Electro-mobility

On the move with electricity

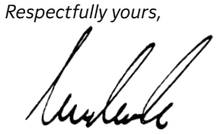
Dear readers,

Electro-mobility is an essential feature of every automobile fair these days. We'd like to give you an insight into what's behind it. Using electricity for powering vehicles on the road means more than just zero-emissions driving. In the long term, the overall concept of electro-mobility is set to drive the transformation of the energy sector.

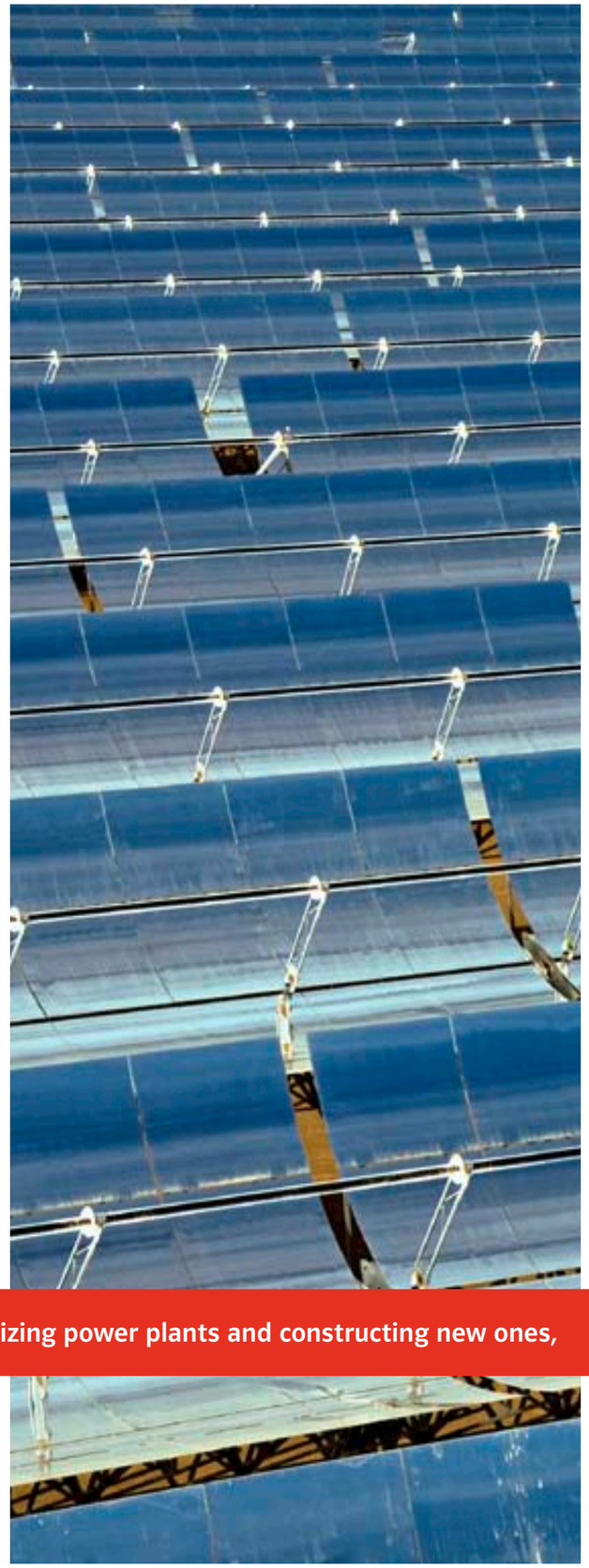
In other words, batteries for electric cars will eventually help to increase the proportion of our electricity generated by renewable energy sources. In 2010, E.ON constructed the globally highest number of wind turbines at sea, where favorable wind conditions can be harnessed for the creation of electric energy. We are continuing to press ahead with this course, which will mean that in the future, we will increasingly be in the situation of having more electricity in the grid than our customers need at the time – on windy weekend days, for example. Electric cars will be one of the many intelligent solutions with which we will rise to this new challenge. We already offer our customers intelligent electricity meters with flexible tariffs. In the future, these Smart Meters could be able to manage battery charging for electric cars by specifically making use of times with low electricity demand, which also tend to be times when electricity tariffs per kilowatt hour are lower.

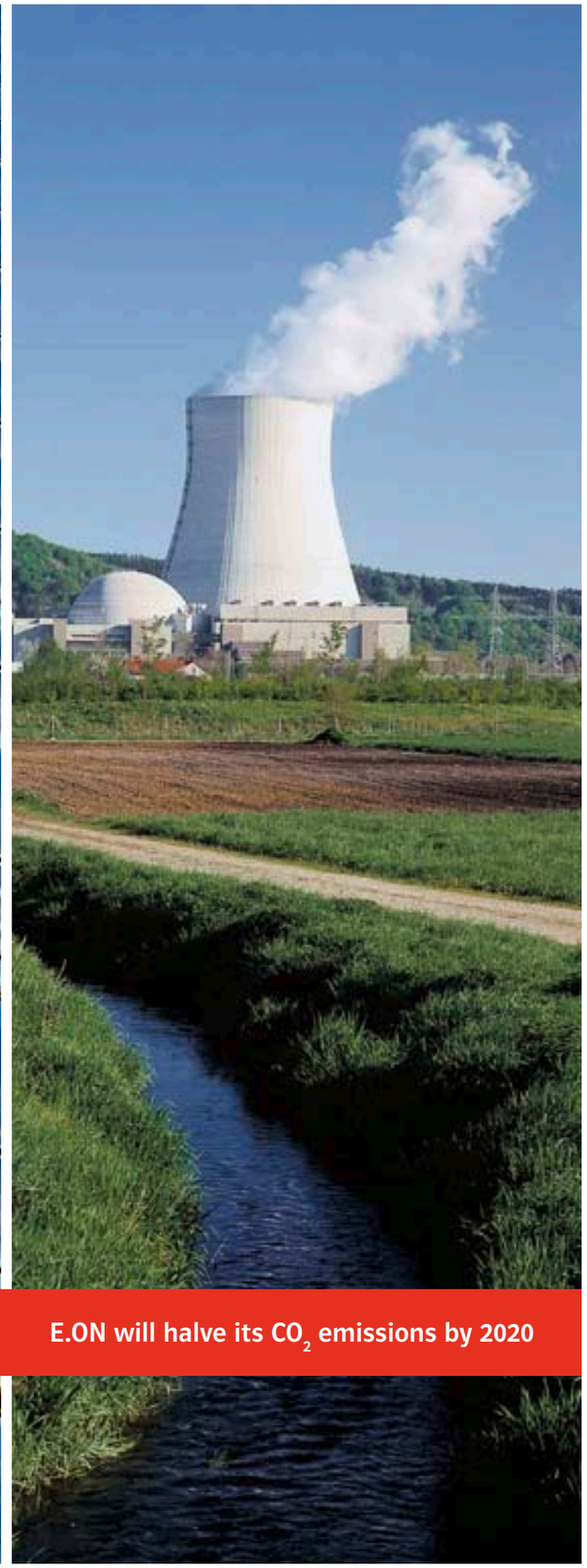
The model projects with electric cars currently running in many regions will undoubtedly contribute important insights in this field – but we are already looking beyond them. For us, the real excitement in electro-mobility comes when products are ready to be launched. In this context, our international project team has developed solutions to meet the needs of the market, basing their work on a thorough analysis of these needs and initial fleet trials. **E.ON is now able to offer a complete range of charging points and stations for individual consumers and businesses**, making the electricity network into a reliable charging infrastructure reaching into every corner of Europe. Now we're looking forward to the first series-production vehicles. E.ON is ready!

