of 2018, MEGAWATT-LOGISTICS would be inconceivable without the professional commitment of the Climate and Energy Fund. With the Climate and Energy Fund by our side as a reliable partner, we are managing to drive e-mobility forward in Austria as a member of strong consortia. We are catching up with our European competitors and are producing innovations that are now also attracting international attention. The DNA of the unique Council for Sustainable Logistics stems to a large extent from collaborations with the Climate and Energy Fund.

The consortia combine a broad spectrum of knowledge and open the way to new partnerships – and even friendships! This is rapidly creating opportunities for testing the newly developed technologies on the market and driving the transition to "Zero Emission Mobility".

MAX SCHACHINGER
Schachinger Logistik Holding GmbH

Photo: Climate and Energy Fund / Hans Ringhofer

SMART INFRASTRUCTURE

Across Europe and in Austria, the number of charging stations and charging points at locations such as shopping centres, service stations, garages and public car parks is constantly growing. Many of the projects undertaken as part of the "Flagship Projects" programme – such as EMPORA, CMO or CROSSING BORDERS – have laid the foundations for the smart infrastructure of the future. With 56 public charging stations per 100,000 inhabitants, Austria is among the top 10 in a European comparison. In total there are more than 5,500 publicly accessible charging connections in Austria.[1]

Every charging station in Austria and in Europe is recorded on the platform e-tankstellen-finder.com. It includes public charging points of operators such as energy companies, supermarkets and hotels. As of November 2019, there were around 2,100 publicly accessible charging points in Austria with a charging power of up to 22 kW, around 1,800 with up to 45 kW and 389 with a charging capacity of >45 kW.[2]

The eleven leading energy companies in the Austrian Federal Association for Electric Mobility operate the BEÖ charging network (about 3,000 public charging stations) with electricity from renewable energy sources. SMATRICS offers a comprehensive high-performance charging network with 450 charging points (of which around 210 are high-speed) with electricity from 100% hydropower.[3]

In 2019, the partner companies of BEÖ and SMATRICS set an important milestone and connected their charging stations to Austria's largest and fastest charging network. Since then, 3,500 publicly accessible charging points have been made available between Vienna and Bregenz. For e-car drivers, this partnership means that they can activate both BEÖ and SMATRICS charging stations with their respective charging cards.[4]

There are numerous apps that provide live information about vacant charging points. Customers are usually billed per unit of time rather than in kilowatt hours to eliminate waiting times for other users.

SOURCES

[1] www.bmnt.gv.at/umwelt/luft-laerm-verkehr/verkehr/meilenstein-für-E-Mobilitaet.html
Figures according to EAFO, VCÖ 04/2019

[2] e-tankstellen-finder.com, accessed on 5 November 2019

[3] Bundesverband Elektromobilität Österreich
www.beoe.at/laden/
https://smatrics.com/ladenetz

[4] www.bmnt.gv.at/umwelt/luft-laerm-verkehr/verkehr/meilenstein-für-E-Mobilitaet.html

Photo: Climate and Energy Fund / Ringhofer

SUSTAINABLE ENERGY SUPPLY

The "Ökobilanz alternativer Antriebe" (a life cycle assessment of alternative drives) published by the Environment Agency Austria reveals that electric and fuel cell vehicles perform significantly better than conventional passenger cars. For the purpose of this study, the experts considered the environmental impact throughout the entire life cycle of the vehicles, from production and operation right through to disposal.

For an electric vehicle, the ideal result is if 100% of the electricity used to power the vehicle comes from renewable energy sources. When the entire life cycle of the vehicle is considered, a fully electric battery vehicle produces about 80% fewer greenhouse gases than a fossil-powered passenger car.[1]

Austrian companies are actively involved in the area of electric mobility and are busy developing solutions to create a user-friendly infrastructure. The core tasks are to ensure a secure and sustainable power supply and to integrate electric vehicles into the power networks intelligently. By incorporating electric mobility into our energy system, business and industry are making a major contribution towards reducing CO_2 emissions.

If 10% of all passenger cars in Austria were to run on electrical power, the annual demand for electricity would increase by 1.3 TWh, representing a rise of just 1.8%. To power a million vehicles, it would have to rise by 2.6 TWh or 3.6%. Even if the full number of passenger cars currently in existence were to switch over to electric drives, Austria's electricity consumption would only increase by around 18% compared to its current annual level of approximately 70 TWh, equating to a rise of 13 TWh.[2]

SOURCES

[1] Federal Environment Agency: Update: Ökobilanz alternativer Antriebe (life cycle assessment of alternative drives) www.umweltbundesamt.at/fileadmin/site/publikationen/DP152.pdf

[2] Faktencheck Klima- und Energiefonds (Fact Check of the Climate and Energy Fund), 2017, own calculations

In the eyes of the VCÖ, a comprehensive energy transformation requires us to apply the concept "avoid – shift – improve" for the entire transport system. The most resource-efficient transport is one that does not happen at all. This can be achieved, for example, by strengthening town centres and stopping urban sprawl. Shifting means the change to energy-efficient and emission-saving mobility, such as rail travel or cycling. Where neither avoidance nor a shift can be implemented, the focus is on increasing efficiency. This is where e-vehicles have great potential in freight and passenger transport because they reduce both greenhouse gases and air pollutants.

ULLA RASMUSSEN
VCÖ

Photo: VCÖ / Rita Newman

ZERO EMISSION MOBILITY – THE FUTURE – MADE IN AUSTRIA

Photo: Climate and Energy Fund / Astrid Bartl

The automotive world is being turned upside down. In addition to ever more ambitious climate targets and emissions regulations, people are also beginning to think differently, as can be seen, for example, from the declining sales figures for diesel vehicles, especially in the private customer segment, and the sharp rise in the number of registrations of electric vehicles. On top of that, technological development is racing ahead and although this is not confined to the area of electric mobility, it is particularly apparent there.

All these factors mean that the automotive industry is undergoing a process of transformation, whose speed is being strongly dictated by external factors and which is happening much faster than expected just a few years ago.

This development is particularly relevant for Austria. Firstly, the country's economic structure is very heavily geared towards the automotive sector. For instance, the automotive industry accounts for 450,000 jobs and is worth EUR 43 billion in sales.[1] Secondly, transport in Austria is responsible for generating 45.8% of greenhouse gas emissions in the non-ETS sectors (those outside the emissions trading system).[2]

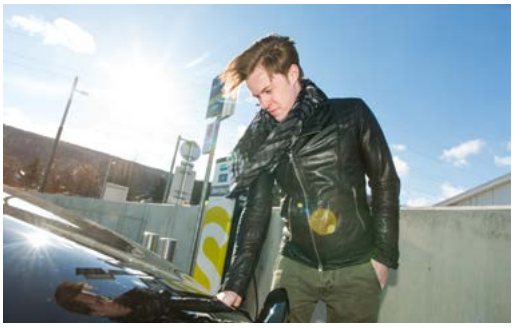
It was in light of all this that the Climate and Energy Fund initiated the **"Electric Mobility Flagship Projects"** research programme back in 2009 to prepare and support the transformation and greening of the automotive (supply) industry in Austria. Following a positive evaluation of the programme in 2017, it was adapted and upgraded together with the former Federal Ministry for Transport, Innovation and Technology (BMVIT) and the framework was laid out for the period 2018 to 2022.

In 2018, the revised programme was launched under the new name, **"Zero Emission Mobility"**. Due to the positive evaluation results, large parts of the familiar programme structure were retained. Thus the three pillars vehicle – infrastructure – user and the technology-neutral, mission-oriented approach still form the core of the programme. The systemic, market-oriented approach with a binding research and demonstration phase was also retained. An important new factor, however, is the claim of zero emissions, which is even anchored in the name. This means that only solutions that use 100% zero-emission technologies, i.e. that achieve 100% electrification, will be promoted. Battery electric and hydrogen-based concepts as well as solutions with supercapacitors are considered of equal value in terms of technological neutrality.

SOURCES

[1] www.fahrzeugindustrie.at/zahlen-fakten/wirtschaftsfaktor-automobil/

[2] www.umweltbundesamt.at/fileadmin/site/publikationen/REP0702.pdf



Photos: Climate and Energy Fund / Astrid Bartl

Photos: Climate and Energy Fund / Astrid Bartl

Research and development are crucial for strengthening Austria's ability to compete as a key centre of technology. This is particularly true in the case of electric mobility. The framework conditions, technologies and business models within this area are changing rapidly and the transformation triggered thereby is a major factor for Austria, a country where the automotive supply industry plays an important role.

In light of this, the Climate and Energy Fund has been successfully supporting electric mobility research projects that are conducted close to the market since 2009. The redesign of the programme will really help strenghtening the innovative power of the Austrian economy while at the same time actively supporting climate protection.

GERNOT WÖRTHER
Project Manager and Controller, Climate and Energy Fund

Photo: Climate and Energy Fund

The programme supports lead projects and cooperative R&D projects. This basic programme orientation is rounded off by accompanying studies on current issues in the field of electric mobility, and by setting the focus every year on the latest developments and needs of the Austrian industrial and research landscape. With this orientation, the Zero Emission Mobility Programme forms the research core for implementing the Austrian Federal Government's e-mobility campaign 2019–2020.

The objective is clear: the decarbonisation of the mobility sector can make a significant contribution to reducing CO_2 levels in Austria. It will require research and development and, ideally, solutions that are "Made in Austria". The Zero Emission Mobility programme provides the necessary (research) funding framework. Another important goal of the programme is to improve the competitiveness of the Austrian (vehicle) industry by promoting the development and testing of systemic solutions, thus securing and increasing the number of jobs in Austria.

In terms of content, it can be seen that the thematic trends of recent years are continuing. Electric mobility and its areas of application continue to develop dynamically. At the beginning of the "Electric Mobility Flagship Projects" programme, many basic technological questions were still unanswered, so most of the research questions focused on passenger cars and the necessary infrastructure and user requirements.

In recent years, the emphasis has shifted towards larger vehicle categories (from light commercial vehicles and special-purpose vehicles right through to HGVs) and the infrastructure required for these areas of application, involving a higher charging power and an intelligent charging management. Now there is an increasing number of applications for small projects that specifically address gaps in existing solutions and develop targeted research results.

SUCCESSES AND FUTURE OUTLOOK – EVALUATION OF THE PROGRAMME

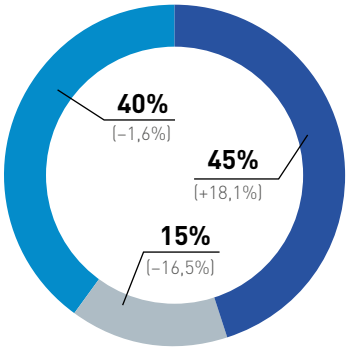
Photo: Climate and Energy Fund / Astrid Bartl

The support programme relies on a holistic approach that is both mission-oriented and system-focused. Together with the proactive programme management, this has helped the Electric Mobility Flagship Projects to make very successful progress over recent years. When the programme was evaluated in the autumn of 2017, the findings were extremely positive.

The programme is very close to the business world (75% of participants are companies) and it is particularly satisfying from a funding policy perspective to see such a high proportion of small businesses involved (47% of the participating companies) and cooperating with research facilities and large corporations.

What technology/topic is the primary focus of your activities as part of the project?

- Vehicle technology (including energy storage)
- Infrastructure technologies (intelligent charging stations, grid integration, etc.)
- Applications and users (integration into the transport system, etc.)



In brackets: percentage change since 2013
Source: Prognos AG

The programme focuses on all relevant areas of electric mobility, with the flagship projects covering the topics of vehicle technology, infrastructure technologies and applications/users.

Not only that, but new participants are being constantly brought on board and new collaborations between Austrian companies are being initiated (83% of the participating companies) all the time. The evaluation of the programme also reveals that this is one of the programme's keys to success. For many companies, one of the main motivating factors for participating in the projects was the opportunity to find cooperation partners.

Not only is the programme securing and creating jobs but there is firm evidence to show that it is resulting in a high level of input additionality (i.e. the extent to which the research funding encourages further R&D investments to be made at the supported companies and organisations).

In addition to this, since 2013 Austria has managed to improve its international position in the studied areas of "vehicle technology", "infrastructure technology", "applications" and "users".

From a technological perspective, substantial progress can be seen in all areas. On average, the degree of maturity of the technology within the implemented subprojects has increased by three degrees, taking the projects much closer to readiness for application. In turn, this is leading to innovations in products, services, business models and processes. The high innovation quality is evident from the fact that three quarters of the innovations are new to the national or international market and that 86% of them have already been placed or are due to be placed on the market.

By reducing traffic, relocating traffic, introducing alternative drives and making use of renewable energy sources the programme is having an effect on multiple levels, making it highly relevant to climate policy.

In addition, the scenario calculations made for the flagship projects reveal that it will be possible to achieve significant CO_2 savings if the project objectives are implemented as planned.

SOURCE
Evaluierung des Forschungs- und Technologieprogramms „Leuchttürme der Elektromobilität"
im Auftrag des Klima- und Energiefonds
(Evaluation of the "Electric Mobility Flagship Programme" for research and technology on behalf of the Climate and Energy Fund), Prognos AG, Berlin 2017

Pressing ahead – Improving Austria's ability to compete and giving it a stronger technological advantage

Recent years have been marked by rapid development. Within this context, Austrian companies have managed to improve their ability to compete internationally in the area of electric mobility, not least because of the Electric Mobility Flagship Projects.

Nevertheless, a whole host of research questions will still need to be tackled over the coming years. New areas of interest are constantly being added alongside the classic ones of how to reduce costs or increase the range of vehicles. Examples include sector integration, the fusion of autonomous driving and electric mobility and how to integrate these into multimodal mobility solutions, or the opening up of new application areas. Not only are these topics extremely exciting and rewarding from a research point of view but, within the context of an increasingly competitive international environment, location policy demands that they be properly addressed.

