TRANSPORTATION

TECHNOLOGY FOCUS

WPT – added flexibility to EV charging
Robots at your door
Evolving battery technology
Shipping sector goes green

INDUSTRY SPOTLIGHT

Tomorrow’s urban transport at a glance

IEC WORLD

The rise of renewable energies

IEC FAMILY

Driving into the future
Transportation

Issue 03/2016 of e-tech focuses on several issues pertaining to the transportation sector, e.g. the electrification of public means of urban transport on roads and, increasingly, on water too; the introduction of small battery-powered driverless vehicles for home deliveries; and the development of so-called energy independent vehicles propelled entirely by on-board conversion of wind, sun, waves and other ambient energy sources.

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Going all electric soon?
The electrification of urban transport is underway

Growing concern about the adverse impact of noxious emissions from internal combustion engines is driving the electrification of public means of urban transportation on roads and, increasingly, on water too.

On roads and on water
The general adoption of fully electric buses is still some years away, but a gradual transition to cleaner vehicles relying on various hybrid solutions is underway. In some countries, electric drives are being installed in small ferries carrying passengers and vehicles to cut pollution from diesel engines on inland waterways.

Meanwhile, in additional steps to cut reliance on fossil fuels and pollution, small battery-powered driverless vehicles are being introduced for home deliveries and so-called energy independent vehicles propelled entirely by on-board conversion of wind, sun, waves and other ambient energy sources, are being developed.

Fully electric soon?
While public urban transportation is slowly but surely moving towards the electrification of its fleet, and while hybrid cars have successfully entered the market, fully electric cars are still seen as a niche market, albeit a growing one. However, manufacturers and engineers are working hard to solve several crucial issues that keep customers from going all electric. Batteries for instance: R&D is going full speed on the development of low-cost, long-life, energy-dense and high-power batteries that would take drivers farther than the current average range offered by today’s personal electric vehicles (EVs).

With technologies evolving at such a rapid pace, it is nevertheless certain that the trend towards full electric vehicles will not plateau soon.
David Appleyard

If electric vehicles are to reach their full potential, consumer concerns over range and reliability in operation and charging must be addressed decisively. Wireless power transfer (WPT) through magnetic induction is seen as the most promising approach to resolve this key issue. IEC International Standards are set to play a central role in the roll-out of WPT.

Wireless power transfer is seen as an ideal solution to the range and reliability challenge of electric vehicle ownership. Despite the ostensibly attractive environmental advantages of these vehicles, the almost primordial fear of being stranded far from home on a deserted road is widely perceived as one of the central barriers to the widespread uptake of electric vehicle technology.

“Electric vehicles are going to be the way we re-invent transportation and reduce the cost in terms of the environment,” says Ned Freeman, a member of the executive committee at Plugless Power (Evatran). “Given that, you start to think about what are some of the things that are holding consumers back when it comes to considering electric vehicles. Number one is range and life.” WPT offers a range of benefits in this respect.

IEC Technical Committee (TC) 69 develops International Standards for electric road vehicles and industrial trucks, totally or partly electrically propelled from self-contained power sources, including issues associated with WPT, which are addressed by JPT 61980: Electric vehicle wireless power transfer systems.

IEC TC 69/JPT 61980 is a Joint Project Team set up by IEC TC 69 and a Subcommittee (SC) of the International Organization of Standardization (ISO) TC 22: Road vehicles, to develop International Standards for WPT.

Bridging the gap

Wireless power transfer describes a range of technologies which permit electrical energy to be transmitted to a source of demand without the need for conductive cables or making a physical connection.

Promising approaches include radio, microwave or even laser transmission, coupled capacitance and the most market-developed WPT technology to date – magnetic induction.

Similar to the induction charging systems found in the domestic environment on low-power devices such as electric toothbrushes, razors or inductive cookers, in an EV application, WPT induces an electrical current in an appropriately tuned coil. It is capable of delivering significant power – systems supplying several hundred kW are under development.

Certainly, inductive power transfer is the technology of choice for major auto manufacturers as they look to launch systems commercially in the coming years. It is also the technology behind the world’s first market-ready EV WPT system from Plugless.