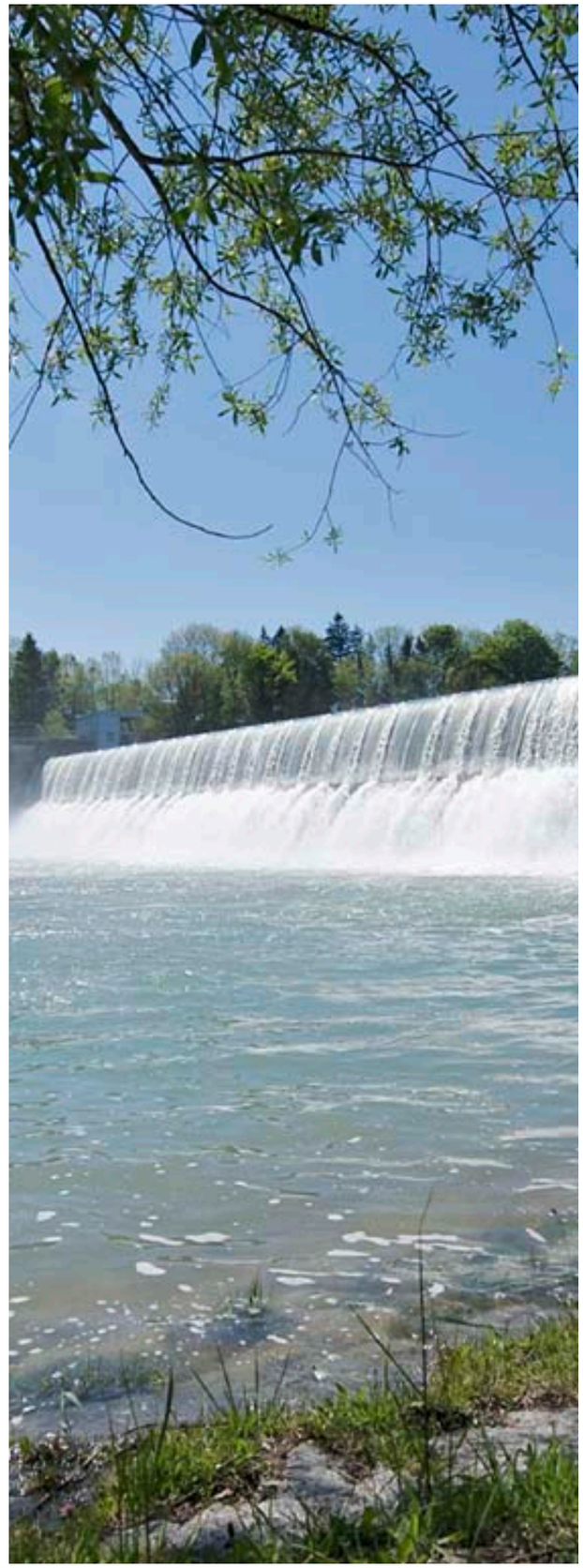
Respectfully yours,



Prof. Dr. Klaus-Dieter Maubach,
Member of the Board of Management, E.ON AG







By modernizing power plants and constructing new ones, E.ON will halve its CO_2 emissions by 2020

Electro-mobility: emission-free on the move

Electric engines will be the defining face of future mobility. This will be the only way of achieving Germany's and Europe's climate protection goals in the field of traffic and transportation. An electric car itself does not produce emissions; generating the electricity it needs, however, does. For example, due to the high proportion of nuclear energy and the rapidly growing amount of renewable energies in today's E.ON electricity mix, an electric car with a consumption of 15 kilowatt hours per 100 kilometers will only generate 75 grams of CO_2 per kilometer. This places the vehicle substantially below the limit of 120 grams per kilometer for a car manufacturer's fleet consumption that will be prescribed by the EU from 2012. Where renewable energies such as wind power are used, a car that is exclusively powered by electricity will be emission-free even today.

Many countries want to take additional steps to support the breakthrough of electro-mobility. In London, for example, electric cars are exempt from the congestion charge due to their positive environmental characteristics. The decisive benefit of electro-mobility is its independence from individual energy sources. While combustion engines will always require gasoline or natural gas as fuel, electric cars can benefit from the current shift in power generation toward renewable energies and low-emission technologies – without requiring any modifications to the technology inside the vehicle. Regardless of the energy source, the additional power demand from electric mobility is manageable: The German federal government expects there to be about one million electrically powered cars by 2020. These vehicles would increase the current annual power consumption of approximately 600 billion kilowatt hours by less than half a percent.

Even a total of about 10 million electric cars in Germany – which would make one in four cars electric – would increase electricity demand by just three to five percent, a demand which could be met without the need to build one single additional power plant. However, one thing is necessary, indeed decisive: Vehicle charging needs to be intelligently managed so that it happens outside of times when electricity demand is high.

Where renewable energies such as wind power are used, a car that is exclusively powered by electricity will be emission-free even today.