That is why the Climate and Energy Fund will continue to support electric mobility in the future. Taking into account the requirements of economic and climate policy as well as technological progress, it will offer tailored funding to support the further development of electric mobility in Austria and the directly associated imperatives of securing and creating jobs.

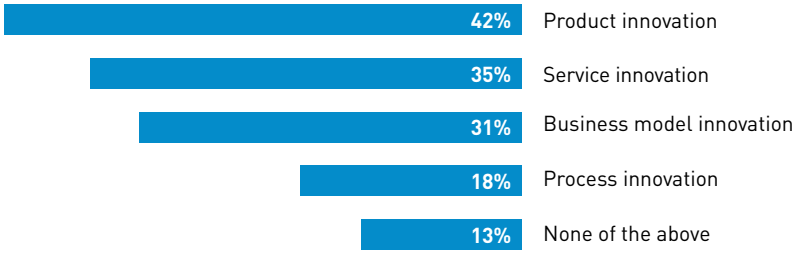
▶ PROGRAMME IS CLOSE TO THE BUSINESS WORLD
75% of the participants are companies; of these, 53% are SMEs.

▶ NETWORKING
83% of the companies were able to find new cooperation partners by participating in a flagship project.

▶ SIGNIFICANCE OF THE SUPPORT
Without the support, none of the projects would have been fully realised and 42% would not have happened at all.

▶ NEW PRODUCTS AND BUSINESS MODELS
¾ of the developments are new to the national and international market.

Project results (multiple responses allowed)



Source: Prognos AG

We conducted tests with hydrogen buses in Vienna, Graz and Klagenfurt. The result was always the same: positive feedback at all levels – from our passengers, our drivers and from the public media. The results were also convincing on an operational level. Consumption, for example, was lower than expected.

Now it is important to move from test operation to regular operation as quickly as possible. This calls for infrastructure – hydrogen filling stations and electrolysers to produce hydrogen – and start-up financing to get the projects off the ground. If these conditions can be met, nothing stands in the way of the triumphant advance of hydrogen buses as a climate-friendly alternative in bus transport. Postbus has already proven that it works.

SILVIA KAUPA-GÖTZL
Managing Director ÖBB Postbus GmbH

Photo: ÖBB Postbus GmbH

ZERO EMISSION

Research and development in the field of e-mobility

www.klimafonds.gv.at/unsere-themen/mobilitaetswende/leuchttuerme-der-elektromobilitaet/

MOBILITY

ELECTRIC MOBILITY FLAGSHIP PROJECTS THAT POINT THE WAY– FINALISED PROJECTS

eMORAIL / CMO / VECEPT / eMPROVE / E-LOG-BioFleet / RE²BA / EMPORA 1 & 2 / CROSSING BORDERS / EMILIA / SMILE – simply mobile

Numerous innovations in the field of e-mobility have been developed in cooperative R&D projects with the support of the Climate and Energy Fund in recent years and have already been successfully launched on the market.

ZERO EMISSION MOBILITY – CURRENT PROJECTS

SEAMLESS / LEEFF / ETA / EMPA-Trac / MEGAWATT-LOGISTICS / FlyGrid / HySnow

Current R&D projects are working on the entire system of electric mobility and are developing and testing innovative technologies for vehicles, infrastructure and users.

NEW LAUNCHES: R&D SCHEMES FROM THE LATEST CALL FOR PROJECTS

MHP – Mobile Hydrogen Powersupply / HySnowGroomer / ZERO Logistics / URCHARGE / E-ASY CHARGE / move2zero

2019 saw the start of some exciting new projects that address new technology issues and fields of application in "Zero Emission Mobility".

ELECTRIC MOBILITY – FROM RESEARCH TO MARKET

NTT Data / SMATRICS / E-mobility support programme for private individuals / ÖBB Rail&Drive / KEBA Wallbox / Upstream Mobility

Five examples of how knowledge has been successfully transferred to the market, and the description of a market incentive programme supported by the Climate and Energy Fund.

ELECTRIC MOBILITY FLAGSHIP PROJECTS THAT POINT THE WAY – FINALISED PROJECTS

eMORAIL
INTEGRATED EMOBILITY SERVICE FOR PUBLIC TRANSPORT

CONTACT
tbw research GesmbH
Angelika Rauch
eMORAIL@tbwresearch.org

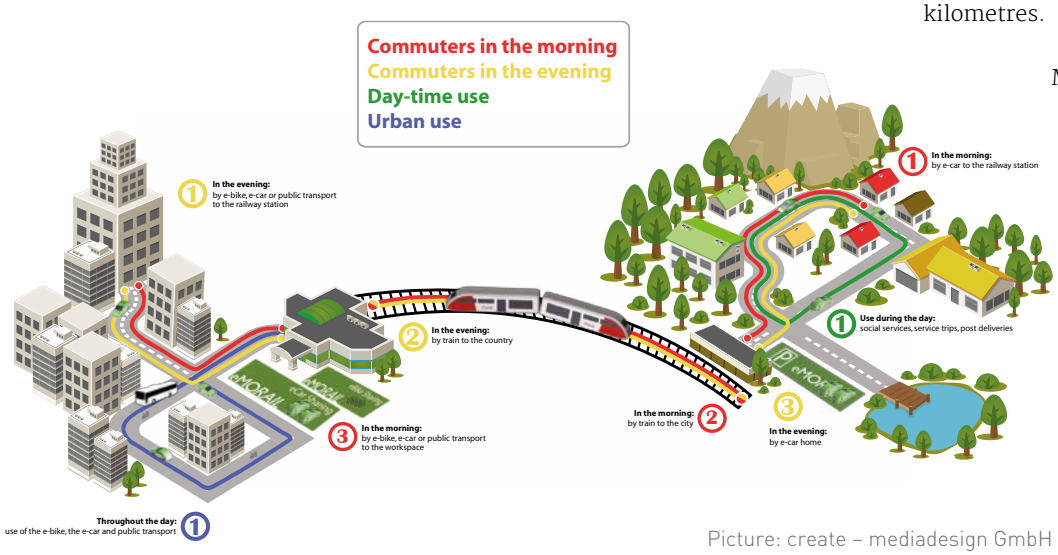
PROJECT PARTNERS
tbw research GesmbH / create – mediadesign GmbH / Quintessenz Organisationsberatung GmbH / HERRY Consult GmbH / PL.O.T. EDV-Planungs- und Handelsgesellschaft mbH / iC consulenten Ziviltechniker GmbH / DB Rent GmbH / EBE Mobility & Green Energy GmbH / NTT DATA Österreich GmbH / Rail Equipment GmbH / ÖBB-Personenverkehr Aktiengesellschaft / Verkehrsverbund Ost-Region (VOR) GmbH

The thought of having to walk the "first and last mile" from the station to your final destination and then back again often acts as a psychological barrier to using public transport. With eMORAIL, an environmentally-friendly and cost-effective mobility service for commuters was developed that systematically links electric mobility (eSharing models and eMobility services) and public transport. The intelligent mobility concept was successfully tested by test users in a 16-month pilot phase in the rural regions of Bucklige Welt and Leibnitz. In order to achieve a high level of vehicle utilisation, the e-cars were used operationally during the day by the post office, EVN and local companies.

Photo: Climate and Energy Fund / Astrid Bartl

With eMORAIL, the foundation stone was laid for an integrated mobility platform that allows customers to access important information (availability, booking times, ranges, public transport information in real time, etc.) on various end devices and is freely accessible to all mobility providers. The project partner ÖBB is currently already using 35 electric vehicles for its Rail&Drive car-sharing offer (see page 52), where, in addition to Vienna and the provincial capitals, a car can also be booked at the station in smaller towns for the last few kilometres.

Mobility as a Service (MaaS) is a very important topic at the moment. As early as 2010, eMORAIL was developed as the first functioning MaaS system for commuters in Austria.



Picture: create – mediadesign GmbH

CMO
CLEAN MOTION OFFENSIVE

Photo: Automotive Cluster

The main barriers preventing the spread of electric mobility are the high costs of the battery, the short range of the vehicles and the underdeveloped infrastructure. As the number of electrically powered vehicles increases, extensive demands are placed on the grid operators. The project CLEAN MOTION OFFENSIVE deals with the entire e-mobility system from the range extender to the intelligent electric filling station. Coordinated by the Automotive Cluster Business Upper Austria – OÖ Wirtschaftsagentur GmbH, twelve companies from industry and research cooperated to develop powerful electric mobility technologies that are perfectly in line with the needs of the market.

CMO innovations

The range extender in the form of a compact two-cylinder common rail diesel engine from STEYR MOTORS extends the range of electric vehicles by 150 to 200 km. A new battery concept from Ligthweight Energy combines five times cheaper lead storage batteries with high performance lithium batteries. The "SEM" box from Smart E-Mobility controls the interaction between the combustion engine and the electric motor. The "Flywheel", a flywheel energy storage system, was developed at Graz University of Technology to increase efficiency. All CMO innovations were integrated into a sample vehicle and tested in real-life operation. Suitable business models were developed at TIC Steyr.

Various further developments of the cluster partners build on the experience gained in the CMO: for example, the insights gained in the area of vehicle technology helped STEYR MOTORS develop the "Energy Cube". KEBA AG was able to use the project results for new developments in the charging infrastructure (e.g. the Wallbox, see page 52). The Clean Motion Offensive project has given rise to the "Initiative Connected Mobility" (ICM), a continuing platform of the automotive cluster for promoting new technologies for future vehicles.

Range extender, photo: STEYR MOTORS GmbH

SEM box, photo: Automotive Cluster

CONTACT
Wolfgang Komatz
Automotive Cluster
Business Upper Austria –
OÖ Wirtschaftsagentur GmbH
wolfgang.komatz@biz-up.at
www.connected-mobility.at
www.automobil-cluster.at

PROJECT PARTNERS

Business Upper Austria – OÖ Wirtschaftsagentur GmbH / Automotive Solutions GmbH / FH OÖ Campus Wels / KEBA AG / Lagermax Lagerhaus und Speditions AG / Lightweight Energy GmbH / LINZ Strom GmbH / reload multimedia / Smart E-Mobility / STEYR MOTORS GmbH / Technology & Innovation Center TIC Steyr GmbH / Graz University of Technology

KEBA Wallbox,
photo: KEBA AG

VECEPT
VEHICLE WITH COST-EFFICIENT POWERTRAIN

CONTACT
Theodor Sams
AVL List GmbH
theodor.sams@avl.com

PROJECT PARTNERS
AVL List GmbH / AIT Austrian Institute of Technology GmbH / ecoplus. Niederösterreichs Wirtschaftsagentur GmbH / Fluidtime Data Services GmbH / IESTA – Institute for Advanced Energy Systems & Transport Applications / Infineon Technologies AG / IVD Prof. Hohenberg GmbH / Magna E-Car Systems GmbH & Co OG / University of Vienna / Samariterbund Wien Rettung und Soziale Dienste gemeinnützige GmbH / VERBUND AG / VIF – Kompetenzzentrum Das virtuelle Fahrzeug Forschungsgesellschaft mbH (Graz)

The focus of VECEPT was the development of a cost-efficient plug-in hybrid vehicle (PHEV) suitable for everyday use, which was designed as a volume model for the world market with a pure electric range of about 50 km. Key criteria for the innovative car drive concept were efficiency, weight, performance, comfort, range and cost. An all-encompassing thermal and energy management as well as a weight and energy-optimised battery were further key factors. In 2017, the world's first demo vehicle could be presented.

Photo: Climate and Energy Fund / Astrid Bartl

The energy and cost-optimised battery system was developed by Samsung SDI Battery Systems GmbH, taking into account CO_2 emission reductions and safety aspects. By using an alternative cell technology, the energy density could be increased and at the same time the weight of the battery reduced. Compared to a conventional battery, the electrical range was increased by more than 20%.

Furthermore, a professional management tool for mixed vehicle fleets was developed and the behaviour of different user groups with regard to the charging infrastructure was investigated. Charging data for the evaluation of user behaviour was collected at four rapid charging stations set up between Vienna and Graz.

eMPROVE
INNOVATIVE SOLUTIONS FOR THE INDUSTRIALISATION OF ELECTRIFIED VEHICLES

PROJECT PARTNERS
AVL List GmbH / AIT Austrian Institute of Technology GmbH / ATT advanced thermal technologies GmbH / 4a manufacturing GmbH / IESTA – Institute for Advanced Energy Systems & Transport Applications / Leichtmetallkompetenzzentrum Ranshofen GmbH / Montanuniversität Leoben / REDUX Recycling GmbH / Samsung SDI Battery Systems GmbH / Saubermacher Dienstleistungs AG / VIF – Kompetenzzentrum Das virtuelle Fahrzeug Forschungsgesellschaft mbH (Styria) / Zoerkler Gears GmbH & Co KG

In the eMPROVE project, the components and e-vehicle concepts developed in VECEPT were evaluated with regard to industrial mass production, and further developed with a view to energy and cost efficiency. Flexible PHEV drive design and modular HV battery systems allow easy integration into a larger number of vehicle classes and reduce the cost of producing electrified vehicles.

CONTACT
Michael Nöst
IESTA – Institute for Advanced Energy Systems & Transport Applications
office@iesta.at
www.eMPROVE.at

Recycling and second life solutions for electrochemical storage systems also offer new possibilities to reduce costs in the area of serial production.

The development results were integrated into near-market demonstrators (a complete PHEV vehicle and a modular battery system). This allowed the functionality of the new technical solutions to be demonstrated and prepared for market launch.

