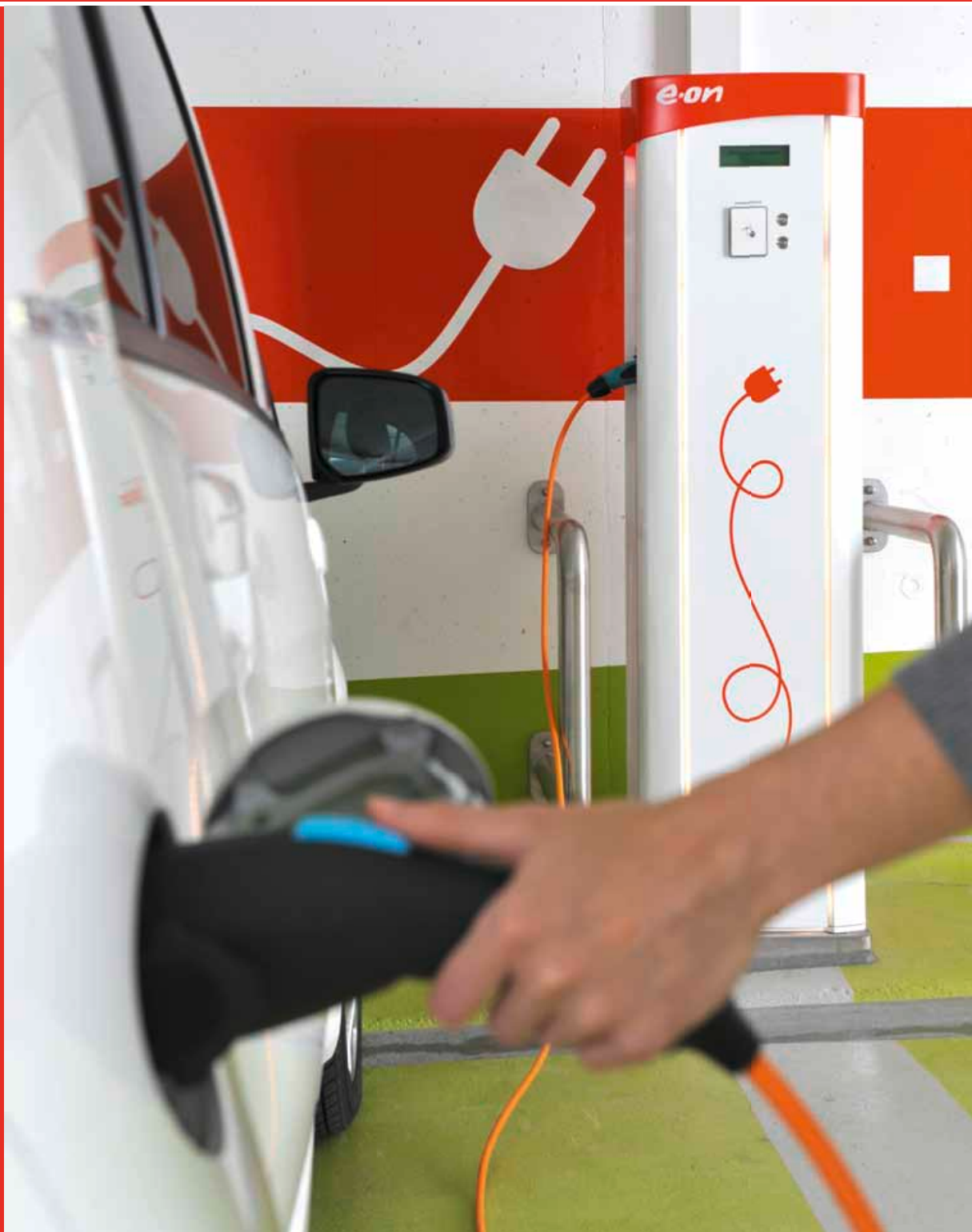


e.on



Electromobility at E.ON
"Safe, simple, convenient – charging technology for electric cars"

Wallbox: the right connection for garages

More and more motorists are turning to electric cars as an alternative way to make the daily commute to work. These vehicles are particularly popular with environmentally conscious commuters living around big cities who cover 50-100 kilometers a day. Commuters benefit in particular from the relatively low energy costs entailed in the long distances they cover - using electricity costs less than half the money needed to run a comparable, fuel-efficient car with an internal combustion engine. Most of these electric cars are recharged in people's own garages, something confirmed by all of the data gathered as part of E.ON's pilot projects, which have now been completed.