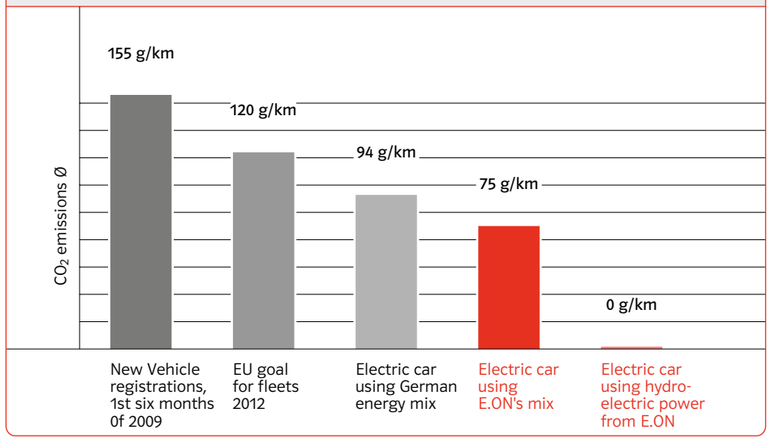
Electric cars can act as a decentralized energy store

Electric cars will make a significant contribution to the use and development of renewable energies: Together, the batteries of many electric cars form a large, decentralized electricity repository which can provide a buffer for weather-related fluctuations in energy production from renewable energy sources. An intelligent interface is necessary to connect them to the electrical grid.

It is not even beyond the bounds of possibility for electric vehicles – those parked in an office complex's underground garage during the day, for example – to feed electricity back into the electric grid. If only half of the million electric cars expected to be in use in 2020 were connected to the grid and provided it with a mere 20 percent of their battery capacity, the feed-in of electricity into the network would be equivalent to the output of two pumped-storage power plants. Such potential developments mean that electric cars can make a key contribution toward the use of renewable energy sources.

CO_2 emissions

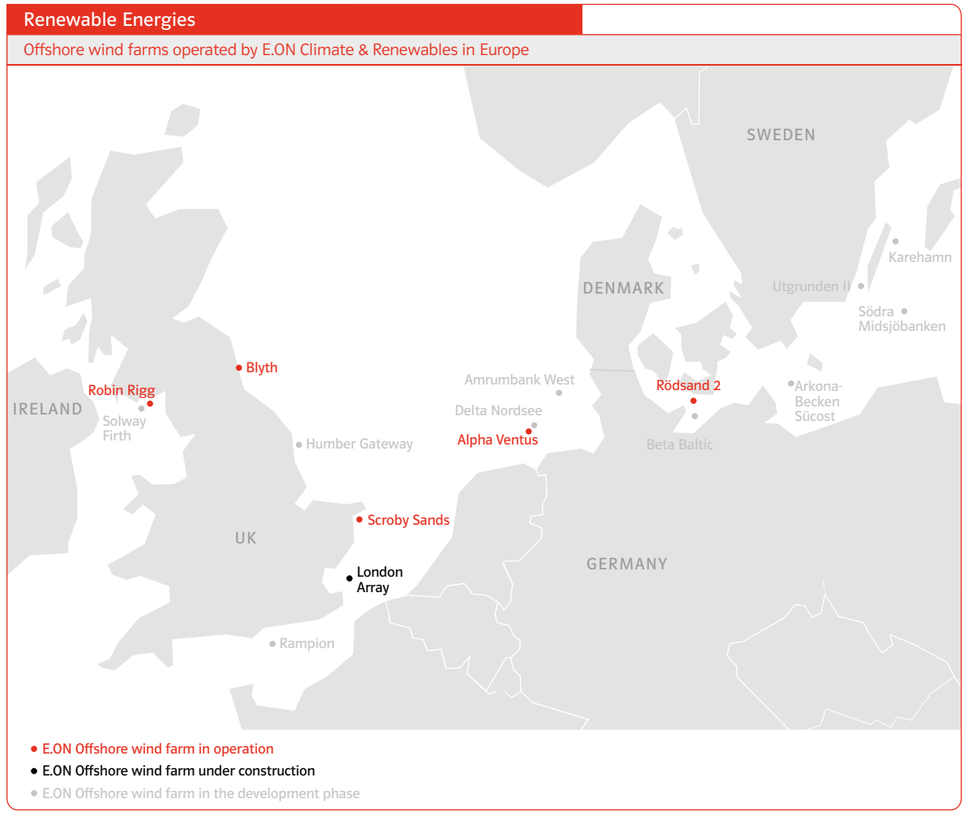
The use of renewable energies puts electric cars straight ahead of the competition in terms of eco-friendliness.



E.ON invests in renewable energies

Renewable energies are key, not just for emission-free mobility, but also for a sustainable overall energy supply. Policymakers have set the course in this regard, with the EU aiming, by the year 2020, to reduce its overall emissions by at least 20 percent from 1990's levels.

Our own aims are considerably more ambitious: By 2020, we intend to have reduced specific CO_2 emissions per kilowatt hour of electricity generated by 50 percent compared to levels in the reference year 1990. In order to achieve this, the period 2010 to 2013 will see E.ON investing approximately EUR four billion in renewable energies. Moreover, we are increasing the efficiency of our conventional power plants, and have, to name an example, built ten highly efficient gas and steam turbine power plants over the past five years. This is our significant contribution to achieving the climate protection goals set by policymakers.



E.ON leading the field in wind power generation at sea

E.ON is one of today's largest operators of wind farms which harness the favorable wind conditions found at sea to generate electricity in an environmentally friendly manner. In the UK, Denmark and Germany, we run wind farms which taken together account for more than a quarter of the world's total installed output from such systems. Around 46 percent of all offshore wind farms which went live in 2010 are run by E.ON; the Group is also a project partner in alpha ventus, the first German wind farm located at sea, where electricity is generated in deep sea waters far offshore. This project required the development and implementation of entirely new technologies and materials.

But the sea is not the only source of clean energy. Many E.ON customers have become generators of electricity themselves. In 2010, in Bavaria, Germany's sunshine state, alone, E.ON's network technicians connected approximately 400 new photovoltaic systems to the electricity network on every working day.

Electricity with a long way to go

The exponential growth in the number of systems generating electricity in renewable energies presents us with new challenges as well as new opportunities. While conventional power plants largely produce electricity in the locality of its consumers, the large wind farms of the future will be out at sea. We will need to extend existing pipelines or construct new ones in order to get the electricity to its consumers.

E.ON already operates five wind farms at sea and is pursuing this course with further investments.

Electricity networks: from supplying to managing

It's not just offshore wind farms that will require expansion of pipeline networks. There are also great challenges in store for regional distribution networks. Up until now, the task of Germany's electricity grid has been to transport electricity to the customer. Large power plants generate electrical energy and feed it into the high voltage networks, from where it is carried through the individual voltage levels and via local low-voltage networks to the customer.