E-LOG-BioFleet
FUEL CELL TECHNOLOGY FOR INDUSTRIAL TRUCKS

The development and integration of fuel cells with hydrogen storage as range extenders is a technological leap forward in the improvement of electric industrial trucks. For the first time in Austria, hydrogen sourced from biomethane will be carried out at a decentralised hydrogen production plant with hall fuelling.

In the course of the E-LOG-BioFleet project, it proved possible to develop this innovative concept for a logistics application, and to test it in a real-life industrial environment at DB Schenker in Hörsching (Upper Austria). Twelve battery-powered industrial trucks were converted to hybrid operation with a power package (fuel cell, hydrogen pressure storage, lithium-ion accumulators and control electronics).

Photo: HyCentA Research GmbH

The vehicles have proved to be reliable and durable in everyday use in demanding multi-shift logistics operations. Not having to change the battery means easier work and cost savings, and it only takes a few minutes to refuel the H_2 vehicle.

In light of the extremely positive project results, it was decided that operation should continue and the vehicles are still being used successfully today. In the course of follow-up projects, the hydrogen production will be switched to electrolysis coupled with electricity from renewable sources. An upgrade of the refuelling infrastructure for HGV refuelling is also being evaluated.

CONTACT
Alexander Trattner
HyCentA Research GmbH
trattner@hycenta.at

PROJECT PARTNERS
Fronius International GmbH / HyCentA Research GmbH / JOANNEUM RESEARCH Forschungsgesellschaft mbH / Linde Fördertechnik GmbH / OMV Refining & Marketing GmbH / Schenker & Co AG

RE²BA
RECYCLING AND REUSING LITHIUM-ION BATTERIES

In this project, a new concept for recycling batteries from electric mobility was developed in order to optimise costs and make e-mobility more economical overall. To this end, the recycling of used industrial batteries was tested to find out how flexible the process is with regard to different chemical structures. A knowledge of their chemical composition is vital for assessing the cost-effectiveness of a reprocessing plant. With a view to optimising recyclability as early as possible, some improved design factors were defined.

For the first time in the German-speaking countries, it was possible to test the technical suitability of these batteries as a storage medium for PV electricity or for covering peak demands. The results of a long-term test at the partner company Smart Power GmbH & Co KG in Germany were promising. A battery system from an electric motorbike would, for example, be sufficient to act as a storage system for a home PV system with an installed power of approximately 5 kWp. In 2017, the project won the Energy Globe Styria Award and the national Energy Globe Award.

CONTACT
Astrid Arnberger
Saubermacher Dienstleistungs AG
a.arnberger@saubermacher.at

PROJECT PARTNERS
Saubermacher Dienstleistungs AG / AVL List GmbH / KTM AG / Montanuniversität Leoben / Smart Power GmbH & Co KG

Battery recycling at the Saubermacher company, photo: Climate and Energy Fund / Astrid Bartl

EMPORA 1 & 2
E-MOBILE POWER AUSTRIA

EMPORA
E-MOBILE POWER AUSTRIA

CONTACT
Eva Maria Plunger
VERBUND AG
eva.plunger@verbund.com

PROJECT PARTNERS

A1 Telekom Austria AG / AVL List GmbH / BEKO Engineering & Informatik AG / DiTest Fahrzeugdiagnose GmbH / EVN AG / Fluidtime Data Services GmbH / Ecotech / Infineon Technologies Austria AG / LINZ STROM GmbH / Magna E-Car Systems GmbH & Co OG / Österreichisches Forschungs- und Prüfzentrum Arsenal GmbH (AIT) / Raiffeisen Leasing GmbH / REWE International AG / Salzburg AG für Energie, Verkehr und Telekommunikation / Siemens AG Österreich / The Mobility House GmbH / UBIMET GmbH / VERBUND AG / Wien Energie GmbH / Wiener Linien GmbH & Co KG

As part of the EMPORA cooperative research and development project, 22 leading firms from the automotive, power, infrastructure and research sectors have spent several years working on integrated technical and organisational solutions to facilitate the large-scale deployment of electric mobility across Austria.

Because partners from different sectors cooperated, it was possible to develop solutions along the entire value chain, ranging from technological developments in vehicles to energy supply from renewable sources and the testing of e-mobility services with customers. Examples include powertrain/charging/storage components in the car itself, intelligent charging pillars, smart grids, tools for energy-efficient routing and new business models.

The results are serving as a basis for the CROSSING BORDERS flagship project and the international CEGC (Central European Green Corridors) project, which was funded by the Trans-European transport networks (TEN-T). Here, VERBUND worked together with international partners to implement a cross-border network of rapid charging stations as well as cross-border roaming services.

CROSSING BORDERS
CROSS-BORDER E-MOBILITY SERVICES

CROSSING BORDERS

CONTACT
Eva Maria Plunger
VERBUND Solutions GmbH
eva.plunger@verbund.com

PROJECT PARTNERS

AIT Austrian Institute of Technology GmbH / E.ON Technologies GmbH / SMATRICS GmbH & Co KG / Ecotech e.U. / Fluidtime Data Services GmbH / IFSTTAR / ENTPE / OVOS Media GmbH / Siemens CVC Convergence Creators GmbH / PDTS GmbH / Ubimet GmbH / VERBUND Solutions GmbH / TRAFFIX / ZSE Západo slovenská energetika

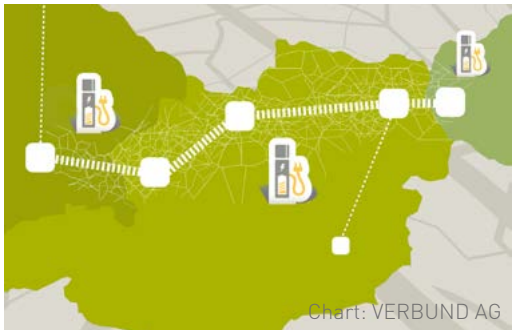


Chart: VERBUND AG

Through the CROSSING BORDERS project, VERBUND and its partners from Germany, Austria and Slovakia are achieving new milestones to enable the rapid implementation of electric mobility. The four e-mobility regions Bratislava, Vienna, Salzburg and Munich were connected within the project and a transnational e-mobility corridor was developed. The entire infrastructure was built along this axis.

13 companies participated in this process of creating an international and interoperable electric mobility network. The establishment of the rapid charging corridor was based on a network plan that was developed based on socio-economic and traffic planning input data.

SMATRICS, founded by EMPORA partners VERBUND and Siemens, took over the operational management of the cross-border charging infrastructure.

SMATRICS (see page 51) offers a comprehensive high-performance charging network in Austria. Currently it has more than 435 charging points (of which around 210 are high-speed) with electricity from 100% hydropower. By cooperating with national and international partners, SMATRICS today enables e-mobility far beyond national borders.

EMILIA
ELECTRIC MOBILITY FOR INNOVATIVE FREIGHT LOGISTICS IN AUSTRIA

Making freight logistics in urban areas more efficient and environmentally-friendly in the future was the goal of the EMILIA flagship project, in which a consortium of 15 Austrian companies worked together. They developed innovative freight logistics concepts for towns and cities as well as small electrically powered transport vehicles for what is known as "last-mile distribution". The project was broken down into three phases, which consisted of surveying customer needs, developing innovative technological components, logistics concepts and software solutions, and then combining them in a demonstration phase. New logistics concepts are designed to improve the use of e-vehicles in freight logistics and aim to offer greater efficiency, sustainability and customer service. Two light commercial vehicles – an electric cargo tricycle and an electric van – were optimised to increase their efficiency and reduce costs.

The project culminated in a demonstration phase in 2017 which put the resulting developments (concepts, vehicles and apps) on the street under real conditions. It was possible to successfully meet the logistics requirements. In the course of the trial, the vehicles optimised as part of the project covered a distance of more than 1,500 km and delivered more than five tonnes of goods.

DPD Demo with EMILIA cargo tricycle
©Austrian Mobile Power, photo: Anna Lilly Wimmer

EMILIA ELECTRIC MOBILITY FOR INNOVATIVE FREIGHT LOGISTICS IN AUSTRIA

CONTACT
Boschidar Ganev
Electric Drive Technologies
AIT Austrian Institute of Technology GmbH
boschidar.ganev@ait.ac.at
www.emilia-project.at

PROJECT PARTNERS
AIT Austrian Institute of Technology GmbH / Austrian Mobile Power / Automobil-Cluster Clusterland Oberösterreich GmbH / Bitter GmbH / DPD Direct Parcel Distribution Austria GmbH / ECONSULT Betriebsberatungsges.m.b.H / Gebrüder Weiss GmbH / gleam technologies GmbH / isn – innovation service network GmbH / Leichtmetallkompetenzzentrum Ranshofen GmbH / Magna Steyr AG & Co KG / Miba Sinter Group / Rewe International AG / Schachinger Logistik Holding GmbH / SIGNON Österreich GmbH

SMILE – simply mobile
SMART MOBILITY INFO & TICKETING SYSTEM

The SMILE project involved developing a prototype for a multimodal mobility platform that could be used all across Austria. SMILE links public transport (PT) with electric mobility and brings together different elements in one unified system, namely information, booking and payment processes, and the benefits of various transport types.In order to test the SMILE platform, a multi-stage practical trial was carried out over the course of one year with more than 1,000 participants. When the pilot phase was evaluated, the results revealed that the mobility platform can be used to increase the use of sharing and electric mobility services while reducing the number of journeys made by private cars. The three-year, multiple award-winning research project ended at the end of May 2015.

The results from SMILE were subsequently further developed by the project partners at various levels. With a view to implementing and operating the highly successful multimodal "Wegfinder" route planner app, ÖBB Holding set up a special subsidiary called iMobility. Meanwhile, Wiener Linien and Wiener Stadtwerke are operating an open multimodal platform solution via their subsidiary "Upstream – next level mobility" (see page 53) and offer their customers multimodal travel assistance through their "Wien Mobil" app.

Photos: Wiener Stadtwerke Holding AG

smi)e einfach mobil

CONTACT
Reinhard Birke
Wiener Stadtwerke Holding AG
reinhard.birke@wienerstadtwerke.at
www.smile-einfachmobil.at

PROJECT PARTNERS
Wiener Stadtwerke Holding AG / Wiener Linien GmbH & Co KG / Wien Energie Stromnetz GmbH / WienIT EDV Dienstleistungsgesellschaft mbH & Co KG / ÖBB-Holding AG / ÖBB-Infrastruktur AG / ÖBB-Personenverkehr AG / iC consulenten Ziviltechniker GmbH / Fluidtime Data Services GmbH / NTT DATA Österreich GmbH / create – media-design GmbH / TU Wien – Research Center of Transport Planning and Traffic Engineering / Quintessenz Organisationsberatung GmbH / tbw research / ETA Umweltmanagement / Neue Urbane Mobilität Wien GmbH

ZERO EMISSION MOBILITY – CURRENT PROJECTS

SEAMLESS
SUSTAINABLE, EFFICIENT AUSTRIAN MOBILITY WITH LOW-EMISSION SHARED SYSTEMS

Electric mobility is rarely used in commercial environments, because company vehicles usually have to satisfy lots of different requirements. Company cars are used for long journeys as well as shorter ones, they are generally assigned to individuals and they are available for business and personal journeys alike. In May 2016 the SEAMLESS flagship project was launched, which focuses on innovative concepts for business e-fleets. The aim is for new technologies and mobility solutions in the areas of car sharing and car pooling to make the commercial use of electric vehicles more attractive.

Enio e-charging station, photo: Enio

CONTACT
Matthias Prandtstetter
AIT Austrian Institute of Technology GmbH
matthias.prandtstetter@ait.ac.at

PROJECT PARTNERS

AIT Austrian Institute of Technology (lead) / Österreichische Post AG / HERRY Consult GmbH / tbw research GesmbH / SPECTRA TODAY GmbH / im-plan-tat Raumplanungs GmbH & Co KG / iC consulenten Ziviltechniker GesmbH / ETA Umweltmanagement GmbH / T-Systems Austria GesmbH / ENIO GmbH / Fronius International GmbH / Kalomiris Consulting e.U. / ecoplus. Niederösterreichs Wirtschaftsagentur GmbH / Greenride GmbH / creative-it Software & Consulting e.U.

The forms of financial relief for electric cars that have taken effect following the 2016 tax reform (company vehicles no longer classed as benefits in kind, input tax deduction) are an opportunity to establish electric mobility more firmly within the commercial environment. Innovative mobility concepts plus new business and operator models are required so that companies are able to switch their fleets over to electrically powered vehicles.

Under the leadership of the AIT Austrian Institute of Technology, project partners from a large number of Austrian companies are in the process of devising various e-fleet concepts. This means analysing and testing internal company car fleets as well as cooperative car pooling models that involve the use of vehicles across different companies. The issue of how to connect car sharing to multimodal mobility solutions is another major focus of the project.

HIGHLIGHTS ▼

- → Electric mobility solutions within corporate fleets
- → Car pooling and car sharing models
- → Innovative technical implementation
- → Test operation with six demonstration partners
- → New business and operator models for internal company car fleets
- → Connection to existing multimodal mobility solutions
- → Tailored to the needs of employees

Car pool Fahrvergnügen, photo: fahrvergnügen.at

It is extremely important to get vehicle users involved. Employee motivation and acceptance are vital to ensuring that the new solutions are introduced successfully.

Technical implementation and test phase
Alongside the organisational and commercial aspects, technical implementation also has a crucial role to play. Within the framework of the project, a car sharing technology was developed so that electric cars could be used within fleets in an uncomplicated and convenient manner. This technology includes a straightforward booking and billing system, route and trip planning, optimised vehicle allocation and charging, and the intelligent use of back-up batteries and energy management systems.