It began a low-volume roll out of its L2 System – developed and manufactured by Evatran – in mid-2014, following more than two years of trials with partners including Google, Duke Energy, and Hertz. Currently available for the Chevrolet Volt and Nissan Leaf vehicles, a 7,2 kW system for the Tesla S is due for launch in the next few months.

It uses inductive power transfer from a transmitting coil in a parking pad and charges an EV as quickly as a plug-in Mode 2 (240 V) station. Mode 2 charging refers to the connection of an EV to the AC
supply network (mains) not exceeding 32 A and not exceeding 250 V AC single-phase or 480 V AC three-phase utilizing standardized single-phase or three-phase socket-outlets, according to IEC 61851-1:2010, Electric vehicle conductive charging system – Part 1: General requirements.

“If you have an in-ground mount system, that’s what I would say is the candidate which has the most advantages,” says Dr Jochen Mahlein, who heads the LMS division at SEW-EURODRIVE. SEW-EURODRIVE has had experience in WPT for industrial applications for more than 16 years and is a member and secretary of IEC TC 69/JPT 61980.

For example, rather than poles, stanchions or other street furniture, inductive charging systems can be contained within a concrete pad that is flush with the road surface, and are therefore very difficult to damage, representing potentially low maintenance costs. It also solves the issue of the need for an appropriate plug at a charging point. Furthermore, Mahlein argues that the installation costs of a WPT system are comparable with those of existing wired alternatives.

Freeman also comments: “It’s obvious that wireless power transfer has unique advantages”.

For example, there is the possibility of ‘dynamic’ charging whilst a vehicle is in motion. Such systems are already in use in industrial environments and in August 2015 the UK’s Highways Agency began off-road trials of dynamic wireless power transfer.

The trials will involve replicating motorway conditions. The trials are expected to last for approximately 18 months.

Certainly there is some evidence of gathering momentum behind WPT technology for the EV market. A 2014 report from Navigant Research concludes: “Most wireless charging systems are in the pilot phase and are likely to remain there for another two to three years. […] Within a decade, wireless charging could be the leading way of charging EVs”.

Navigant forecasts that wireless charging equipment for light duty vehicles will grow by a compound annual growth rate of 108% from 2013 to 2022, reaching annual sales of some 300 000 units in 2022. Another recent forecast indicates that by 2019, WPT for the EV market is expected to be worth around USD 4.6 billion.

Choosing infrastructure

With the high power transfer capability of WPT comes the possibility of rapid charging.

There are already projects using high power systems for commercial vehicles and increasing power capacity is one key area of research. For instance, in March this year, a 20 kW wireless charging system was demonstrated at the US Department of Energy’s Oak Ridge National Laboratory running at 90% efficiency. Working with companies including Toyota and Evatran, the researchers say they are already looking ahead to their next target of a 50 kW WPT system.

Nissan is expected to launch a unit of more than 7 kW in the coming year, doubling the transfer capacity of its early developments. And Qualcomm has developed a 7.2 kW system, also doubling the capacity of its previous version.

However, at higher powers, safety becomes more of a concern, as Mahlein explains: “Current WPT systems are in a frequency range of 20 to 140 kHz. In terms of safety, 140-150 kHz is the starting point of broadcast radio applications; this is also something that needs to be borne in mind.”

As a result, mechanisms to address the possibility of animals, people or even waste such as aluminized paper
entering a strong magnetic field are being looked at.

Oak Ridge’s Power Electronics Team lead, Madhu Chinthavali, picks up on this: “The high-frequency magnetic fields employed in power transfer across a large air gap are focused and shielded. This means that magnetic fringe fields decrease rapidly to levels well below limits set by international standards, including inside the vehicle, to ensure personal safety”.

The role of International Standards
IEC International Standards for issues associated with WPT are developed by IEC TC 69/JPT 61980.

This JPT, in which some 70 experts from 13 Participating Members are active, has already published IEC 61980-1:2015, which deals with general requirements for electric vehicle WPT systems, and is preparing additional Standards in the IEC 61980 series to cover specific requirements for communication between EVs and infrastructure, as well as for magnetic and electric field power transfer systems.

Mahlein outlines some of the key issues in developing appropriate Standards: “The process of finding a unique solution is still ongoing; we have to deal with a lot of demands. I think we have some good approaches in standardization to cover most of those demands and I think we’re close to finding a consensus in this for public infrastructure”.