Today's electricity is increasingly being produced by solar plants, by small cogeneration plants and by biomass systems. Due to their small size, and unlike large wind farms, these systems are generally connected to the medium- or low-voltage network. This means that the electricity they produce is fed into and discharged from the network at almost all levels. Networks are no longer one-way streets: electricity flows both ways. A challenge for network management, calling for completely new systems and processes.
These alone will not suffice, however, to successfully integrate the rapidly increasing proportion of renewable energy sources into the electricity network. Wind and solar energy in particular are highly dependent on weather conditions. Unlike conventional power plants, they cannot be regulated according to demand. Even today, networks in some regions find themselves at their limits when strong winds prevail during periods of low demand, such as at night. There is thus an increasing need for electricity storage capacities to retain this energy and feed it back into the network at times of high demand.

Creating more electricity stores

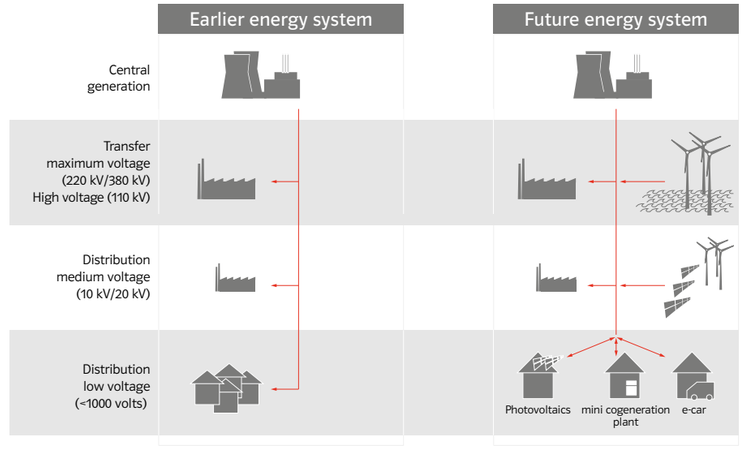
To this end, E.ON is expanding its capacities at pumped-storage power plants, which currently represent the best available technology for electricity storage.
In these systems, water is pumped into an elevated storage basin during periods of high electricity supply. When demand increases, the water flows back and generates electricity in the turbines. E.ON is currently planning considerable expansion of its pumped-storage capacities at Edersee in Hesse, Germany, as well as constructing a new plant in cooperation with an Austrian partner on the river Danube. Looking forward to the future, pumped-storage power plants will be joined by the batteries of electric cars as buffers to compensate the weather-dependence of wind power. New storage technologies are a principal focus of work at the E.ON Research Center at RWTH Aachen University.
In addition to these efforts focused on the expansion of storage capacity, E.ON is also active in the search for ways of flexibly managing electricity demand. Electricity production is currently largely organized according to the principle of response to demand. Put simply, when our customers require electricity, we start up the power plants needed. Better use of renewable energies will require us to manage the demand of individual consumers to a degree to encourage them to correspond to supply – of course within the framework of what our customers stipulate. This task will require intelligent electricity meters; we already offer these in combination with innovative products. We envisage a future in which, for example, washing machines or other electricity-consuming devices which have little dependence on operation at particular times will switch themselves on automatically – of course within limits specified by the customer – at times when electricity supply is high and prices per unit are low. In cooperation with BSH Bosch und Siemens Hausgeräte GmbH, E.ON is performing an analyzis of customer needs and expectations in 100 households. E.ON wants pilot projects such as these to develop as soon as is practicable into a service available to all our customers, and so is committed to across-the-board introduction of intelligent electricity meters.

Pumped-storage power plants like this one in Waldeck, Germany, represent a good way of storing electricity for later consumption.

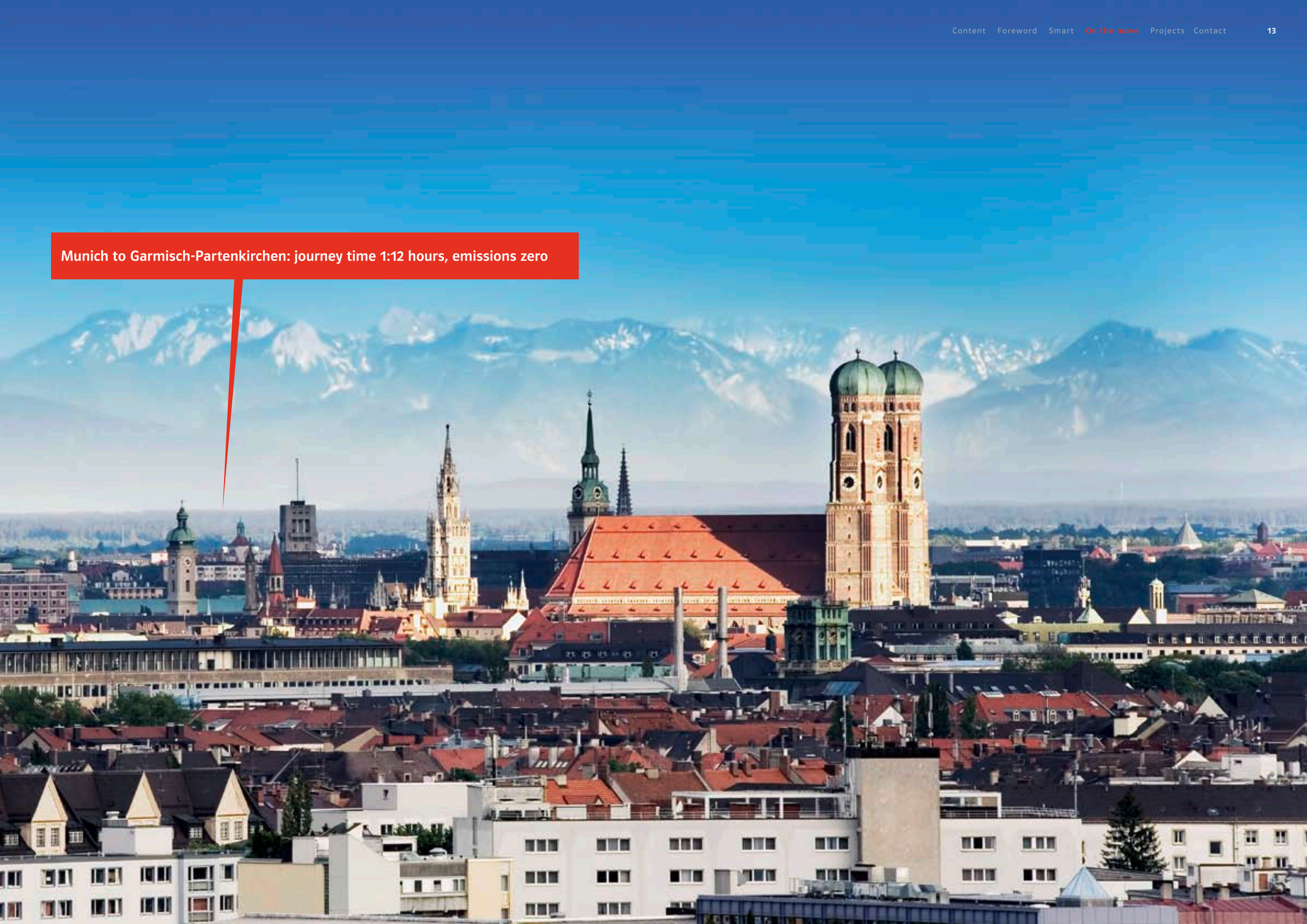
Looking forward to the future, pumped-storage power plants will be joined by the batteries of electric cars as buffers for the weather-dependence of wind power.