In the demonstration phase in 2019, the solutions were tested by six demonstration partners (Post AG, iC consulenten, ETA Umweltmanagement, t-systems/t-mobile Austria, Spectra Today, Fronius International) in fleets with different vehicles (combustion engines and electric motors) and with the integration of public transport.

Particular importance is being attached to user acceptance, cost-effectiveness and positive environmental impact. Initial results show that providing innovative company mobility concepts has a positive effect for both company and private mobility by lowering CO_2 emissions.

Greenride car pool, photo: greenride

"SEAMLESS aims to smooth the way as we move away from the idea of company cars as status symbols and towards the concept of mobility as a service provided by employers. This will call for a permanent transformation/paradigm shift in the thinking of company car users and employers alike. In turn, this will encourage greater use of electric vehicles within company fleets and the incorporation of alternative modes of transport (such as public transport) into everyday working life and the private sphere. At the same time, SEAMLESS will also allow technical components that are usually developed and tested independently of one another to be brought together into one cohesive whole so that it is easier for companies to switch over to a future-oriented mobility solution."

Photo: AIT

Matthias Prandtstetter
Project Leader, SEAMLESS
AIT Austrian Institute of Technology

LEEFF
LOW EMISSION ELECTRIC FREIGHT FLEETS

Road freight transport is responsible for a large proportion of the world's greenhouse gas emissions. If electrically powered vehicles were to be used in the transport industry, the environmental impact of the transport sector could be reduced significantly. The LEEFF flagship project developed new electric mobility solutions for freight transport along with appropriate planning and communication tools for electric fleets.

CONTACT
Bartosz Schatzlmayr-Piekarz
i-LOG Integrated Logistics GmbH
bp@i-log.at

PROJECT PARTNERS

Kreisel Electric GmbH / Oberaigner Powertrain GmbH / SMATRICS GmbH & Co KG / SPAR Österreichische Warenhandels-AG / Schachinger Logistik Holding GmbH / Quehenberger Logistics GmbH / Energie Ingenieure GmbH / Consistix GmbH / University of Natural Resources and Life Sciences Vienna, Council for Sustainable Logistics (CNL) / Satiamo GmbH / University of Vienna, Department of Business Administration / University of Applied Sciences of Upper Austria – Hagenberg campus / FEN Sustain Systems / Gebrüder Weiss GmbH / Selecta Betriebsverpflegungs GmbH

Photo: i-Log GmbH

The project, which was launched in 2016, covers the full range of vehicle technology, the charging infrastructure and also new business models for using electrically powered vehicles in freight fleets. Under the leadership of i-LOG Integrated Logistics GmbH, the project team was not only looking at technical aspects but also at organisational and socio-economic issues.

As part of the project, an electric van with an adapted battery system was developed along with an intelligent charging station that is suitable for commercial use at logistics centres. In addition, an innovative business model for fleet operators and tailored planning tools were implemented (in the form of a prototype) and tested during a demonstration phase.

Vehicle technology

By developing an electric transporter van that is ready for series production, the hope was that new discoveries will be generated in the area of electrically powered light commercial vehicles (LCVs). The advanced e-van is to feature a 120 kW rear wheel electric drive and have a range of 200 to 300 km. It will be equipped with an on-board charger that supports rapid charging.

A single-stage transmission for electric vehicles was specially developed by Oberaigner that should work for engine speeds of up to 12,000 rpm. It will also have a parking lock and a connection for a tachograph.

Most of the costs associated with electric vehicles are attributable to the energy storage system. The key technologies here are the battery and charging equipment. That is why research work was so focused on finding the right layout for a powerful and cost-effective battery/charging technology. Lithium-ion battery packs are being optimised so that a higher energy density (4.1 kg/kWh and 1.95 dm^3/kWh) can be achieved for various applications with a low-weight solution that is more compact. The development work also encompassed the thermal management of the batteries plus optional use of the batteries for active vehicle

"As far as Tesla boss Elon Musk is concerned, there can be no doubt that the future of mobility is electric. It is high time that this started applying to urban delivery logistics as well. Electric stacker trucks are already used as standard in intralogistics. In view of the constantly increasing volume of e-commerce parcels, delivery vehicles such as those used for courier, express and parcel services should – ideally – also play their part in minimising noise and emissions in the main conurbations. Particularly in the case of major cities that are growing strongly, such as Vienna, this is becoming an important part of the smart city concept. Together with our top project partners, we want to make a major contribution in this regard."

Bartosz Schatzlmayr-Piekarz
Project Leader, LEEFF
i-LOG Integrated Logistics GmbH

Project partner and funding party,
photo: Schachinger Logistik Holding GmbH

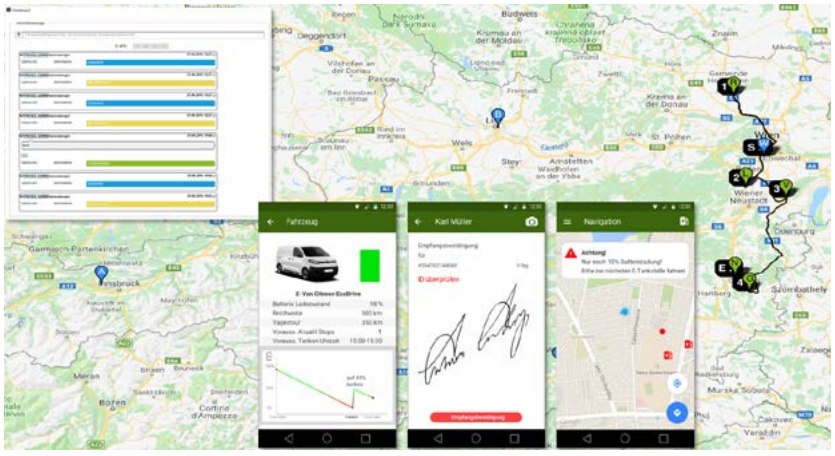


Photo: Satiamo GmbH

HIGHLIGHTS ▼

- → Enhancement of electric vehicles for use in freight fleets
- → Solutions for creating an intelligent charging infrastructure
- → New fleet concepts
- → Optimisation of mixed fleets
- → Innovative operating and business models
- → New logistics, scheduling and routing solutions
- → Integration of user needs

Photo: SMATRICS

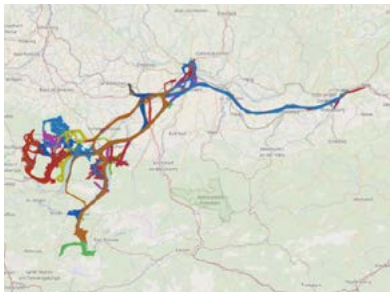


Photo: Energie Ingenieure GmbH

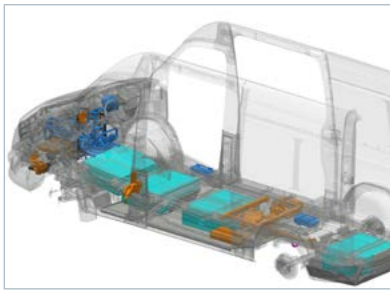


Photo: Kreisel Electric GmbH

heating and cooling. Several different charging strategies (from high-performance charging to battery changes) were investigated as part of the project.

Optimisation of charging management and planning tools

As far as the charging infrastructure is concerned, ICT-based solutions were devised to enable charging control and energy management within a commercial fleet setting. The process of integrating these technically into existing fleet management systems was analysed and tested.

The project also involved developing prototypes for a new fleet management tool and a mobile application that will actively support drivers.

Intelligent routing and planning tools are the key to implementing electric mobility successfully within a route-planning context.

The new technologies are being combined with suitable business models with a view to creating something that is both cost-effective and highly convenient for users.

The new developments were tested on a demonstration fleet. The demonstration started in January 2017 at the SCHACHINGER Logistics Group's Hörsching Logistics Park and Logistics Center Linz and was extended to other practice partners in the greater Vienna, Graz and Innsbruck areas in 2018. A total of eleven e-transporters were in use at the partners' premises and more than 100,000 km were driven in practice.

LINKS

www.leeff.at

https://infothek.bmvit.gv.at/chancen-wie-elektronutzfahrzeuge-die-verkehrswende-voranbringen-elmotion/

ETA
ADVANCED ELECTRIC TRANSMISSIONS IN WHEEL LOADER APPLICATIONS

While the extensive trend towards electrification has mainly created production-ready solutions in the field of the automotive industry, current sociopolitical activities indicate clearly that a new era in this sector has begun faster than expected, and that the demand for particularly low-carbon or even local zero emission drives in construction and mobile machinery is imminent.

CONTACT
Hans Knapp
Chief Engineer for Advanced Development and Power Train Wheel Loader
Liebherr-Werk Bischofshofen GmbH
hans.knapp@liebherr.com

PROJECT PARTNERS

TU Wien, Institute of Mechanics and Mechatronics, Department of Control and Process Automation / KRISTL, SEIBT & Co GmbH / HYDRIVE Engineering GmbH

With its hydraulic-mechanical XPower® power split transmission, Liebherr today already has by far the most efficient wheel loader drive in the large-size segment. This has been impressively demonstrated through independent comparison runs by renowned companies in the building materials industry on the basis of the lowest fuel and energy consumption, respectively.

As an Austrian manufacturer of construction machinery, the company is perceived in the industry as a global technology leader.

In order to further minimise energy consumption and emissions, it is necessary to continuously improve the efficiency behaviour of highly developed drives. In reaching this goal, electrification plays a key role – but not in the form of conventional, electric drive structures, which is highlighted by recent examples. Attempts by competitors to gain a foothold with hybrid-electric drives have not been successful so far. There are two reasons for this: on the one hand the efficiency has fallen short of expectations due to requirements that are specific to wheel loaders, and on the other hand expenses are many times higher than with highly developed hydraulic-mechanical drives.

Photo: Liebherr


Photo: Liebherr

"Our research on electric components and driveline structures focuses on several goals. Electric drives feature low power losses, thus improving the overall efficiency also of construction machinery. This leads to lower energy consumption and less exhaust emissions. In combination with emission-free energy sources like batteries and fuel cells, the vehicles will be without any local emissions. By means of this project we want to prepare our construction machinery for this next technology step."

Herbert Pfab
Product Development Manager Wheel Loader
Liebherr-Werk Bischofshofen GmbH

Photo: Liebherr

Therefore, the focus lies on increasing the efficiency of traditional drives through more advanced electrified ones. This may be considered as the "way-in" for gaining ground in the electrification of the construction and mobile machines industry. This opens up new possibilities:

> Low energy consumption is the key for achieving large ranges of operating time with regard to battery-powered equipment.
> Reduction of vehicle emissions to a minimum wherever battery-powered equipment cannot be deployed.
> Pioneer for the replacement of combustion engines with fuel cells.
> Cost-optimised components due to low energy consumption.

HIGHLIGHTS ▼

→ Development of advanced electric powertrain concepts that improve the efficiency compared to hydromechanical powertrains

→ Researching on key technology enabling zero emission battery-powered concepts in wheel loader applications

→ Development of new types of electric power trains to reduce exhaust emissions to a minimum

→ Optimising transmission and electric components

Photo: Liebherr

LINKS

www.liebherr.com

EMPA-Trac
ELECTRIC MODULAR PLATFORM ARCHITECTURE-TRACTOR

CONTACT
Peter Kainz
Adolf Tobias GmbH
peter.kainz@stmk.or.at

PROJECT PARTNERS

AIT Austrian Institute of Technology GmbH / Hellpower Energy e.U. / TÜV Austria Automotive GmbH

All pictures: kainz@tobias.at

Within the EMPA-Trac project, a modular, battery electric carrier vehicle was developed for municipal services vehicles and the agricultural sector with a total weight of up to 7.5 tonnes.

The core competence of the drive platform is the pure electric power head, which combines the advantages of the precise traction control of the electric drive, the weight-optimised power distribution in the vehicle and the common parts strategy to minimise production costs.

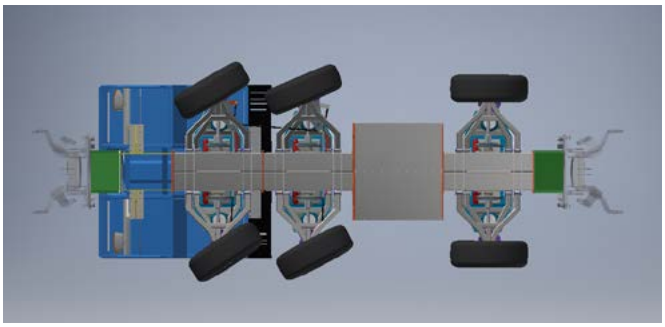
The development exploits all the ecological advantages of emission-free mobility – but electric drive technology is also a basic technology for significantly reducing overall weight and for efficient traction control.

Reduced costs through modular design

Given that vehicles for municipal applications are so highly customised, it makes sense to use a modular electric drive platform because versions with two, three or even four axles can then all be built from the same modules without too much additional development effort.

By adding electric power take-offs (E-PTO), the vehicle can be precisely tailored to the actual application requirements. This significantly reduces the manufacturing costs for the vehicle hardware, thereby making it possible to compensate for the costs of the battery pack.

As part of the project, the company developed its own lithium battery packs, which, in addition to the required safety and robustness, also enable the simple replacement of defective or reduced-power battery segments and their cost-effective use in other applications. Careful attention is paid to the applicable licensing criteria and compliance with the relevant safety standards from the moment the researchers start developing the components and modules.