Focusing on the needs of this customer group, E.ON has created the easy-to-use and safe Wallbox. A trained E.ON electrician goes to the car owner's garage to install this charging unit and fit it with the plugs that suit the car in question, doing away with awkward charging and extension cables. When installing the Wallbox, E.ON's expert also checks the house's electrics - after all, electric cars spend hours using the maximum connection capacity of 3.5 kilowatts to recharge their batteries, and this puts a tremendous strain on cables and connections. The heat this generates can become a problem, especially in old buildings.

Customers can also have their Wallboxes fitted with a smart meter and so benefit from the flexible electricity prices that E.ON has already included in its range of services in some areas. A smart meter gives the Wallbox the potential to charge electric cars when this suits best, e.g.

when a lot of wind-generated electricity is available at night. E.ON is currently conducting research on several pilot projects to ascertain the conditions for flexible electricity tariffs. For example, the cost of domestic electricity would be based on the current stock market prices, so charging a car's battery would cost little when demand is low.

**Safe and convenient:
an E.ON Wallbox
for recharging
electric cars**



Complete charging solutions: the right infrastructure for all commercial customers

Every day, people use the 100 and more charging stations that E.ON has set up all over Europe. The technology used in the stations has not only proven its flexibility in the different pilot projects E.ON has established across the continent from Sweden to Spain, but it has now also found its first customers. A growing number of municipalities and companies want to install their own charging stations and so play a role in the rapid development that electromobility is experiencing - intended sites include shopping center parking lots, and some solutions even take the form of an all-round package comprising consulting, charging infrastructure and service issues for fleet operators.

E.ON's aim is not to establish its own charging infrastructure so much as to develop practical charging solutions that suit the different needs that customers have. All hands-on demonstrations so far have shown that electric

car drivers tend to charge their cars where the vehicles are left standing for a long time: this is due to the relatively long timespan it takes to recharge a battery. For this reason, E.ON expects that parking space operators will also start offering recharging facilities. These will not only include parking lot operators, but also retailers and municipalities whose public transport systems include large park and ride parking lots. E.ON has created integrated payment systems for these target groups so that users can pay for parking and recharging costs in one.

In addition, E.ON is working on other demonstration projects to take electricity fuel stations' technology to the next level. One focus of this work is the development of fast charging stations, with technology that provides electric cars with enough power in less than 30 minutes to cover 100 kilometers. Shorter waiting times will substantially increase cars' range.



Recharging cars where they're parked for a while - E.ON makes this possible at parking lots.

Charging faster with direct current – a real option today

Direct current charging makes it possible to reenergize batteries using a higher charge. The alternating current technology commonly used today delivers a maximum output of 10 kilowatts, but direct current units can already deliver 50 kilowatts, and it is technically possible to even achieve a charging output of 100 kilowatts. This significantly reduces the time it takes to fully recharge a battery, cutting it to 10-30 minutes. It takes over six hours to do this using a typical domestic connection with a capacity of 3.5 kilowatts.

E.ON has already begun to construct fast charging stations for electric cars along Germany's highways. The first station of this kind was installed on the A8 highway at the exit for Irschenberg in Bavaria: this is the first unit along Germany's highways to use direct current to charge cars. The new stations comply with the CHAdeMO protocol, a standardized norm that enables charging stations in Germany to recharge electric cars that are already in production, such as the Mitsubishi iMiEV, Peugeot iOn, Citroën C-Zero and the soon-to-be-released Nissan Leaf. During the test phase, high-speed recharging costs a flat

rate of €5. The electricity used for charging is exclusively generated at E.ON's own hydroelectric power plants in Germany, turning the cars that use the charging stations into zero-emission vehicles.