The crucial role of standards in accelerating the roll-out of EV WPT is also picked up by Freeman, who says: “Interoperability is something that’s going to be transformative for wireless power transfer. Standards can be a key enabler of getting interoperability”.

Looking forward, he says: “Wireless charging as an after-market accessory is something I think we’ll see more of. In the near term, the key is to take away those everyday concerns at home by making it hands free and automatic with wireless power”.

Freeman concludes: “The success in terms of helping to catalyze EV adoption comes when people stop worrying about it”. Wireless Power Transfer is set to be a key enabler in achieving that goal.

Are energy-independent vehicles the future of transport?
Looking beyond electric vehicles that need self-contained power sources

Morand Fachot
The wider introduction of electric vehicles is seen as a major move in cutting emissions of harmful substances and dependence on fossil fuels. Going a step further, some transport sector analysts forecast that a new generation of vehicles relying on the on-board conversion of harvested energy, rather than on self-contained power sources, will have a significant impact on the future of transport. Dr Peter Harrop, Chairman of IDTechEx, a market research and business intelligence company, shared with e-tech details of some of the current developments in this area.

Solar Impulse, the Swiss experimental solar-powered aircraft, is about to complete its trip round the world (Photo: Solar Impulse)
Beyond purely electric vehicles

Dr Harrop, can you tell us what are the prospects of ever seeing vehicles that do not rely on on-board energy storage or power sources such as batteries or fuel cells?

Harrop: There’s a realization now that where we’re headed goes beyond a purely electric vehicle, it goes even beyond having EV charging from solar roads that provide electricity without stopping. It’s attractive and it has been demonstrated to work, but it’s expensive to introduce on a mass scale.

The endgame goes even beyond that; it’s an endgame that won’t be reached for everything but for lots of things, such as vehicles, that won’t ever need electricity. We call these vehicles energy-independent vehicles, or EIVs. EIV is a term that has started popping up on occasion. A couple of weeks ago, at an event on e-mobility organized by AVERE, the European Association for Electromobility, several speakers touched on energy-independent vehicles.

Not a crazy dream

But these EIVs are nowhere to be seen...

Harrop: Right now you can actually buy some EIVs, it’s not a crazy dream.

Today, in China you can buy a tourist microbus for eight people. This vehicle, which looks like a slightly large golf cart, has been very cleverly designed with very efficient electrics and very efficient solar panels on its roof. This is a real indication of the endgame, because you can buy it with a battery, but if you want you can also buy it without a battery. Then it’s what we call a lizard electric vehicle: it wakes up with the sunshine. They’re thinking of tourist areas that want to be green and not even have a battery, and find it’s OK to drive it only in daylight.

There are also fixed-wing aircraft that can fly in the upper atmosphere and stay up there for five years at a time, autonomously. Well, they are EIVs: you can’t refuel them and there’s no way they can be plugged in.

These days we can observe the Swiss experimental solar-powered aircraft Solar Impulse on its way to complete its trip around the world.

Four years earlier we saw a German-Swiss boat, PlanetSolar, circumnavigating the globe on sunshine alone, a big boat, quite fast as well.

These are energy-independent vehicles.

Flying with the sun

A solar-powered microbus may not be ideal for northern Norway in the winter...

Harrop: Well, the interesting thing is that when you don’t have the weight of that battery, when you have really efficient solar cells, very efficient drivetrains, motors that are 10% more efficient than usual, and all that, it’s amazing what you can do.

Thinking the unthinkable

So we’re thinking the unthinkable here, we’re talking about electric vehicles that have no energy storage; we’re talking of electric vehicles that work even on Canadian sunshine, and there are many others being developed. Obviously that is not going to be in every street in your city soon. That is going to be only a part of the picture even in 10-20 years from now, but the work on these EIVs, like the solar-powered Nuon Solar car, which won the 3 000 km 2015 World Solar Challenge in Australia, does draw people’s attention. We had a lecture recently by an Australian who is going to use this technology to make a [solar] sports car, the Immortus, that will be street legal. We think that this Immortus project is very exciting.
Beneficial spinoffs

Put all this together and these people are just like those in Formula 1 racing: they’re giving us things which we can use for everything else. The Nuon Solar Team has spun off five companies already, with its technology.