The House of the Future

Smart Grids: from electricity distribution to intelligent networks



Munich to Garmisch-Partenkirchen: journey time 1:12 hours, emissions zero



Charging electric cars safely and conveniently: using the Wallbox "Wave", for example.

Charging technology: the right connection wherever you are

The results from initial pilot projects in electro-mobility are in. One of the key insights: Most drivers tend to charge their vehicles in their garage at home and at work. Public charging points in parking lots or multi-story car parks only rank number three.

In response to these findings, E.ON offers charging points for different areas, supplying not just electricity, but the complete service, from analyzing requirements and advising on the installation of the charging point to servicing the station. In addition to standard products, E.ON experts are also developing tailored solutions for such customer groups as fleet managers or operators of multi-story car parking facilities. One idea is to make it possible for customers to settle their bill for charging their car battery in a parking facility when they pay their parking fee.

Home charging points are quick and easy to use

E.ON has developed the Wallbox "Wave" and Wallbox "Cube" charging points for use in residential garages. Mounted on the wall, they enable the vehicle to be charged safely and conveniently, with no need for complex plug connections and extension leads.
An electricity meter inside the charging box records information on the duration of charging and the power required. In the future, smart meters will allow consumers to avail themselves of new tariffs such as ones which will reward consumers for charging when supply of electricity from renewable energies is high. E.ON already offers variable tariffs under which electricity consumed at night is cheaper per kilowatt hour than by day.

The charging station is the standard model for public use. Customers can use a magnetic card for identification purposes; the charging process is then billed to the user by the operator of the charging point. In the future, the technology will enable charging points to be integrated into a larger network of charging stations.

In the future, smart meters will allow consumers to avail themselves of new tariffs such as ones which will reward consumers for charging when supply of electricity from renewable energies is high.

Just plug in and charge up – drivers of electric cars need the right connection wherever they are.

Types of charging points

Each type of device has different advantages, according to where it is installed.



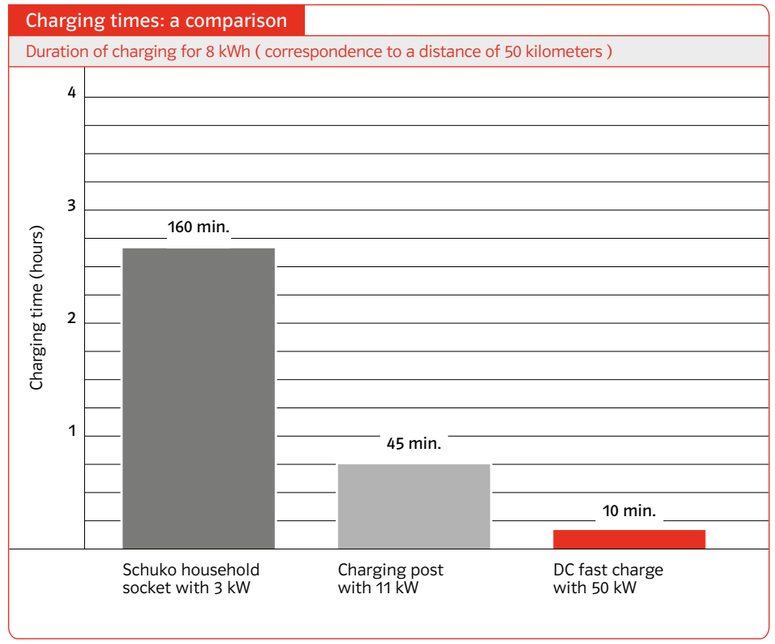
	Charging station	Wallbox „Cube"	Wallbox „Wave"
Number of charging points	2-4	1	1
Authentication	RFID	Key	–
Connection with Schuko plug (220V/16A/3 pins)	●	○	○
IEC 2 connector (max 400V/32A/7 pins)	○	○	○
Jasaki connector	○	○	○
Output voltage 63A / 16A (alternatively 32A)	63A	16A (optional 32A)	16A (optional 32A)
Protection class of casing	IP 44	IP 44	IP 54
Electronic meter	●	○	○
Availability	available	available	from May 2011

○ = Optional ● = as standard

Visionary thinking: new charging technologies

With suitably equipped parking spaces, an electric car can be charged without the need for cables.

E.ON isn't just selling its existing technologies, but is continuing to develop new ones. A criticism voiced by drivers taking part in the pilot project "Electro-mobility in Munich" was the necessity of dealing with charging cables. We have taken this on board and taken a step toward greater user-friendliness with the Wallbox's integrated charging cable. As a high-end solution for residential garages, E.ON is developing an induction charging system, using a technology which is found as standard today in electric toothbrushes or transport robots in production facilities and which we want to adopt for use in charging electric cars: An inductor installed in the floor of the garage transfers the energy into the vehicle's battery using wireless technology. The charging process begins automatically as soon as the car has "checked in" via another wireless connection. Under optimum conditions, energy losses during this process are negligible. This technology's potential applications are not limited to garages: it could also be used in queues at taxi stands, to name just one example. E.ON is currently trialing a prototype system for wireless inductive charging in cooperation with TÜV Süd; the project is also intended to serve to lay down standards and regulations as guidelines for the safe use of this technology. The insights gathered during the test series will be incorporated into the development, in close cooperation with the relevant industries, of an inductive charging system which is ready for mass production.



Speedy charging in just a few minutes
Charging times currently act as a constraint on the distances today's electric vehicles can cover in one charge. The batteries of electric cars available today have sufficient capacity for most people's daily commute: after all, approximately 80 percent of all car journeys are shorter than 70 kilometers.
In this case, charging overnight at home is not an issue, although it can take several hours. When longer distances need to be covered, however, electric cars begin to reach their limits, particularly when air conditioning systems are running at the same time. The answer – systems for fast charging. With the aid of a DC power supply with a high charging capacity of up to 50 kilowatts, a typical electric car could be 'filled up' with electricity sufficient for more than 50 kilometers in about ten minutes.