E.ON is concentrating in particular on public charging stations that use direct current because stopping to recharge during a trip will only be possible with these stations' shorter charge times. Fast charging stations substantially enhance electric cars' range. Until now, these vehicles have been suitable above all for commuters who recharge their cars overnight in their own garages at home and whose trips to and from the workplace do not exceed the range of some 100 kilometers that is currently possible. Fast charging stations will make it possible to cover longer distances easily, e.g. 150-200 kilometers, the distance from Munich to Salzburg or Stuttgart to Frankfurt. In addition, fast charging stations would enable people without a garage of their own to use electric cars. The recharging process can ultimately be reduced to just a few minutes, almost the same as filling up a car's fuel tank today.



A Mitsubishi iMiEV charging at an E.ON fast charging station by the highway

eflott – electromobility in the Munich test region

In autumn 2011, project partners Audi, E.ON, Munich's municipal services and Technical University of Munich will put 20 Audi A1 e-tron cars on the road and construct some 200 charging stations. This project is called eflott and is part of a program, supported by Germany's transport ministry, to test electromobility solutions in the Munich region. There are a number of different sides to the project. One aspect involves the transfer of data between drivers, cars and charging points (possibly going as far as the electricity grid), and it will also explore options such as the use of smartphones as a central interface for drivers.

E.ON is installing 100 charging stations as part of the eflott project. Most of them are in the region around the Bavarian capital, and all of them supply renewable energy generated at E.ON's hydroelectric power plants. In line with the information obtained in previous projects, most charging stations will be installed at existing parking facilities such as private garages, park & ride sites and multi-level parking garages. As it still takes a long time to recharge batteries, vehicles by and large have to be charged at locations where they will be left standing for some time. E.ON plans to further develop the technology used at charging stations and

is particularly interested in communication options with grid operators. After all, intelligent charging stations are more than just electrical refueling points: within the scope of the future's intelligent power networks, they will play a role in the use of vehicle batteries as a storage facility for renewable energy.

Technical University of Munich gathers and evaluates data about drivers' mobility-related behavior. The university's automotive technology institute has designed a mobile application which all project participants receive on a smartphone. These phones can then track their movements – by bike, EV, car, bus and train alike. Working on a parallel development, the marketing institute is creating a study designed to reveal which payment model for electromobility power is the one that most appeals to customers.

The Audi A1 e-tron cars used in the study possess a lithium-ion rechargeable battery, located in the floor in front of the rear axle to save space. In city driving, it enables the cars to cover over 50 kilometers using electricity alone. In exceptional cases, the compact single-disc Wankel engines of these near-series cars give them a theoretical range of approximately 200 kilometers.



The eflott project features 20 Audi A1 e-tron cars – E.ON is installing 100 charging stations in and around Munich.

Volkswagen's electromobility fleet test

Since June 2008, E.ON has been cooperating with Volkswagen and other partners on electromobility tests with a fleet of cars. Eight Golf Twin Drive cars started their on-road trials in 2011 to try out the carmaker's hybrid technology in everyday conditions. This test fleet will grow to 20 cars by the end of this year. One of the project's aims is to use the intelligent recharging of electric cars so that renewable energy can be integrated with electricity networks as efficiently as possible, thereby facilitating zero-emission motoring at low prices.

This fleet test is the first in Germany that focuses on charging EVs' batteries and then replenishing the electricity grid. This process is controlled via an intelligent electricity meter, and the project uses variable electricity prices. The prices are updated every 15 minutes and transferred to the intelligent meter one day in advance. To see what their recharging statistics are like, users can

access a protected website via computer or smartphone to see the latest prices and charging intervals. The project's participants receive a monthly report informing them of how much money they save by adjusting their charging times to match the range of electricity prices. They are paid these savings, thereby giving them a real incentive to enhance their efficiency.