The user needs were determined by collecting the current vehicle data through GPS data loggers at selected municipalities of the climate and energy model region Tullnerfeld-Ost. The data provided essential information about actual vehicle use in both summer and winter operation. Additionally, data from the large vehicle fleet of the city of Tulln was collected and evaluated.

After initial CAD models and shell constructions were made, three identical axle modules were assembled and interlocked to form a multi-purpose prototype vehicle. The drive platform will be tested in various real-life application scenarios. The selected configuration is a very compact three-axle vehicle with the battery pack in a parallel arrangement. This is ideal for use with snow ploughs because the synchronously steered double axle is located at the front. At the same time, this technically very sophisticated design demonstrates the possibilities offered by the modular concept.

HIGHLIGHTS ▼

- → Battery-powered carrier vehicle for municipal services vehicles and the agricultural sector
- → Two-, three- or four-axis versions without additional development effort
- → Reduced manufacturing costs due to modular design
- → Reduction of the total weight of the vehicle
- → Electric drive technology for emission-free mobility
- → Efficient traction control
- → Safe and robust lithium battery packs

LINKS

www.empa-trac.eu

Photo: private

"The electric drive enables us to create completely new, modular vehicle architectures based on common parts. It is therefore not the battery electric drive as an end in itself that is at the forefront of our research and development work, but the completely new construction methods that lead to a complete vehicle that makes sense both economically and ecologically thanks to its segmented design. Working in such a competent and committed team as here at EMPA-Trac is extremely demanding and challenging, but at the same time extremely productive."

Peter Kainz
Project Manager Prototypes, Adolf Tobias GmbH

MEGAWATT-LOGISTICS
ELECTRIC TRUCKS FOR CLEAN CITY LOGISTICS

Switching diesel fleets to electric fleets in the heavy commercial vehicle sector is a major challenge for logistics companies.

CONTACT
Werner Müller
University of Natural Resources and Life Sciences Vienna
Council für nachhaltige Logistik (CNL) (Council for Sustainable Logistics)
cnl-team@boku.ac.at

PROJECT PARTNERS

EVN AG / i-LOG Integrated Logistics GmbH / Kairos – Institut für Wirkungsforschung & Entwicklung / LSG Building Solutions GmbH / Magna Steyr Fahrzeugtechnik AG & Co KG / Netz Niederösterreich GmbH / Österreichische Post AG / Quehenberger Logistics GmbH / REWE International Lager & Transportgesmbh / Schachinger Logistik Holding GmbH / SMATRICS GmbH & Co KG / SPAR Österreichische Waren-handels-AG / Stiegl Getränke & Service GmbH & Co.KG / VERBUND Solutions GmbH / LOC: MAN Truck & Bus AG / LOI: Energie-Control Austria

There are very high financial risks involved in investing in electric freight transport fleets. The MEGAWATT-LOGISTICS project develops sustainable solutions for the conversion and operation of emission-neutral logistics fleets and lays the foundation for sustainable investment and business models. An interdisciplinary consortium of research institutes, energy suppliers, planning companies and infrastructure operators is working together under the leadership of the University of Natural Resources and Life Sciences Vienna (Council for Sustainable Logistics).

Logistics companies were selected for four different applications, where the operation of e-fleets is being tested in practice. The four areas for testing are classic store delivery (REWE, SPAR), the transport from local manufacturers to the factory (Magna), various recipient deliveries (Schachinger, Quehenberger) and beverage transport (Stiegl). In addition, feasibility studies for Post transport logistics and for transport between different production sites at Magna are being investigated.

Project goals:

> Carry out a three-year road test with 26t-electric vehicles in four different applications.
> Build up an expandable e-logistics database, collection of "key performance indicators" from e-logistics subsystems for various relevant scenarios.
> Develop planning tools for electric truck fleets and charging infrastructure with a daily power consumption of several megawatt hours. These investment planning tools should save 10-15% of the total investment costs compared to an investment strategy without modelling and simulation.
> Optimise operational processes with the help of a TCO (Total Cost of Ownership) model.
> Develop new business models for energy supply companies (EVUs) and logistics companies.

Photo: private

"Everybody wants zero emission logistics, but nobody knows how to make the switch. In view of the enormous complexity and scope of the expected investments (e.g. new transformer stations), we want to use this project to give companies a clear perspective for the switch."

Werner Müller
Leader: Council für nachhaltige Logistik (CNL) (Council for Sustainable Logistics), University of Natural Resources and Life Sciences Vienna

HIGHLIGHTS ▼

- → Planning tools for electric truck fleets and charging infrastructure
- → Road test with 26t-electric vehicles in four different application cases
- → Development of an e-logistics database
- → Optimised operation of e-fleets
- → Solutions for switching to emission-neutral logistics fleets
- → Sustainable investment and business models
- → The project has already achieved CO_2 savings of approx. 120 tonnes

All photos: MAN Truck & Bus AG

At the end of the first project year, significant milestones had already been reached. The pre-test was completed in time for the handover of the e-trucks in September 2018. During this time, in addition to holding driver training courses, important data on the respective fleet, tour and hub characteristics was collected. This data provides the basis for further simulation at the logistics centres.

In the next step, cost-optimised solutions will be determined from the multitude of technical possibilities, which will enable diesel fleets to switch to electric mobility. In addition to the experience gained through the use of e-trucks, CO_2 savings of approx. 120 tonnes have already been achieved in the project.

Photo:
Barbara Krobath

FlyGrid
HIGH-POWER FLYWHEEL ENERGY STORAGE SYSTEM FOR EV FAST CHARGING AND GRID LOAD MITIGATION

FlyGrid
Energy Storage for Vehicle Fast Charging and Grid Integration

CONTACT
Armin Buchroithner
Graz University of Technology
Institute of Electrical Measurement and Measurement Signal Processing
Energy Aware Systems Group
armin.buchroithner@tugraz.at

PROJECT PARTNERS

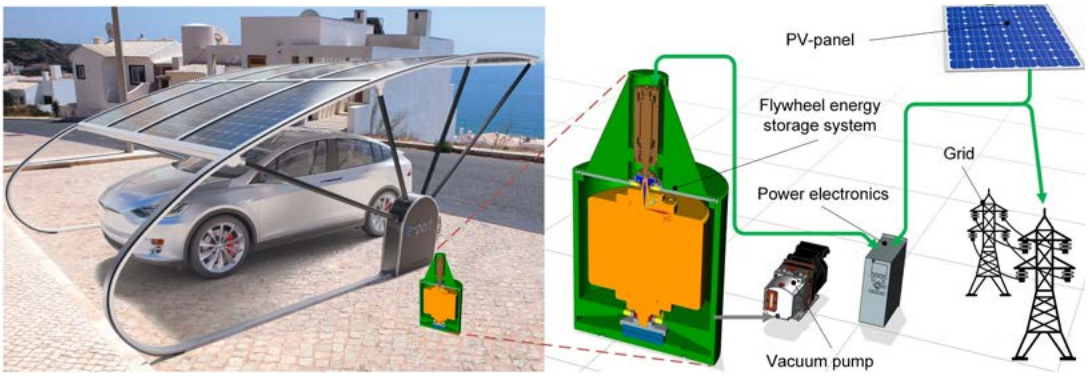
DAU GmbH & Co KG / easelink GmbH / Energie Steiermark Technik GmbH / Energienetze Steiermark GmbH / Chair of Energy Network Technology (EVT) Montanuniversität Leoben / myonic GmbH / Secar Technologie GmbH / THIEN eDrives

The expansion of electric mobility puts great demands on energy suppliers, network operators, vehicle producers and charging station manufacturers.

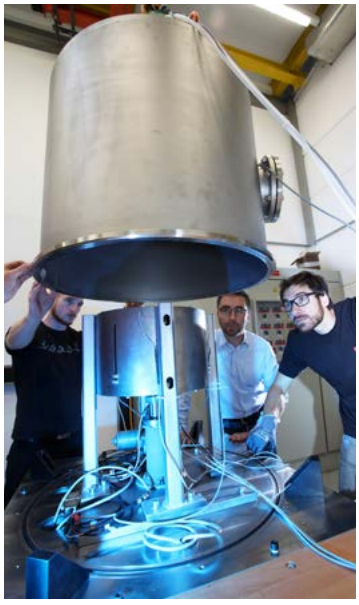
Increasing charging powers and the growing energy supply from renewable, volatile sources place an enormous load on the grid and can cause instabilities or even blackouts. On the other hand, the development of a nationwide rapid charging infrastructure (100 kW and more) is an important prerequisite to assess the omnipresent range anxiety issues, which EV users frequently suffer and to achieve a broad acceptance of e-mobility in general. Innovative solutions are needed to provide a high-performance network of rapid charging stations without costly network expansion.

In the FlyGrid project at Graz University of Technology, in cooperation with research and industry partners, a high-performance flywheel energy storage system is being integrated directly into a fully automatic rapid charging station for electric vehicles. The FESS (Flywheel Energy Storage System) acts as a "buffer" and reduces potentially harmful peaks on the grid by averaging the load. This enables high charging power with low grid load and local, volatile energy sources (such as PV modules on a carport) can be utilized in a much more efficient way.

One of the big advantages is that FlyGrid enables fast charging rates of 100 kW and more, even if there is only an AC connection with 400 V and 50 Hz available. Other key characteristics of the concept include: the excellent cycle life of the energy storage system, the ability to feed high levels of power back into the grid and the fact that it can be easily transported as a mobile "rapid charging box" (e.g. for electrified construction machinery).



Picture: Secar Technology GmbH / Graz University of Technology



Upper pictures: Graz University of Technology
below: Barbara Krobath

HIGHLIGHTS ▼

- → High-capacity flywheel energy storage made in Austria
- → Integration in a fully automatic rapid charging station for electric vehicles
- → Reduces charging time of EVs leading to higher market penetration
- → Avoids cost-intensive network expansion
- → Improved integration of renewable sources for supplying electric mobility
- → Higher customer satisfaction thanks to improved charging network

FlyGrid is a disruptive technology that can be manufactured in Austria. It will make a significant contribution to building up the infrastructure, increasing the share of renewable energy and improving the market penetration of e-vehicles. The versatile, interdisciplinary project consortium consists of two research institutes and seven industrial partners. The world's first combination of flywheel energy storage, highly innovative, fully automatic charging technology (easelink MATRIX CHARGING) and local renewable energy sources (Secar E-Port) underlines the uniqueness of the project.

LINKS

www.tugraz.at/projekte/flygrid/home/

Photo: Michael Bader

"Electromechanical flywheel energy storage systems are particularly well suited as buffer storage for EV charging stations and for grid stabilisation, as they are many times superior to chemical batteries in terms of cycle life, power density and ecological balance. In addition, this technology can be manufactured in Austria, thus enabling independence from the Asian battery market."

Armin Buchroithner
Graz University of Technology
Institute of Electrical Measurement and Measurement Signal Processing,
Energy Aware Systems Group

Left: Photovoltaic power plants, right: Hydrogen production plant including fuel dispenser, photos: BRP-Rotax GmbH & Co KG

HySnow
HYDROGEN TECHNOLOGY FOR EMISSION-FREE WINTER TOURISM

CONTACT
Walter Hinterberger
Project Management,
Advanced Engineering
BRP-Rotax GmbH & Co KG
walter.hinterberger@brp.com

PROJECT PARTNERS

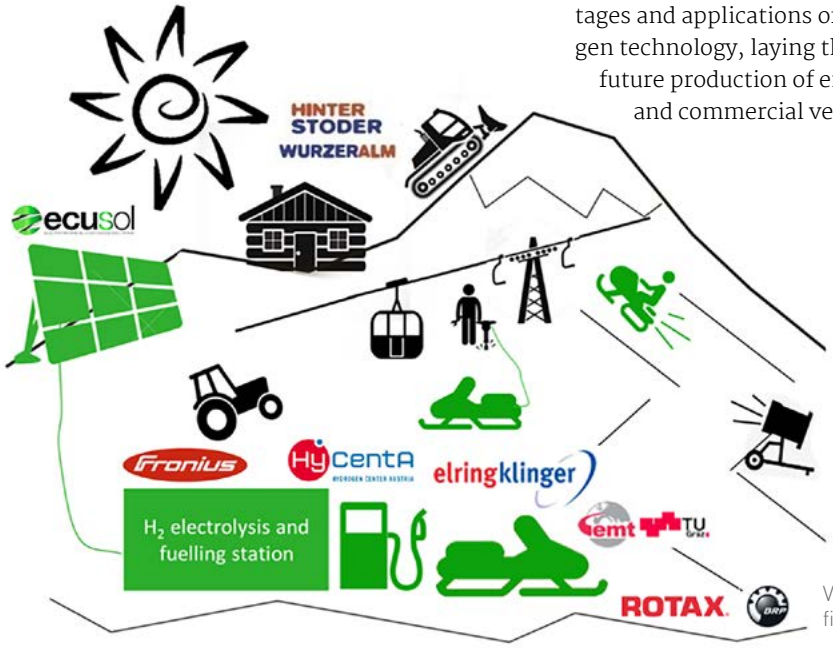
BRP-Rotax GmbH & Co KG / HyCentA Research GmbH / ElringKlinger AG / Fronius International GmbH / Hinterstoder-Wurzeralm Bergbahnen AG / Graz University of Technology, Institute of Electrical Measurement and Measurement Signal Processing / ECuSol GmbH

The HySnow project demonstrates how to operate a winter tourism area without releasing pollutants, greenhouse gases or noise.

Winter sports operations are energy-intensive. They can cause considerable noise and produce pollutant emissions in areas with sensitive landscapes. HySnow uses hydrogen as an energy source to create an emission-free energy cycle in alpine tourism regions.