Part of the electro-mobility fleet trial in cooperation with Volkswagen involves the development of a DC charging system. One vision for the future is to set up such public fast charging stations along the hard shoulder of freeways connecting conurbations.

Fast charging can supply an electric car with enough electricity for a distance of 50 kilometers within a few minutes.

Europe:
Germany
Great Britain
Sweden
Spain
Czech Republic

Malmö: Sustainable Malmö

Wolfsburg and Potsdam: Golf Variant Twin-Drive

Coventry and Birmingham: Mitsubishi i-MiEV

Stuhr and Weyhe, northern Lower Saxony: Peugeot iOn

Czech Republic: Mercedes Smart

Munich: Audi A1 e-tron

Munich: MINI E

Santander: Think City

Pioneering: electro-mobility in Munich

As early as July 2009, E.ON launched one of the first large-scale trials of electro-mobility: the "Electro-mobility in Munich" project. The one-year project phase produced impressive results: About 100 drivers covered a distance totaling over 150,000 kilometers with BMW Group electric vehicles – all emission-free, using E.ON electricity generated by hydroelectric power from Bavaria.

Green power for the cars was right at the top of the test drivers' wish lists. A clear majority of them placed importance on being completely emission-free on the move by using renewable energies, for which they were prepared to accept a higher energy price.

The project also permitted E.ON to gain valuable insights into the drivers' charging behavior: While cars powered by combustion engines tend to be taken on specific trips to gas stations to fill up, charging of

The test drivers tend to charge their cars in their garages at home.

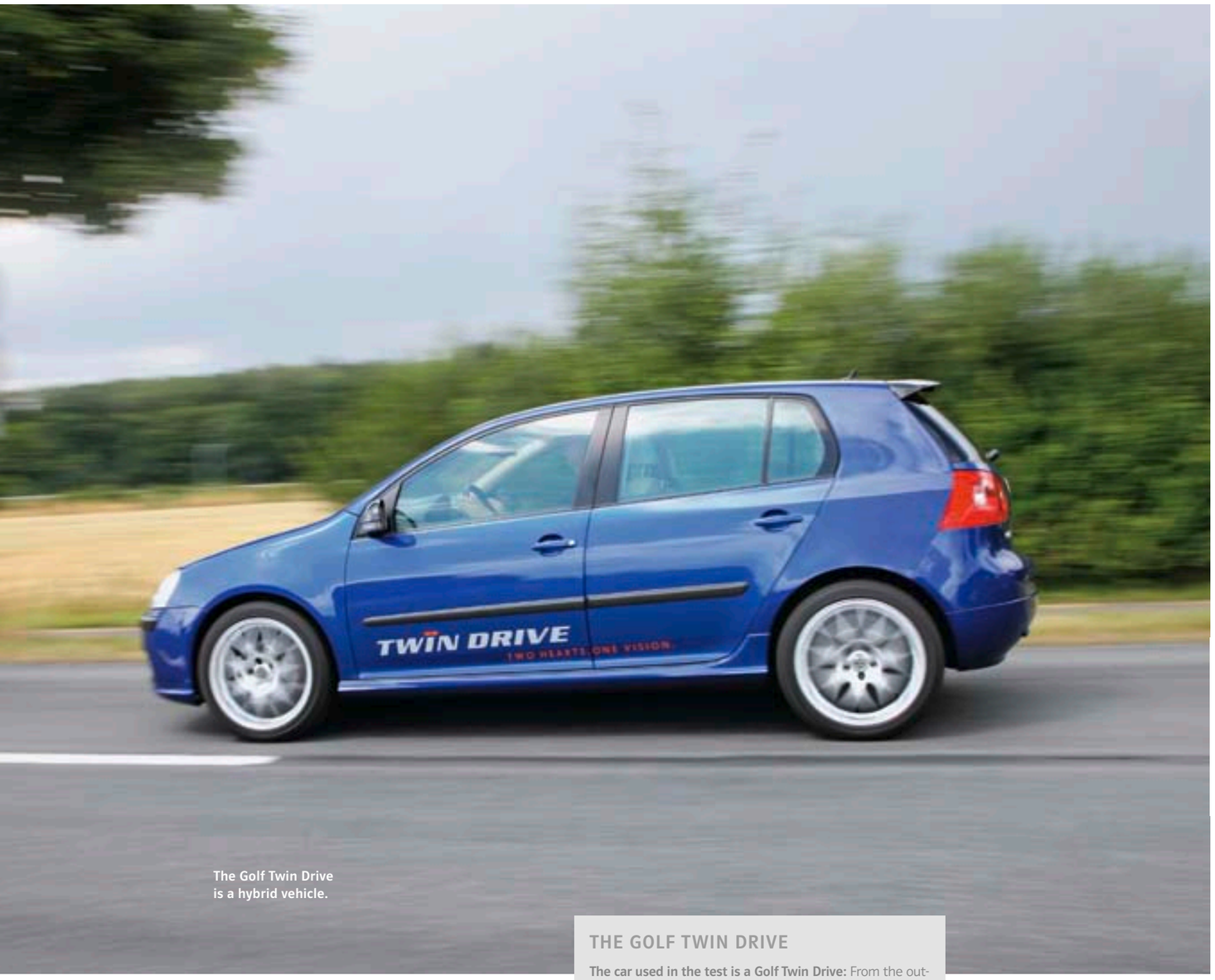
electric cars will generally happen 'on the side'. Typically, the users connected their MINI E to the power grid in their garage at home or at their workplace – in other words, where their cars were usually parked. The public charging stations that were set up as part of the project were only a third choice.

For the pilot project "Electro-mobility in Munich", E.ON has set up public charge points as well as charging stations in the test drivers' garages.

E.ON has drawn important conclusions from these results, which it is using to drive the development of products responsive to customer needs. It now offers various types of charging stations: for garages at home, parking garages or fleet operators' depots. The 15 MINI Es used in the Munich project are part of the world's biggest test fleet, comprising more than 600 vehicles. The field trials showed that the typical range of an electric car, of about 150 to 180 kilometers, is adequate for the needs of most drivers living in an urban environment.

THE MINI E

The MINI E is powered by an electric motor with an output of 204 HP and a maximum moment of force of 220 Newton meters. Its energy comes from modern lithium-ion accumulator batteries which have been specially developed for use in automobiles and give the MINI E a range of up to 180 kilometers.