The Immortus project’s proposal for raising money includes a commitment to spin off companies. So, they say “even if we make few vehicles which we sell for huge sums of money to very rich people, even if we don’t sell many, you should get a return on your money because we have invented, say, shock absorbers that make electricity.”

In the same vein, Formula 1 racing gave us the disc brake and the flywheel recovery system that is now used on London buses – it’s gone from F1 racing to London buses!

It’s obvious that the discipline of EIV is going to benefit what we do, and the vehicles we ride. It’s cascading down. We think it’s a big sea change, a major breakthrough in electric vehicles.

Cleaner, greener shipping

Electric propulsion makes a bigger splash on the water

Morand Fachot

Electric propulsion has been used on waterways since the 1880s, where it is primarily installed in small boats transporting a limited number of passengers on rivers or lakes. Outperformed on water and on land in the early 20th century by more efficient internal combustion engines with their longer range, electric propulsion is now making a comeback on waterways.

A number of IEC Technical Committees (TCs) and Subcommittees (SCs) develop International Standards that provide essential support for this renewal.

Environmental concerns push electrification

Environmental concerns are on the agenda for many shipping companies, in common with other industries. In a variety of countries, they are being met by electrifying various aspects of the shipping infrastructure. For the main part they have so far been limited to shore installations such as the supply of high and low voltage (HV and LV) power to moored ships to allow them to cut down on emissions in ports from their onboard diesel generators.

The global adoption of High Voltage Shore Connection (HVSC) has been possible since 2012 through the publication of IEC/ISO/IEEE 80005-1:2012, Utility connections in port – Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements. This triple logo International Standard was developed by IEC TC 18: Electrical installations of ships and of mobile and fixed offshore units, in cooperation with IEC SC 23H: Industrial plugs and socket-outlets, together with ISO/TC 8/SC 3: Piping and machinery, an SC of the International Organization for Standardization (ISO) TC 8: Ships and marine technology, and with the IAS Petroleum and Chemical Industry Committee (PCIC) of the Institute of Electrical and Electronics Engineers (IEEE).

IEC TC 18 has also developed a Publicly Available Specification,
IEC PAS 80005-3:2014, for LV shore connections.

However, further steps are still needed to clean up the industry and to meet increasingly stringent regulations for inland waterways and harbours. This can be achieved if full electric propulsion is adopted. What was once an unrealistic proposition is now possible and is slowly being introduced.

**The known unknowns: hidden costs**

Marine diesel (including diesel-electric) engines have major drawbacks; foremost among them is that they are harmful to health.

The European Environment Agency estimates that 432 000 people in 40 European countries died prematurely in 2012 due to high concentrations of particulate matter (PM) in the atmosphere, while another 75 000 died from long-term exposure to nitrogen oxide (NOx). Diesel engines are seen as significant contributors to PM and NOx emissions and they also produce CO2. Shipping contributes to these disturbing statistics, although it is impossible to estimate the exact level of its responsibility.

The financial cost of transporting and processing oil products in order to fuel ships needs also to be taken into account.

**Putting a figure on emissions**

Concrete examples are now available demonstrating the hidden costs of diesel propulsion for small inland waterways shipping, thanks to in-depth research carried out by Sweden-based Echandia Marine.

According to this company, which bases its estimates on the relative costs of diesel and electricity in a number of European countries, as well as on the costs to society, electric propulsion presents major benefits once the playing field has been levelled to take into account negative factors.

Giving as an example the Djurgården ferry, which is part of the Stockholm Public Transportation network, Hans Thornell, naval architect and founder of Green City Ferries, told participants to the IDTechEx Printed Electronics Europe 2016 event: “this little fellow emits 5 tonnes of nitrogen oxide (NOx) and 75 kg of particulate matter (PM) per year, at a cost to society of EUR 4 and EUR 1 310 per kg, respectively, according to the Swedish Transport Authority”. As a result, Thornell said, the total cost to society is EUR 120 000 per year, or one euro per litre of diesel, yet Swedish ship operators pay about 40 euro cents per litre of diesel.

In short, this means that society is subsidizing ship operators to pollute.

To demonstrate the technical and economic viability of operating an electric ferry, Green City Ferries have acquired a 75-foot diesel-powered ferry, Movitz, with a grant from the Swedish Energy Agency. The boat, which can carry 100 passengers, was retrofitted with two 125 kW electric motors, advanced batteries and an innovative supercharging system.