The entire chain – from the photovoltaic power plant and hydrogen production with a refuelling system to a small fleet of fuel cell driven snowmobiles – is being developed, constructed and tested under real operating conditions in the Hinterstoder-Wurzeralm ski area.

HySnow demonstrates a whole range of advantages and applications of innovative hydrogen technology, laying the foundation for the future production of emission-free mobility and commercial vehicle solutions.



Vision and project partners, fig.: BRP-Rotax GmbH & Co KG

„The issue of 'zero emission mobility' is often discussed in a very one-sided way. What's important is that we learn to see the big picture – from generating and storing the energy to the vehicle transmission and how to come up with a functioning, integrated business model. The HySnow project is laying the foundation for this."

Walter Hinterberger,
Project Management, Advanced Engineering, BRP-Rotax GmbH & Co KG

Photo: private

HIGHLIGHTS ▼

- → Demonstration of a continuous hydrogen energy cycle
- → Construction of the first hydrogen filling station in an alpine environment
- → Direct coupling of photovoltaic and electrolysis system
- → Development of a fuel cell drive system for snowmobiles
- → Operation and evaluation under real operating conditions

Snowmobile,
photo: BRP-Rotax GmbH & Co KG

The aim is to produce hydrogen from renewable energy sources. To this end, the project also included the installation of a photovoltaic power plant in the ski resort, to generate electricity.

The hydrogen is produced by means of electrolysis modules. For this, a hydrogen production plant complete with a fuel dispenser was erected on the mountain. It is particularly challenging to operate such a plant in an alpine environment with low temperatures, reduced air pressure and changing weather conditions. In order to compensate for weather disturbances and to ensure unrestricted vehicle operation, the system has a large capacity for hydrogen storage. The main focus is on analysing the real-life operation, optimising the strategy of operation to increase its efficiency and finding cost-saving potentials.

Two prototypes of snowmobiles with fuel cell drives will also be assembled. The fuel cell system is being developed especially for alpine operating conditions. Series vehicles were modified as required, in order to integrate the powertrain. Furthermore, a hydrogen storage system was developed and integrated into the vehicle that increases the range.

The main advantages of hydrogen technology are the comparatively long driving range and the short refuelling times. These result in high vehicle availability. In addition, the fuel cell vehicle can also be used as a power source for operating external devices or tools.

The core issues to consider while developing the HySnow fuel cell drive are procuring the necessary components, the cold start-up of the fuel cell, how to increase the dynamics, the optimisation of heat management, and how to test it in the ski resort under real operating conditions.

NEW LAUNCHES: R&D SCHEMES FROM THE LATEST CALL FOR PROJECTS

MHP
MOBILE HYDROGEN POWER SUPPLY

CONTACT
Axel-Oscar Bernt
Product Manager
Hydrogen Systems
Magna Steyr
Fahrzeugtechnik AG & Co KG
axel-oscar.bernt@magna.com

PROJECT PARTNERS

Magna Steyr Fahrzeugtechnik AG & Co KG / TU Wien – Institute for Powertrains and Automotive Technology (IFA) / Austrian Automobile, Motorcycle and Touring Club (ÖAMTC)

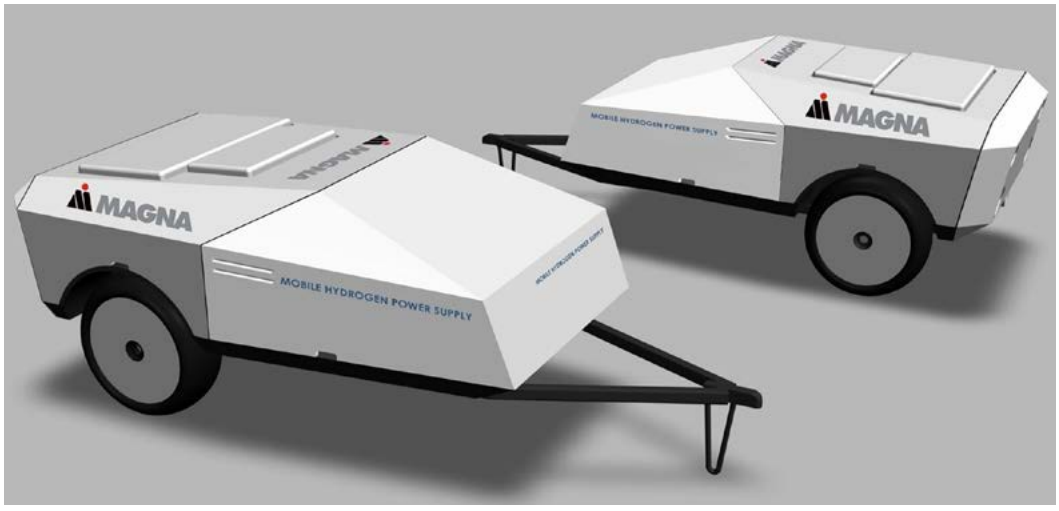
The aim of this project is the development of a mobile, emission-free e-charging station for on-site recharging of e-vehicles. In collaboration with the TU Wien, Magna Steyr is developing a system with a PEM fuel cell, a hydrogen storage system, HV battery, power electronics and HV charging station (CHAdeMO, CCS and AC Type 2), installed on a trailer.

The drawback of pure battery electric vehicles (BEV) is their relatively limited range and the as yet insufficiently developed charging infrastructure. BEVs cannot be simply recharged from a "reserve canister" when necessary. The project partners, ÖAMTC (Austrian Automobile, Motorcycle and Touring Club) and other European automobile clubs envisage that, as e-mobility becomes more widespread, there will be an increasing requirement for charging stranded e-vehicles.

The mobile e-charging station has its own communications system (Smart Charge Communication System SCCS), which establishes the connection to the stationary charging infrastructure and to the e-vehicle. This system enables the best and most resource-efficient management of the charging process and of energy use.

The MHP can be refilled at any public hydrogen filling station in just 3 minutes, so that it is quickly up and running again. Its emission-free operation means that it can be used in enclosed spaces such as underground car parks. The noise emissions of the system are around 90% lower than fossil fuel based e-vehicle charging systems.

Other potential use cases include the emission-free supply of energy to aircrafts on the ground (Aircraft Ground Power Supply) and mobile emergency power supplies for aid operations and organised events. The project results form the basis for a completely new product with major potential in the expanding e-mobility market.



Picture: Mobile Hydrogen Powersupply, Magna

HySnowGroomer
PROTOTYPE OF A HYDROGEN SNOW GROOMER

The HySnowGroomer is being developed by an Austrian consortium, under the umbrella of the Green Energy Center Europe and ARGE HyWest, as the world's first prototype of a hydrogen electric snow groomer, together with the associated infrastructure. The hydrogen stored in the snow groomer is converted into electricity by means of an on-board fuel cell system which drives the electric motors and the electrical aggregates. This results in a saving of up to 400 litres of diesel, i.e. approx. 1,100 kg of CO_2, per day per snow groomer. The snow groomer is supplied with green hydrogen – produced by the electrolysis of water and electricity sourced locally – from a mobile hydrogen filling station.

The holistic approach of the project enables the greening of winter tourism as follows:

> Emission-free and low-noise snow management (protection of the natural environment).
> Significant environmental offset measures (CO_2) in the relevant ski areas.
> Avoids expansion of alpine diesel and urea depots.
> CO_2-free snow depots can be set up in sensitive natural areas.
> Reduction of load peaks during "power bottlenecks", thus optimising the cost of power supply compensation payments (e.g. during snowmaking periods).
> Year-round emergency power supplies for isolated alpine areas, especially in crisis situations: for example, one HySnowGroomer can cover the normal daily electricity requirements of approximately 100 households.
> Construction of a regional and/or local value-added chain using locally available resources of water and electricity in alpine regions.

The HySnowGroomer project is an important element on the road to a CO_2-free and low-noise future for power supply and tourism and can help to strengthen Austria's system leadership position in the ecologisation of winter tourism.

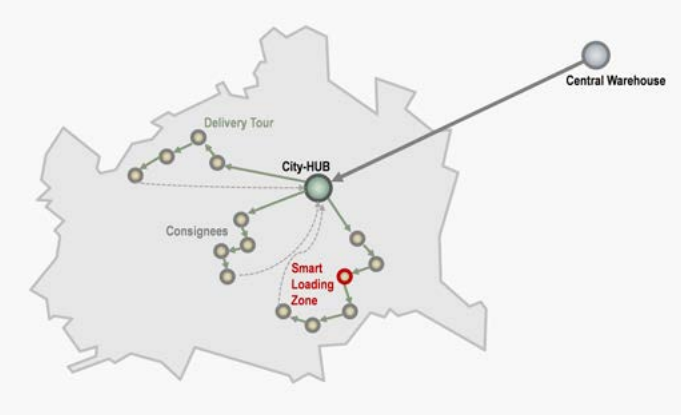
CONTACT
Nikolaus Fleischhacker
FEN Sustain Systems GmbH
nikolaus.fleischhacker@fen-systems.com

PROJECT PARTNERS

Green Energy Centers Europe, ARGE HyWest / FEN Sustain Systems GmbH / Kässbohrer Austria GmbH / Pongau Energie Zentrum GmbH / Schmidberger Elektroinstallationen GmbH

Pistenbully PB 600 E+,
photos: Kässbohrer Austria GmbH

ZERO Logistics
E-VEHICLES FOR FOOD DISTRIBUTION



CONTACT
Bartosz Schatzlmayr-Piekarz
i-LOG Integrated Logistics GmbH
Schachinger Logistik-Gruppe
bp@i-log.at

PROJECT PARTNERS

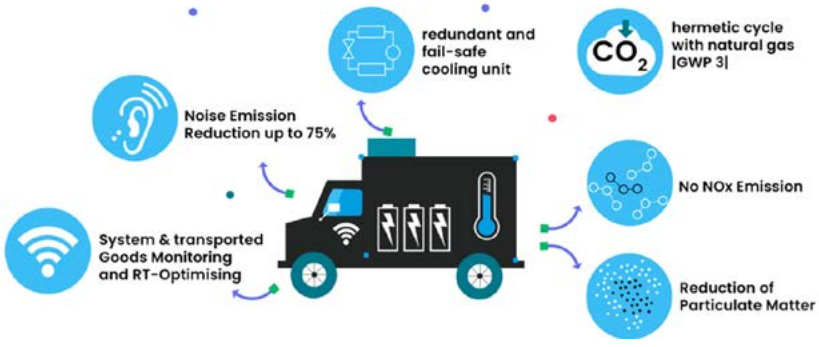
Johannes Kepler University Linz – Institute of Production and Logistics Management _ Chair for Sustainable Transport Logistics 4.0 / AIT Austrian Institute of Technology GmbH / PRODUCTBLOKS GmbH / Energie Ingenieure Consulting GmbH / Voltia AT GmbH / Consistix GmbH / Achleitner Biohof GmbH

In the LEEFF flagship project (see page 32), conventional N1 delivery vehicles were electrified and their suitability for package delivery was demonstrated. This project goes one step further. ZERO Logistics addresses the issue of the distribution of organic foodstuffs in the Upper Austria / Linz area, using temperature-controlled e-vans for the delivery of fresh food to end users.

Existing e-vans have been converted and equipped with an innovative cooling unit directly connected to the vehicle battery. This experimental vehicle design for temperature-controlled transport is being tested in a "E-NV200-Maxi" with a fairly small loading capacity as well as in a larger-sized van. The test procedure will also seek to optimise the relationship between insulation thickness, refrigeration temperature and payload.

The existing logistical system is being adapted to be suitable for use by e-vehicles. First of all, a city hub is being established as the starting-point for each e-transport delivery round. Secondly, urban recharging zones will be equipped so that e-vans can recharge during the delivery round. Battery capacity can thus be minimised. Charging point locations will be chosen in consultation with municipal power suppliers. A recharging slot will be booked using an app for which a prototype is being developed.

On the basis of the test results, a migration strategy for temperature-controlled vehicles will be worked out, together with rollout instructions for practical implementation of the strategy by fleet operators.



All pictures: ZERO Logistics

Photo: KEBA AG

URCHARGE

SMART LOAD MANAGEMENT FOR LARGE-SCALE EV CHARGING INFRASTRUCTURE IN AN URBAN AREA

The URCHARGE project is optimising the charging infrastructure for e-cars and is testing an enhanced load management system for using the KEBA KeContact P30 Wallbox in large-scale residential buildings. The new technology facilitates load management across all charging stations in a large housing complex. This will minimise the load peaks caused by e-mobility and will guarantee that the charging process is coordinated with the power and grid restrictions as far as possible. In addition, targeted surveys and workshops will determine customer requirements for private charging of e-cars and will address legal issues and potential problems.

An optimal load management algorithm is being developed for a scenario with 30% electromobility and a corresponding number of charging stations in a large residential building. With the aid of a simulation model focusing on large residential buildings in a typical district in Linz, different situations can be analysed using varying parameters, e.g. charging capacity, grid restrictions or demand-side flexibility. This allows long-term challenges for charging in urban areas to be flagged up.

In 2019 the project partner KEBA laid the foundation for an expansion of the load management function for its Wallbox.

A 6-month pilot phase will begin in 2020 to test charging infrastructure for 50 electric cars with the residents of a large residential building of NEUE HEIMAT OÖ in Linz. Each participant will exchange his or her conventional private car for an e-vehicle made available on favourable terms. The findings from the test process will be incorporated into further technical developments and appropriate business models.

Through these enhancements, URCHARGE aims at making an important contribution to the growth of the e-mobility market and to the reduction of CO_2 traffic emissions.