As part of this fleet test, E.ON is committed to further developing the technology used to charge EVs, which includes Wallboxes in garages and public fast charging stations. These can be used to recharge the battery of the Twin Golf in just a few minutes. Until now, there have been no studies of the effect this technology has on the car batteries, so the test will provide researchers with important information. The German government also recognizes this concept's potential and is backing the electromobility fleet test.



The Golf Twin Drive will be used to test hybrid technology under everyday conditions.

The electricity grid of the future is being created today in Lower Saxony

As part of the model testing program in Lower Saxony, E.ON is concentrating on future developments by conducting research into the ever-growing contribution made by renewably generated electricity and changes in consumer behavior, such as the impact of EV use. In the communities of Stuhr and Weyhe near Bremen, some 30 households are taking part in a model program: they have been equipped with photovoltaic units, modern heating and cooling appliances, EVs and intelligent electricity meters.

However, this project is larger than just the households participating in it. E.ON is also fitting the electricity networks in both communities with cutting-edge control technology to turn them into intelligent local grids: self-regulating transformers will automatically counteract any fluctuations in voltage caused by the feed-in of solar power. The project uses this ambitious technology for the first

time in conjunction with low-voltage networks, and it enables research to be carried out on a power network under conditions which are likely to be prevalent in 10 years' time.

Some 30 Peugeot iOn models are being used as the electric cars in the project. These cars have a range of approximately 150 kilometers and are therefore particularly suitable for commuters in urban areas such as the region around Bremen. The batteries are charged at charging stations in the participants' garages at home: ideally, this should consume solar electricity produced by the photovoltaic units mounted on the houses' roofs, thereby making the electric cars even more environmentally friendly.

The project is planned to run for three years and the research is overseen by Energieforschungszentrum Niedersachsen, Lower Saxony's energy research centre, in Goslar.



Pioneering work in Lower Saxony: 30 households and the local grid are receiving technology of the future.

CABLED – electromobility with a left-hand drive

The CABLED (Coventry and Birmingham Low Emission Demonstrators) project has been up and running in the UK's midlands since December 2009, and it gives EV drivers access to a network of charging stations. E.ON has so far installed 36 public stations as well as 100 at private homes and a further 18 stations at the workplaces of some of the test's participants. The project is currently testing 110 EVs from different makers under everyday conditions to see how they function on a day-to-day basis. In addition, the program has financial incentives for users if they recharge their cars' batteries using off-peak electricity. CABLED is the first of eight electromobility projects funded

by the UK government. Their aim is to find out about the EV drivers' experiences - how they use their cars and when they recharge them, for example. The initial data from the project shows that the range of the cars used in the test is 80 miles (128 kilometers), which is more than enough for average total distance covered by the participants each day: 23 miles (37 kilometers). The vehicles were parked 97% of the time, mostly at night and while the drivers were at work: this is adequate time to sufficiently recharge batteries. The cars are normally connected to the power source longer than would have been necessary to recharge their batteries - sometimes they are left connected for several days at a time.



100 EVs recharge their batteries at around 150 charging points in Coventry and Birmingham for the CABLED project.

Modern energy technology for households in the UK's midlands

This year, E.ON will start a project for 50 homes in Milton Keynes that brings together all the different aspects of the future of energy. The test's participants will receive the most modern and efficient appliances for heating, mobility and other domestic purposes.

At the participating homes, an electrical heating pump works in combination with a high-efficiency natural gas boiler to provide heating. A photovoltaics unit creates supplementary electricity using solar power: during particularly sunny weather, this can be routed to an electric car or be used to power household appliances. These appliances are intelligently networked with each other and can, for example, start operating when the photovoltaics unit is generating a lot of electricity.



The world of energy, tomorrow: E.ON is conducting several pilot projects to study the interaction of intelligent appliances in the home.