Citing an energy efficiency of 85-90% when running fully electrically, against a 30-35% efficiency for a diesel engine, Echandia Marine claims that going electric will drastically reduce operating costs.

Comparing yearly operating costs for an ordinary ferry operating 3 000 hours a year, the consumption would be around 95 000 litres of diesel, if using diesel, and some 294 MWh of electricity, if operating on electricity alone. Taking into account the differing prices of diesel and electricity in seven European countries, Echandia Marine estimates that savings in operating costs alone (cost

Green City Ferries operates ferries on routes in the city of Stockholm, Sweden
(Photos: Green City Ferries)
of diesel and maintenance costs vs. cost of electricity plus depreciation on batteries) would be between 50% in Italy (or some EUR 33 800) and 65% in Sweden (or EUR 45 500).

The maintenance costs for an electric ferry would also be lower since electric drives have fewer moving parts and so require less maintenance.

Furthermore, emission levels for the diesel/electric ferries would be respectively:
- CO₂ for diesel: 260 tonnes; for electricity: 0 tonnes
- NOₓ for diesel: 2.6 tonnes; for electricity: 0 tonnes
- PM for diesel: 115 kg; for electricity: 0 kg

In addition to the savings realized by operators, running electric ferries would provide society with much cleaner air.

**Technological challenges**

Until fairly recently, the operation of electric boats was restricted due to the limitations of battery technology (reliant on lead-acid batteries in the past), the power available and the time it took to charge batteries. This is changing rapidly with the availability of new generations of batteries with different chemistries and advanced charging systems.

International Standards for secondary batteries are developed by IEC TC 21: Secondary cells and batteries, “irrespective of type or application. The requirements cover all aspects depending on the battery technology such as: safety installation principles, performance, battery system aspects, dimensions, labelling. All electrochemical systems are considered”.

The retrofitted Movitz uses extremely super-advanced Nilar nickel-metal-hydride (NiMH) 180 kWh batteries, which deliver high power instantly and can be charged extremely quickly from a 300 kW charging station (to be upgraded to 600 kW). The batteries have a tailor-made battery management system (BMS) and a guaranteed minimum life of 5-7 years or 25 000 charging cycles. The ferry can be charged in 10 minutes and run for an hour. There are plans to introduce inductive charging which would allow batteries to be charged in 2-3 minutes during stops.

Another interesting example is offered by Ampere, the first electrically-powered car ferry that started operating a regular route in Norway in May 2015. Capable of transporting up to 120 cars and 360 passengers, Ampere crosses a 6 km stretch of water 34 times a day in Sognefjord, north of Bergen.

The vessel’s two 450 kW electric motors are powered by lithium-ion batteries with an overall output of 1 000 kWh and a weight of 10 tonnes.

The batteries are charged in 10 minutes from a 260 kWh lithium-ion battery pack installed at each pier and acting as a buffer power source, since the local power grid is only designed to supply electricity to small villages and so is relatively weak. The buffer batteries are then slowly recharged while the ship is crossing and the ship’s batteries are recharged directly with hydropower from the grid at night after the ferry stops operating.

A conventional ferry travelling the same route would burn a million litres of diesel fuel each year, emitting nearly 2 700 tonnes of CO₂ and 40 tonnes of NOₓ in the process.

Standardization work by IEC TC 18 and IEC SC 18A: Electric cables for ships and mobile and fixed offshore units, is central to the further development of electric power for ships.

Other IEC TCs and SCs playing an important role in flagship vessels like Ampere and Movitz include IEC TC 2: Rotating machinery, which develops International Standards for the type of machinery used in electric motors.

Ampere is also fitted with further systems designed to optimize energy
Fun with chemistry
Batteries enter new phase

David Appleyard

Battery technology has always evolved to meet consumer demand and today a host of new markets are opening up for energy storage applications. Electric vehicles and increasing renewable energy capacity are among the key drivers prompting research into a range of different chemical families. The goal is the development of low-cost, long-life, energy-dense and high-power batteries that can energize our future low-carbon world.

Everywhere from pocket to grid
The cellular telephone in our pocket constitutes one tiny part of the world’s biggest consumer of battery technology – portable electronics.