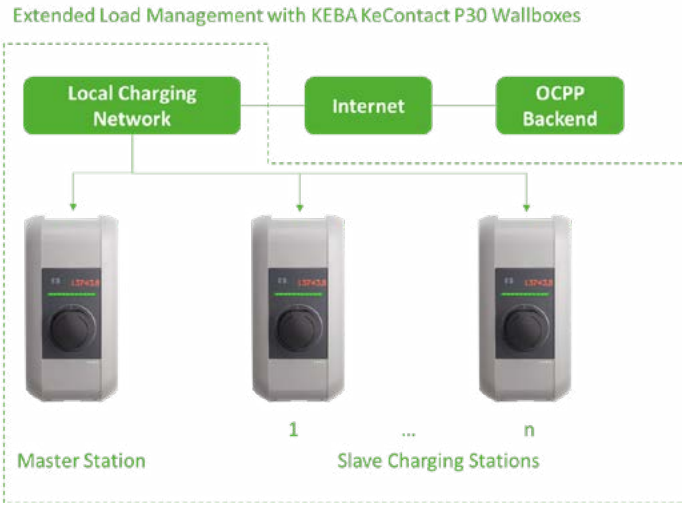


Fig.: KEBA AG

CONTACT
Jasmine Ramsebner
TU Wien-EEG
ramsebner@eeg.tuwien.ac.at

PROJECT PARTNERS

TU Wien-EEG / KEBA AG / LINZ AG Strom / NEUE HEIMAT OÖ / ETA Umweltmanagement GmbH

Volterio Charging Robot with vehicle unit (for private car secor), fig.: Volterio GmbH

E-ASY CHARGE
CHARGING ROBOT FOR E-HGVS

CONTACT
Werner Müller
University of Natural Resources and Life Sciences Vienna
Council für nachhaltige Logistik (CNL) (Council for Sustainable Logistics), Institute for Process and Energy Engineering (IVET)
cnl-team@boku.ac.at

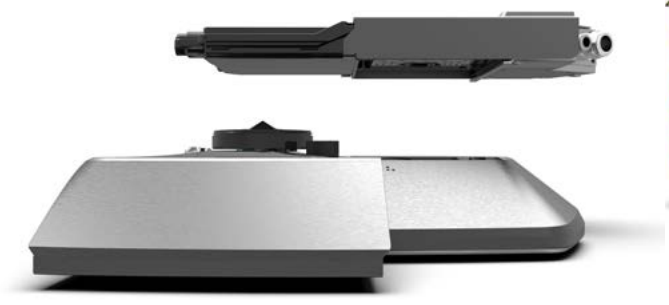
PROJECT PARTNERS

University of Natural Resources and Life Sciences Vienna – Council for Sustainable Logistics (CNL), Institute for Process and Energy Engineering (IVET) / VOLTERIO GmbH / FRAMO GmbH / VIRTUAL VEHICLE Kompetenzzentrum – Das virtuelle Fahrzeug Forschungsgesellschaft mbH

The electrification of logistics fleets can result in the refuelling process at the logistics hub causing increased overall power consumption and extremely high load peaks. To address these issues, logistics companies will have to expand their grid connection at the hub and/or integrate stationary storage to compensate for load peaks. Another pioneering solution is automated, decentralised fuelling of e-HGVs at as many stopping points as possible during their journey. This type of recharging would take the pressure off the logistics hub and avoid expensive extension of the grid connection. For the grid operators, too, decentralised fuelling would be an advantage, since the increased power consumption and the massive load peaks would be spread out as regards both timing and location.

The E-ASY CHARGE project is developing an autonomous charging robot, with a fast-charging capability, for e-trucks in the logistics sector. The technical feasibility of the concept is being studied in collaboration with an e-truck converter and a developer of autonomous charging robots that are currently being designed for the private car sector. The charging robot is anchored on the floor at the desired loading point. This allows the vehicle unit (which is integrated in the vehicle underbody) to automatically charge at any time while the truck is parked over the charging station. A prototype with a fast-charging capability is in development and is currently at the demo stage, undergoing functionality and practicability tests on a 40 t e-HGV.

So as to take into consideration the specialist requirements of various different users, the member companies of the Council for Sustainable Logistics (CNL) and other relevant stakeholders are involved in the project. E-ASY CHARGE has tremendous potential to drive the complete electrification of logistics fleets forward quickly, since it offers solutions to the two main problems (local grid load and insufficient range). Along with battery technology, intelligent charging concepts will be decisive in future if e-mobility is to become the norm in the transport logistics sector.



Volterio Charging Robot (for private car sector) picture: Volterio GmbH

E-trucks, picture: Framo GmbH

Photo: Lupi Spuma

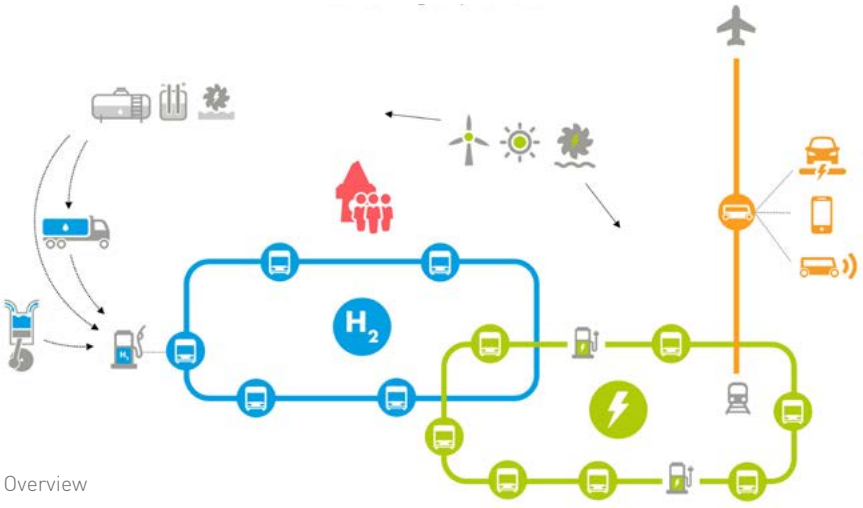
move2zero
DECARBONISATION OF THE URBAN BUS SYSTEM IN GRAZ

Within the scope of move2zero, the Holding Graz, in cooperation with the Graz Energy Agency and twelve corporate partners, is developing a holistic concept for the full decarbonisation of the urban bus transport system. The aim is to achieve climate-neutral energy supply and emission-free operation of vehicles and infrastructure. In a demonstration phase, two bus lines will be completely switched to zero emission vehicles. Seven battery-electric and seven fuel cell buses will be used.

In addition, innovative on-demand services will be developed and tested. In order to make public transport more attractive, a demand-based e-shuttle system will be set up between the Airport Graz, the suburban train and bus station and, if necessary, the public transport hub in Graz Puntigam. Moreover a booking platform will be developed and an innovative, automated charging system will be tested (charging via charging plates integrated in the floor).

All components will have low emission factors along with high reusability and recyclability. The entire life cycle of vehicles and infrastructure will be analysed and a comprehensive Life Cycle Assessment will be made.

The innovative developments will be accompanied by awareness raising measures and marketing activities. The compiled implementation concept of Graz will serve as a role model and should be easily transferable to other cities.



move2zero Project Overview

CONTACT

Andreas Solymos
Divisional Head of Planning Management & Infrastructure
Holding Graz – Kommunale Dienstleistungen GmbH
andreas.solymos@holding-graz.at

PROJECT PARTNERS

ARTI – Autonomous Robot Technology GmbH / Energie Graz GmbH & Co KG / Energie Steiermark Technik GmbH / Grazer Energieagentur Ges.m.b.H. / Hoerbiger Wien GmbH / HyCentA Research GmbH / Invenium Data Insights GmbH / Planungsgruppe Gestering | Knipping | de Vries / Graz University of Technology/ TECHNOMA Technology Consulting & Marketing GmbH / Umweltbundesamt GmbH / University of Graz – Institute of Statistics and Operations Research / Upstream – next level mobility GmbH

ELECTRIC MOBILITY FROM RESEARCH TO MARKET

Electromobility research done within the framework of the "Zero Emission Mobility" programme is intended for practical application. The results from the completed projects are already being successfully applied in many areas. This is fully in line with the aims of the Climate and Energy Fund because the goal is not simply to accumulate knowledge but to actually transfer this knowledge to the market in order to make a sustainable contribution towards climate protection and make the Austrian automotive (supply) industry fit for the future. Below are five examples of how knowledge has been successfully transferred to the market and a description of a market incentive programme supported by the Climate and Energy Fund.

NTT DATA
GLOBAL SUCCESS THANKS TO SUPPORT AT HOME

Photos: NTT DATA

Thanks to the SMILE flagship project, NTT DATA has been able to position itself throughout Austria as a mobility expert.

It doubled the number of employees working in the area of NXT mobility and had global responsibility for worldwide expertise in integrated mobility – this is just a snippet of NTT DATA Austria's success story.

By participating in a flagship project and making strategic use of the available Austrian funding, the Viennese branch of this internationally leading IT provider has turned itself into a global player within the e-mobility sector.

It was back in 2011 that NTT DATA Austria helped initiate the SMILE (Smart Mobility Info & Ticketing System) flagship project. This mobility platform offers users a wide choice of different modes of transport. The associated app provides users with all the information they need in response to their request.

This project enabled the Vienna location to position itself as a global expert within the group, according to Gerhard Hagenauer, Vice President NXT-Mobility at NTT DATA in Austria. "Mobility is a key driver of climate change and as a Trusted Global Innovator, NTT DATA is actively shaping this change with digitalised solutions." Hagenauer is convinced that this kind of positioning would have been absolutely impossible without the SMILE flagship project.
at.nttdata.com

SMATRICS
WHEN RESEARCH BECAME ENERGY!

Source: SMATRICS

SMATRICS, a joint venture between VERBUND, OMV and Siemens Austria that grew out of the EMPORA research project, is a leading provider of solutions for every aspect of electric mobility.

SMATRICS is the first – and only – provider in Austria to establish a comprehensive charging network covering the whole of Austria and beyond. This high-power charging network consists of 450 charging points that are located 60 km apart throughout Austria, with 100% of the electricity coming from Austrian hydropower generated by VERBUND. With this expertise SMATRICS offers tailor-made charging solutions for companies entering the e-mobility market that want to offer charging solutions to their employees, customers and guests.

SMATRICS is a one-stop shop for all services, ranging from consulting, installing and operating the infrastructure through to custom billing models. This allows companies with low personnel and resource requirements to act as independent e-mobility providers ("powered by SMATRICS") and resell standardised products to their customers in their own name. This extensive know-how has already made it possible to implement dedicated charging solutions for renowned Austrian customers such as ÖBB, Umdasch Group, Erste Group, REWE International AG, and VW.

SMATRICS is involved in both national and international research and funding projects and is nationally involved in LEEFF, VECEPT, CROSSING BORDERS and EMPORA, internationally in Ultra-E, EVA+ and Nemo, among others.
https://smatrics.com

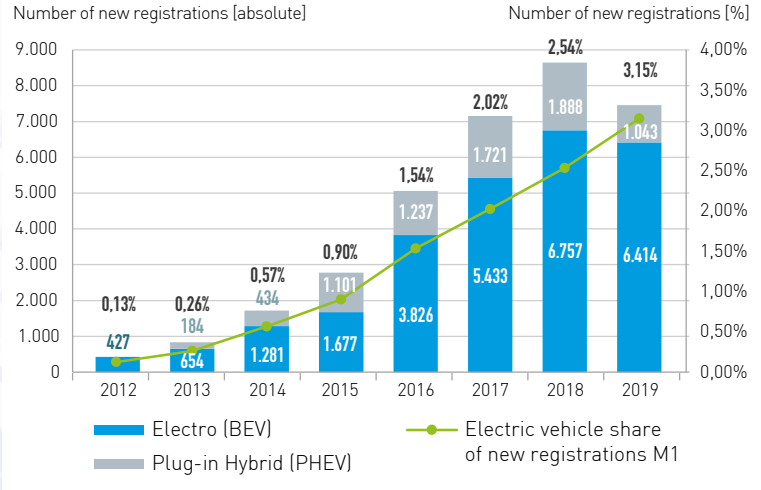
Photo: SMATRICS

E-MOBILITY SUPPORT PROGRAMME FOR PRIVATE INDIVIDUALS

As part of the federal government's support package for the promotion of electric mobility and in cooperation with importers of cars and two-wheeled vehicles, the Climate and Energy Fund has been subsidising the purchase of electric vehicles/fuel cell drive vehicles for members of the public since 2017. This support measure is facilitating the journey towards decarbonisation and is another way of injecting some dynamism that will encourage the spread of e-mobility.

In addition to BEVs and fuel cell vehicles, the measure is also being used to subsidise plug-in and hybrid vehicles, electric motorbikes, plus wall boxes and intelligent charging cables. Having a combination of research and market incentive programmes at the heart of the Climate and Energy Fund is absolutely vital to delivering comprehensive support for electric mobility and creating optimum incentives for rapid market diffusion.