Alongside the units named here, E.ON will also install a modern control unit that can be used to regulate lighting and heating via a smartphone even if the participants are not at home. The participants can also see their precise consumption statistics on an online portal, which creates transparency and helps users to obtain important information that enables them to reduce their energy use. E.ON will supply most of the necessary fittings and equipment for free and will assume responsibility for all service and maintenance issues.

The electricity supplier hopes that this project will generate important data about customer behavior and so improve estimates regarding the energy-saving potential of these intelligent applications. E.ON wants to gather experience in controlling and coordinating the range of technology deployed in the project and use the data it obtains to create innovative domestic appliances for generating electricity and heat. At the same time, E.ON wants to study the extent to which electricity consumption in the home can be rescheduled to different times. This would simplify the integration of weather-dependent renewable energy sources in the electricity grid, making it possible to set washing machines to run when wind electricity is in good supply - while meeting customers' requirements, of course.

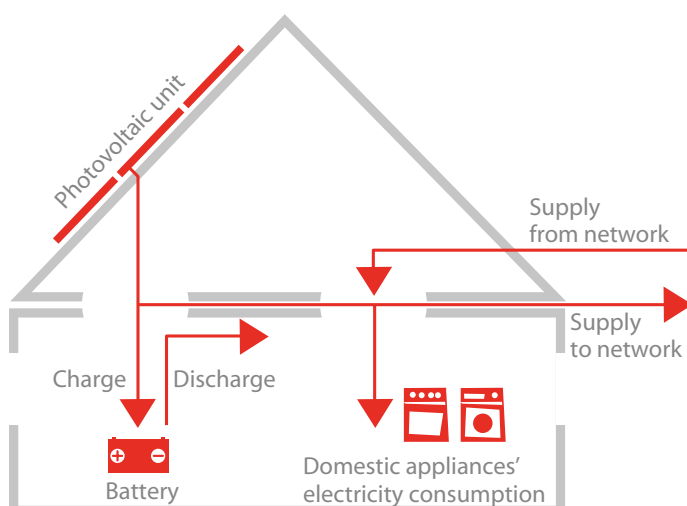
A battery for photovoltaic electricity

The number of photovoltaics sites in Germany is growing rapidly. Combined, the panels would have a total electrical output of 16,500 megawatts, which corresponds to a good dozen conventional large power plants. However, the highly subsidized modules can only produce a similar amount of electricity if the sun is shining at full strength over the length and breadth of the country. This, however, represents a serious issue for local electricity networks. In some regions, photovoltaics units can supply far more electricity to these networks on summer days than the region can actually use, which puts pressure on the networks and requires extensive investments. E.ON is looking into restructuring networks as well as methods of limiting the pressures associated with supply surges. One solution would be to store electricity in the home.

This would satisfy the wishes of a lot of customers who would like to cover their electricity needs to the greatest extent possible with their own photovoltaics units or who want to become electricity producers themselves, i.e. generate power for other people. E.ON is working to turn this vision into reality while simultaneously taking the pressure

off distribution networks. As part of a unique nationwide pilot project throughout Germany, the energy company will install electricity storage systems in 25 of its customers' homes in Bavaria. This region receives the most sunshine in Germany and has the highest concentration of solar plants in the country.

The unit is the size of a drinks vending machine and contains a rechargeable lithium-ion battery with a capacity of up to six kilowatt hours, which is half the daily electricity requirement of a normal household. The unit also contains a converter for direct and alternating current: batteries and photovoltaics systems work with direct current, while domestic appliances and electricity networks use alternating current. Intelligent control technology will ensure that most of the electricity used is generated by the roof-mounted units, which also reduces the need to rely on the public electricity network. If the sun occasionally shines, the test's participants can produce their own solar power or even route electricity to the local network for their neighbors. The electricity provider only kicks in to supply electricity from the grid if the weather has been overcast for several days.



Using solar power can enable households to produce their own electricity – and soon they will be able to store it.