Mobiles, tablets and laptops are a massive market, but while the lithium- or nickel-based battery within may power that latest gizmo, it does not necessarily represent the latest in battery technology development. Designed to supply just milliwatts of power, ideally for a period of several days, with a focus on light weight and sustained low output, such technology is not necessarily ideal for most of today’s emerging battery applications.

The future propulsion systems of ships will be different, but are set to include a greater share of electric power in the overall energy mix, including hybrid diesel electric or combined gas and steam turbine, driving an electrical propulsion system, in addition to full electric.

Professor David Greenwood at the University of Warwick in the UK, outlines the key market drivers: “Mobile energy for things like electric vehicles and large-scale energy storage for operating with the grid and the electrical distribution network. What...
those two growth sectors need is a bit different to the consumer electronics industry, which has driven battery development.”

This is a point echoed by Phil Hare, management consultant with analysis firm Poyry: “These are auspicious times for storage. Batteries actually seem to be coming to the fore, and I think are coming to the fore in part because of the crossover from developing electric cars. So costs are coming down enormously”.

IEC Technical Committee (TC) 21: Secondary cells and batteries, develops International Standards for all secondary cells and batteries, irrespective of type and chemistries (i.e. lithium-ion, lead-acid, nickel-based) or application (i.e. portable, stationary, traction, electric vehicles or aircraft). They cover all aspects such as safety, performance and dimensions and labelling, a new battery technology. Chemistry for flow batteries – another potential candidate for large-scale electrochemical energy storage – is now part of the TC remit.

**Big batteries, big business**

Big batteries are expected to become big business. Just how big is indicated from a recent report by US-based analysis firm Navigant which concludes that annual revenue for the commercial and industrial (C&I) energy storage industry is expected to reach USD 10.8 billion by 2025, from less than USD one billion in 2016.

As Alex Eller, research analyst with Navigant Research, explains: “Despite early challenges, global C&I energy storage system power capacity deployments are expected to grow from 499.4 MW in 2016 to 9.1 GW in 2025”.

A major driver of the demand for increased energy storage capacity has been the high penetration of variable output renewables, particularly wind and solar photovoltaic (PV). As an example, in 2013, regulators in California in the USA, which has a significant proportion of renewables, mandated the state’s three major utilities – Pacific Gas and Electric, Southern California Edison and San Diego Gas & Electric – to procure collectively 1.325 MW of energy storage by 2020, with installation by the end of 2024.

And in February this year, AES UK & Ireland commissioned its Advacion storage array at Kilroot power station in Carrickfergus in Northern Ireland, which provides 10 MW of grid-connected energy storage. Globally, AES owns and operates 116 MW of operational storage with a further 268 MW under construction or late stage development.

**Evolving battery technology**

New requirements for battery system performance characteristics may be emerging, but that does not necessarily indicate that lithium-ion or even older technologies like lead-acid are played out.

Greenwood highlights the evolving nature of battery technologies: “You have this family of chemistries around lead and lead-acid. There is another family of chemistries around nickel, the first of which was nickel-cadmium, while nickel metal hydride is the more modern version and then you have got a further family of chemistries which are around lithium and lithium-ion. There are many different flavours of lithium-ion, more than 40-odd; they are not all the same and they behave quite differently in places”.

He continues: “A lot of the new technologies that we are starting to look at are still lithium-based, but they’re not working on transporting lithium ions, they’re working on different reactions”. Greenwood cites a number of promising chemistries, including lithium-air, lithium iron phosphate and nickel cobalt manganese.

Indeed, in March 2016, sodium-ion battery technology company Faradion announced a partnership with WMG,
University of Warwick and energy storage specialists Moixa Technology in a bid to commercialize this battery chemistry. By using highly abundant sodium salts rather than lithium, sodium-ion cells are anticipated to be 30% cheaper to produce.

Alongside endeavours to explore novel battery chemistries in more detail, the influence that the physical structure of the cell can have on performance is also driving research into new materials such as solid electrolytes or novel electrode structures.

Says Greenwood: “Typically the amount of energy that is held inside a battery cell is directly related to the amount of electrochemical material inside it, whereas the power that you get out of that cell is determined effectively by the active surface area inside the cell over which those reactions can take place”.