Number of new electric vehicle registrations, also expressed as a percentage of the total number of vehicles registered (M1)

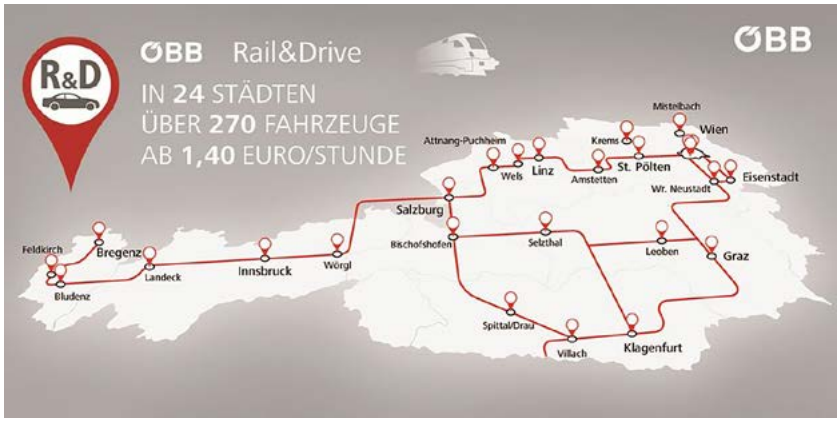


Source: Statistics Austria; as at 31 December of the corresponding year; Presentation: AustriaTech

www.klimafonds.gv.at/foerderungen/aktuelle-foerderungen/2017/e-mobilitaet-fuer-private/

ÖBB Rail&Drive

THE FLEXIBLE COMBINATION OF TRAVELLING BY TRAIN & CAR



Photos: www.railanddrive.at

Whether weekend trip, business meeting, day trip or shopping experience – the mobility offer ÖBB Rail&Drive is a stationary car sharing model at railway stations that can be used flexibly by customers, without an annual fee and at fair prices.

Rail&Drive is a mobility service for the first and last mile and was developed as part of the eMORAIL flagship project, tested in a pilot project and introduced throughout Austria in 2017. Since then, vehicles from the ÖBB fleet have been available at large and medium-sized stations for registered customers (even without an ÖBB ticket). ÖBB Rail&Drive wants to offer environmentally-friendly and CO_2-neutral mobility, so electric vehicles of the latest generation are currently being provided throughout Austria.

The e-vehicles are loaded at the vehicle location and can be recharged via the ÖBB charging card, at ÖBB Park&Ride charging pillars as well as at SMATRICS charging stations throughout Austria.
www.railanddrive.at

Photo: KEBA AG

KEBA Wallbox

INTELLIGENT POWER CHARGING WITH THE KEBA WALLBOX

Since 2009, the automation expert KEBA has been applying its know-how in the area of electric mobility in order to develop innovative solutions and make them ready for the market. With more than 150,000 power charging stations sold, KEBA is now one of the top three manufacturers of smart charging infrastructure in the world.

The foundation stone for the KEBA Wallbox was laid in the CMO flagship project. In addition, research was done on essential framework conditions for many of the functionalities currently available on the market (e.g. load management, online connection). KEBA is also a partner in the URCHARGE project that is testing an optimised charging infrastructure for electric cars in large residential building complexes.

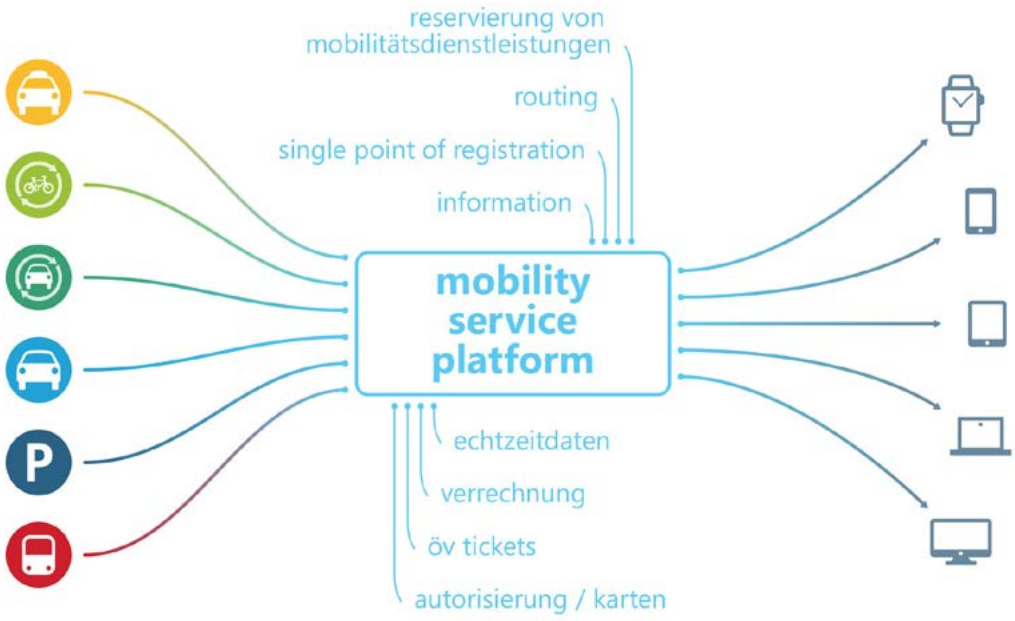
The KeContact P30 power charging station is already the third generation of KEBA Wallboxes, which offers completely new application possibilities thanks to its special communication standards and features. It can not only charge, but also control, communicate and network. With the integration of the Wallbox in the smart home or in backend systems, the coupling with photovoltaic facilities and the invoicing possibilities, KeContact P30 becomes a communication centre for intelligently controlled charging. The latest version – the KeContact P30 ME – is now also compliant with measuring and calibration regulations.
www.keba.com/emobility

Upstream Mobility
HELPS SHAPE THE CITIES OF THE FUTURE

The flagship project "SMILE" demonstrated the mobility of the future: the combined utilisation of public, collective and individual mobility offers as an alternative to one's own car, all in a single app. Based on this, Wiener Linien and Wiener Stadtwerke founded the subsidiary "Upstream – next level mobility GmbH" in 2016, which offers a Mobility as a Service platform as a municipal IT service provider. It links different mobility offers with each other and is open to any public or private provider.

Whether public transport, bike and car sharing offers or taxis, users can plan their routes individually and choose and book their preferred means of transport – and thus do without their own car. Upstream Mobility is aimed at municipalities, cities and greater urban areas that want to adapt their mobility services to the digital age, but at the same time want to remain in control of their mobility. In this way, open and non-discriminatory mobility can be guaranteed for everyone and a sustainable contribution to climate protection can be made.
www.upstream-mobility.at

Photos: Jacek Dylag, Samuel-Elias, Riccardo Gazzin, all Unsplash



Picture: Upstream Mobility

CONTACTS

The Climate and Energy Fund

Gumpendorfer Strasse 5/22
1060 Vienna, Austria
Tel.: +43 1 585 03 90
Fax: +43 1 585 03 90-11
E-Mail: office@klimafonds.gv.at
www.klimafonds.gv.at

Zero Emission Mobility
Programme Management
Gernot Wörther
Climate and Energy Fund
gernot.woerther@klimafonds.gv.at

Electric mobility research department at the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Hans-Jürgen Salmhofer
Strategic Coordinator
Mobility Transformation & Transport Decarbonisation
Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology
hans-juergen.salmhofer@bmk.gv.at

Evelinde Grassegger
Head of Unit,
Mobility and Transport Technologies
Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology
evelinde.grassegger@bmk.gv.at

Special interest groups for electric mobility

Bundesinitiative eMobility-BieM Austria
Angelika Rauch
office@biem.at

Bundesverband Elektromobilität Österreich
office@beoe.at

Zero Emission Mobility – Projects

eMORAIL
Angelika Rauch
tbw research GesmbH
eMORAIL@tbwresearch.org

CMO
Wolfgang Komatz
Automobil-Cluster Business Upper Austria – OÖ Wirtschaftsagentur GmbH
wolfgang.komatz@biz-up.at
www.connected-mobility.at
www.automobil-cluster.at

VECEPT
Theodor Sams
AVL List GmbH
theodor.sams@avl.com

eMPROVE
Michael Nöst
IESTA – Institute for Advanced Energy Systems & Transport Applications
office@iesta.at
www.eMPROVE.at

E-LOG-BioFleet
Alexander Trattner
HyCentA Research GmbH
trattner@hycenta.at

RE2BA
Astrid Arnberger
Saubermacher Dienstleistungs AG
a.arnberger@saubermacher.at

EMPORA 1 & 2
Eva Maria Plunger
VERBUND AG
eva.plunger@verbund.com

CROSSING BORDERS
Eva Maria Plunger
VERBUND Solutions GmbH
eva.plunger@verbund.com

EMILIA
Boschidar Ganev
Electric Drive Technologies
AIT Austrian Institute of Technology GmbH
boschidar.ganev@ait.ac.at
www.emilia-project.at

SMILE – simply mobile
Reinhard Birke
Wiener Stadtwerke Holding AG
reinhard.birke@wienerstadtwerke.at
www.smile-einfachmobil.at

SEAMLESS
Matthias Prandtstetter
AIT Austrian Institute of Technology GmbH
matthias.prandtstetter@ait.ac.at

LEEFF
Bartosz Schatzlmayr-Piekarz
i-LOG Integrated Logistics GmbH
bp@i-log.at
www.leeff.at

ETA
Hans Knapp
Chief Engineer for Advanced Development
and Power Train Wheel Loader
Liebherr-Werk Bischofshofen GmbH
hans.knapp@liebherr.com
www.liebherr.com

EMPA-Trac
Peter Kainz
Adolf Tobias GmbH
peter.kainz@stmk.or.at
www.empa-trac.eu

MEGAWATT-LOGISTICS
Werner Müller
University of Natural Resources and
Life Sciences Vienna
Council for Sustainable Logistics (CNL)
cnl-team@boku.ac.at

FlyGrid
Armin Buchroithner
Graz University of Technology,
Institute of Electrical Measurement and
Measurement Signal Processing
Energy Aware Systems Group
armin.buchroithner@tugraz.at
www.tugraz.at/projekte/flygrid/home/

HySnow
Walter Hinterberger
Project Management,
Advanced Engineering
BRP-Rotax GmbH & Co KG
walter.hinterberger@brp.com

MHP – Mobile Hydrogen Powersupply
Axel-Oscar Bernt
Product Manager Hydrogen Systems
Magna Steyr Fahrzeugtechnik AG & Co KG
axel-oscar.bernt@magna.com

HySnowGroomer
Nikolaus Fleischhacker
FEN Sustain Systems GmbH
nikolaus.fleischhacker@fen-systems.com

ZERO Logistics
Bartosz Schatzlmayr-Piekarz
i-LOG Integrated Logistics GmbH
Schachinger Logistik-Gruppe
bp@i-log.at

URCHARGE
Jasmine Ramsebner
TU Wien-EEG
ramsebner@eeg.tuwien.ac.at

E-ASY CHARGE
Werner Müller
University of Natural Resources and Life
Sciences Vienna, Council for Sustainable
Logistics (CNL), Institute for Process and
Energy Engineering (IVET)
cnl-team@boku.ac.at

move2zero
Andreas Solymos
Divisional Head of Planning Management &
Infrastructure Holding Graz – Kommunale
Dienstleistungen GmbH
andreas.solymos@holding-graz.at

LIST OF ABBREVIATIONS

BEV ..... Battery Electric Vehicle
BEÖ ..... Bundesverband Elektromobilität Österreich
(Austrian Federal Association for Electric Mobility)
BieM ..... Bundesinitiative eMobility Austria
(Federal initiative for e-mobility in Austria)
BMNT ..... Bundesministerium für Nachhaltigkeit und Tourismus
(Federal Ministry of Sustainability and Tourism)
BMVIT ..... Bundesministerium für Verkehr, Innovation und Technologie
(Federal Ministry for Transport, Innovation and Technology)
CEGC ..... Central European Green Corridors
CO_2 ..... Carbon dioxide
D-A-CH ..... Deutschland-Österreich-Schweiz (Germany-Austria-Switzerland)
EEI ..... Electrical and Electronics Industry
EV ..... Electric Vehicle
GSM ..... Global System for Mobile Communications
HEV ..... Hybrid Electric Vehicle
HVAC ..... Heating, Ventilation and Air Conditioning
IAO ..... Fraunhofer-Institut für Arbeitswirtschaft und Organisation
(Fraunhofer institute for work management and organisation)
ICM ..... Initiative Connected Mobility
IEA ..... International Energy Agency
IPHE ..... International Partnership for Hydrogen and Fuel Cells in Economy
km/h ..... Kilometres per hour
kW ..... Kilowatts
kWh ..... Kilowatt hour
kWp ..... Kilowatt peak
MW ..... Megawatts
NOVA ..... Normverbrauchsabgabe (standard consumption tax)
NO_x ..... Nitrogen oxide
ÖBB ..... Österreichische Bundesbahnen (Austrian Federal Railways)
OEM ..... Original Equipment Manufacturer
ÖPNV ..... Öffentlicher Personennahverkehr (local public transport)
PHEV ..... Plug-in Hybrid Electric Vehicle
PKW ..... Personenkraftwagen (passenger car)
PPP ..... Public-Private Partnership
PT ..... Public Transport
PV ..... Personenverkehr (passenger transportation)
REEV ..... Range Extended Electric Vehicle
REX ..... Range Extender
SMEs ..... Small and Medium-sized Enterprises
TEN-T ..... Trans-European transport networks
TÜV ..... Technischer Überwachungsverein (technical inspection service provider)
V2G ..... Vehicle-to-Grid
WKO ..... Wirtschaftskammer Österreich (Austrian Federal Economic Chamber)
ZSE ..... Západo slovenská energetika

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MEDIA OWNER

Climate and Energy Fund
Gumpendorfer Strasse 5/22, 1060 Vienna, Austria
Tel.: +43 1 585 03 90
Fax: +43 1 585 03 90-11
Email: office@klimafonds.gv.at
www.klimafonds.gv.at

RESPONSIBLE FOR CONTENT

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All quotations and any views expressed in interviews merely reflect the personal opinions of the individuals concerned.
We have produced this brochure with the utmost care and have checked the data and information provided within it. Nevertheless, some mathematical rounding, typographical and printing errors may remain.

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www.projektfabrik.at

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