The Golf Twin Drive is a hybrid vehicle.

Part of a network: fleet tests in Wolfsburg and Potsdam

Since June 2008, E.ON, along with Volkswagen and other partners, has been part of an "Electro-mobility fleet test".

Starting in 2011, 20 Golf Twin Drive vehicles will be out and about, testing hybrid technology in daily life. One of the project's objectives is to use smart charging of the cars to incorporate renewable energies into the grid as smoothly as possible, which will help make zero-emissions driving an affordable experience.
The Twin Drive marks the first practical test in Germany of time-variable controlling of charging with feed-in of electricity back into the network (vehicle-to-grid), with charging controlled by means of a Smart Meter. The variable electricity prices used in the project reflect the situation as it will be in the future, when the energy mix will contain a high proportion of renewables. Prices are updated hourly and transmitted to the Smart Meter a day in advance. Users can retrieve the currently valid prices and charge times at any time via a protected area in the internet or on their smartphone, giving them the opportunity to make informed decisions on their charging behavior.

The project involves variable electricity prices which are adjusted hour by hour to reflect the supply situation and transmitted to the Smart Meter.

The trial's participants receive a monthly statement of how much they have 'earned' through these decisions over the past month. The savings they make are paid to them, creating a real incentive for energy-efficient behavior.

For E.ON, the fleet test is an opportunity to push the development of its technology for charging electric vehicles, which will result in the debut of a fast charging point using DC electricity, making it possible for the Twin Golf's battery to be fully recharged within a very short time. As the effects of this procedure on the battery have not yet been studied in detail, the test will provide important insights in this regard. The German federal government recognizes the potential this concept has to offer and is supporting the fleet test.

THE GOLF TWIN DRIVE

The car used in the test is a Golf Twin Drive: From the outside it looks like a completely typical Golf, but inside it is an electric car with a range extender. The Twin Drive is powered by an electric motor for zero-emissions driving in an urban setting and for short trips of up to 50 kilometers. Its lithium-ion batteries can be recharged at a conventional power socket (plug-in hybrid). A combustion engine (range extender) takes over to produce electricity for the electric motor when the battery has run down, doing away with limits on range for the driver.

Munich: model region for electro-mobility

Spring 2011 will see 20 Audi A1 e-tron cars hitting the streets of Munich and about 200 new charging points set up to support them – in a joint effort by Audi, E.ON, Munich Citx Utilities (SWM) and the Technical University of Munich (Technische Universität München).

The project, known as "eflott", is part of the "Modellregion Elektromobilität München" initiative, supported by the Federal Ministry of Transport. One of its principal foci is data transfer between the driver, the car, the charging point and the power grid. In this context, work includes the testing of smartphones as key interfaces for drivers. As part of the "eflott" initiative, E.ON is installing around 100 charging points, the majority of which are located in the region surrounding the Bavarian capital.

All charging stations in the project are being fed with electricity from renewable sources. In response to the insights gained in preceding projects, the main focus is on equipping existing parking facilities such as residential garages or multi-story parking garages with charging points. E.ON is committed to advancing the technology deployed in charging points and in particular to enhancing communications with the grid operator.

The Technical University of Munich records and analyzes drivers' mobility behavior. For this task, the working group at the Chair for Automotive Engineering developed a mobile application which was given to all participants in the fleet trial on a smartphone. The device's purpose is to record their entire mobility behavior: from cycling, driving an e-vehicle or conventional car, to taking a bus or train. At the same time, researchers at the Chair for Marketing are conducting a study designed to reveal which billing methods for electricity consumed in electro-mobility are likely to be most popular with customers.

The test drivers' mobility behavior is recorded by smartphones – from cycling and electric cars to buses and trains.

THE AUDI A1 E-TRON

The Audi A1 e-tron vehicles used in the project are fitted with lithium-ion batteries, which are located in the car's underbody structure in front of the rear axle to save space. Powered exclusively by electricity, the vehicle has a reach of more than 50 kilometers in city traffic. If necessary, a compact single-disc Wankel engine can increase the vehicle's range by around 200 kilometers. The model is approaching readiness for series production.

As part of the "eflott" project, E.ON is installing 100 charging points in and around Munich.

CABLED: on the road with electricity in the UK

The CABLED project (the acronym stands for "Coventry and Birmingham Low Emission Demonstrators") was launched in December 2009. Drivers of electric vehicles in the cities of Coventry and Birmingham can use a new network of charging points. Since the project's launch, E.ON has installed 36 public and 100 private charging stations, as well as 18 charging stations at test drivers' workplaces. Currently, the project is literally road-testing 110 electric vehicles of varying types to ascertain their suitability for everyday use.

With a range of up to 140 kilometers, the Mitsubishi i-MiEV could be relied upon to get test drivers to work and back.

CABLED is the first of eight electro-mobility projects to be funded by the British government, with the objective of finding out about drivers' experience of electro-mobility in practice, how they use and when they charge the vehicles. The project has already yielded initial insights.

The vehicles tested, with a range of about 80 miles (approximately 128 kilometers), are proving more than sufficient to cover the participants' average daily commute of 23 miles (about 37 kilometers).

The vehicles were parked for 97 percent of the time, mainly at night and during the drivers' working hours, meaning there was plenty of time for charging. In most cases, vehicles were connected to the power supply for longer periods of time than necessary for charging, indeed sometimes for several days. Users are being offered financial incentives to charge their cars at times when electricity demand is low.

In the CABLED project, 100 electric vehicles can be filled up at around 150 charging stations in Coventry and Birmingham.