Ideally then, highly porous materials are used which allow rapid reactions for high power and can simultaneously pack in a large ratio of active material to support sustained reactions for high energy density. Graphene and other nanomaterials are showing promise in this area. IEC TC 113: Nanotechnology standardization for electrical and electronic products and systems is developing, for instance, Technical Specifications for “electrode nanomaterial used in nano-enabled energy storage devices such as lithium-ion batteries”, and is also developing a range of publications related to this and to graphene-related applications.

**The search for life**

Lifespan is perhaps the major challenge for any emerging battery technology.

“The basic reactions are reasonably well understood, but like anything, it is the things that that you didn’t want to happen that are harder to control. There are many degradation mechanisms that come into play; the active sites in the electrochemical material effectively get clogged up with lithium deposits, or you can get problems with the electrochemical materials fracturing and coming away,” says Greenwood.

This degradation process has a significant impact on the size and mass of the current generation of battery technologies. In order to compensate for degradation over the eight or 10 years of an electric vehicle (EV) battery’s life, additional capacity is required initially if the system is to achieve design performance parameters after multiple charge and discharge cycles.

Furthermore, as some of these degradation processes are accelerated at states of very high or low charge, ‘buffer’ capacity is typically designed into battery systems to enable required performance whilst maintaining the charge state between, say, 10-90%.

**Crash diet**

One way battery performance may be improved is by reducing the mass of ‘ancillary’ components.

Says Greenwood: “For your typical automotive battery at the moment, only about 40% of the mass of the battery is the electrochemically active material, the rest of it is all the support structure, the cooling structure, the control system, the electrical interconnects.

“There’s a lot you can do to understand how to better package that whole lot and get to a point where a great percentage of that battery pack is the chemically-active material, which is actually delivering on the primary purpose of the battery.”

Industry standards have a clear role to play here, explains Greenwood: “The standards really come in when we start to talk around applications for energy storage, because many of the sectors we have been talking about are...
relatively new to using electrical energy storage systems.”

Standard cell formats are one area of interest for consumers: “Manufacturers have their own proprietary standards that they are working to and that makes it incredibly difficult for users of those batteries to be able to standardize,” says Greenwood, in particular noting pouch and prismatic types of construction.

IEC TC 21 develops Standards for cell formats as part of its scope.

The power of chemistry
Looking forward, Greenwood envisages a number of developments over the coming decade or so. Within the five-year horizon: “It is all about being able to use much better the chemistry that we have got around us, to build electrode structures that give us the right mix of power and energy and which give us the durability that we need”.

Over the next 10 and more years: “That is when you start looking at things like lithium-air chemistries, which are still very much at laboratory scale. Typically these are operating with quite short life times at the moment. There is a lot of development work left to understand how we get the very best out of those chemistries and get them to a point where they can all be industrialized”.

“The different chemistries of batteries are still waiting in the wings,” concludes Hare, “and interestingly, lithium-ion batteries I think have a massive momentum behind them. We’ve already looked at lithium batteries, but the prospect of tuning those to meet the static applications is very intriguing.”

Hare envisages the prospect of lowering costs significantly by focusing on static applications, rather than requirements for lightness and power density.

He also posits another way to improve the lifetime performance of existing battery technology, using end-of-life EV batteries in static applications as well. With the performance specifications on EV batteries so much higher than required for, say, an average domestic static application, such as a solar PV system, the residual performance of an ‘end-of-life’ EV battery could be sufficient for many years.

“I think that’s at an early stage, but there’s a definite thought about that, and that’s going to require all sorts of interesting questions about standardization.”

Peter Feuilherade
From robots delivering small packages in cities, to driverless trucks transporting bulk loads over long distances, advances in robotic delivery in the next decade will lead to significant changes in retail markets, the freight haulage industry and transport in general.

New capabilities and functions for transportation
Most trials of autonomous delivery services have involved aerial drones or unmanned aerial vehicles (UAVs). Meanwhile, the latest “connected car” technologies are being tested in hundreds of semi-autonomous cars on public roads around the world. In the words of a report by the US-based market research and consulting firm

Estonia-based Starship Technologies has built a fleet of small battery-powered delivery robots... (Photo: Starship Technologies)
Navigant Research in April 2016, “electrification, sensing and actuation technology, wireless connectivity and mobile apps built on the internet have each spawned fascinating new capabilities and functions for transportation.”