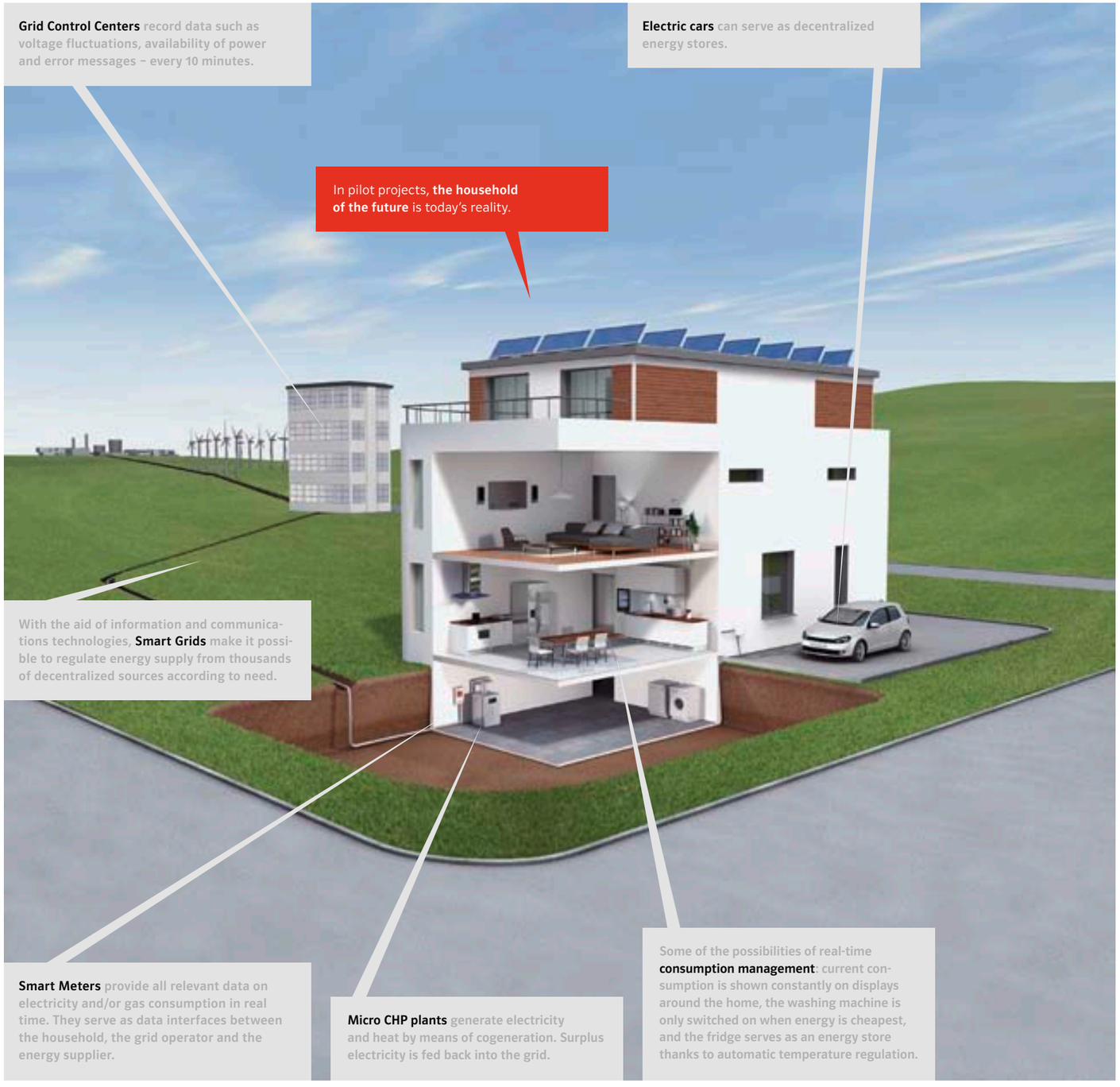
THE MITSUBISHI I-MIEV

The CABLED project includes, among others, 25 Mitsubishi i-MiEV vehicles. The Japanese model's lithium-ion battery gives the car a range of up to 140 kilometers and can be recharged from a conventional socket in about six hours. Its electric motor has an output of 64 HP.

Malmö: electro-mobility as part of urban development

Just a few years ago, the "Västra Hamnen" (West Harbor) area of Malmö was an old harbor district dominated by pollution and high unemployment. Today, this district, which E.ON helped to develop, serves as a paradigm of innovative and sustainable urban development. Electric vehicles are set to make a significant contribution to sustainable development in the traffic and transport sector. Working in partnership with the city of Malmö, E.ON is pioneering groundbreaking mobility concepts for the Swedish metropolis in the "Sustainable Malmö" project.

A field test set to run over several years will deploy 70 electric and hybrid vehicles; E.ON will install 250 charging stations in the city and its environs, in householders' garages as well as on parking lots belonging to companies, shopping malls and leisure facilities. Additionally, there will be charging stations in the vicinity of bus stops and train stations, to create convenient conditions for combining the use of electric cars and public transportation.



Lower Saxony: the future is now

Cars, houses, grids – two towns in Lower Saxony are making them smarter. What's behind it? New forms of technology – being tried out for real for the first time.

E.ON is currently testing its own fleet totaling 60 Peugeot iOn electric cars, the lion's share of which we are deploying in a groundbreaking pilot project which will see the test drivers' households fully integrated into a smart electricity grid.
The small towns of Stuhr and Weyhe, in the German state of Lower Saxony, are currently test sites for these new forms of technology.

Photovoltaic arrays generate electricity which is used in households or stored in the batteries of electric cars, and measured by means of Smart Meters. The project, however, goes beyond private households: E.ON is equipping the electricity grids in both locations with new regulating technology, transforming them into smart local grids. An example would be self-regulating substations, which automatically balance out fluctuations in voltage caused by the feed-in of solar energy. This is the first use of this complex technology in the low voltage network.

On their way: electric cars on the Iberian peninsula

In June 2010, E.ON launched a pilot project in Santander, Spain, using the Norwegian Think City vehicle. E.ON España will be using the vehicles in its own fleet, as well as installing charging points in the city which can be used by drivers of other electric cars as well. Moreover, it is testing an online payment system which will contribute experience and insights to E.ON's group-wide electro-mobility project.

THE THINK CITY

The Think City, produced in Norway, is a car exclusively for urban settings. It is designed as a two-seater, although its trunk can accommodate an extra row of seats for children. The motor's performance amounts to 60 kilowatts, giving an acceleration of 0-50 km/h in a little over six seconds, while the battery allows for a range of up to 180 kilometers.

The launch of the pilot project in Santander, Spain, drew considerable media attention.

Ready to go: Smarts and scooters in the Czech Republic

In the Czech Republic, E.ON and Mercedes-Benz have joined forces to run a field test with 25 electric Smarts. Furthermore, the police at E.ON locations in the country are already using electric motor scooters provided by E.ON.

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Photos: AREVA Multibrid/Jan Oelker 2010 (p.4, alpha ventus), Paul Langrock/Agentur Zenit (p.4,solar park), E.ON AG/Hans-Peter Strauß (p.5, power plant), E.ON AG (p.3/5/16/20/21/27/28/30), Ekkehard Winkler (p.7/14), DOTI 2009/Matthias Ibeler (p.9), E.ON Wasserkraft (p.10), iStockphoto (p.12/13), AUDI AG (p.15/24/25), Getty Images (p.18/19), Volkswagen AG (p.22), E.ON UK/PAGE ONE (p.26)

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