As these trends converge, several companies are trialling the use of driverless wheeled vehicles in urban environments for “last mile” deliveries of food orders and small packages, regarded as the most problematic and least efficient step in the e-commerce delivery chain. These terrestrial drones are battery-powered and drive themselves along city pavements and cycle lanes without the active intervention of a human operator. They are equipped with sensors and location technology to avoid collisions with pedestrians or street furniture, and microphones for two-way communication.

Robots, electric trucks and trolleys with a degree of automation have been used for decades in factories and warehouses to transport products and packages or deliver mail to offices. In hospitals, fleets of autonomous robots travel for miles along corridors delivering medical supplies, patients’ meals and other goods. Warehouse and logistics sectors are increasingly automating the supply chain process to meet the growing need for accuracy and faster delivery time. Recently BMW Group has tested suitcase-size self-driving robotic trolleys on its factory floors in Germany, as part of an automation drive to help cut costs by 5% per car annually.

### Minimizing risks with IEC standards
Autonomous delivery vehicles and self-driving cars have many safety requirements and standards in common. The primary aim is to ensure that automated systems operate efficiently and to minimize the risks to pedestrians and road users as well as goods.

Several IEC Technical Committee (TCs) and Subcommittees (SCs) draw up International Standards for the electronic systems, sensors, motors and batteries used in the driverless technology found in electric-powered autonomous vehicles.

IEC TC 69: Electric road vehicles and electric industrial trucks, prepares Standards for motors and motor controllers, on-board electrical energy storage systems, power supplies and chargers.

Since energy for smaller robot delivery vehicles is supplied mainly by batteries, TC 69 liaises closely with TC 21: Secondary cells and batteries, and its SCs, which prepare International Standards for all secondary cells and batteries. This covers the performance, dimensions, safety installation principles and labelling of batteries used for the propulsion of electric road vehicles. These batteries can be of the lead-acid, lithium-ion, nickel-metal-hydride or lithium iron phosphate types, for instance.

TC 105: Fuel cell technologies, prepares International Standards for fuel cell technologies which are already widely deployed in the industrial and commercial electric vehicle sector.

### Now you see me
Many road-going trucks already include semi-autonomous safety features such as lane change sensors and cruise control. In Europe, all new trucks sold since November 2015 must by law be fitted with autonomous emergency braking.

The next generation of autonomous delivery vehicles is likely to incorporate even more technology already being tested in driverless cars to detect obstacles and hazards. This typically comprises GPS receivers and detailed maps to navigate roads, and a range of 3D vision guidance systems and electronic sensors including laser-surveying systems known as Lidars (light detection and ranging). Lidar sensors fire lasers ahead and analyse the signal reflected back, scanning the road as far as 200 m ahead of the vehicle.

Other autonomous driving technology common to cars and delivery vehicles includes electronic stability control, rear- and forward-view camera systems, sensor arrays to transmit data between those systems and a vehicle’s engine, transmission and brakes, and wireless communication subsystems to communicate with a controller and other vehicles.

IEC work in standardization contributes significantly to the sensors that make driverless technology possible. International Standards prepared by IEC TC 47: Semiconductor devices, and IEC SC 47F: Microelectromechanical systems, enable manufacturers to build more reliable and efficient sensors and microelectromechanical systems (MEMS). TC 56: Dependability, covers the reliability of electronic components and equipment.

### Robot at your door
Battery-powered delivery robots that interact with customers via a smartphone app are being tested on streets – or rather, pavements – in at least three continents.
Estonia-based Starship Technologies, launched by two co-founders of Skype, has built a fleet of small battery-powered six-wheeled delivery robots with a payload of 9 kg. The robots can operate continuously for more than two hours between charges and are intended for short-range deliveries from local businesses in residential areas, travelling on pavements rather than roads. Tests have been carried out in Estonia, Germany, Belgium and the US, and further trials are under way in the London suburb of Greenwich. Each robot has built-in 3G and GPS as well as an array of cameras, sensors and obstacle-avoidance software to help it detect pedestrians and travel safely up to its maximum speed of 6.5 kph. Although the robots are overseen by human operators to ensure safety, their creators say door-to-door delivery costs could be reduced by 10-15% compared with conventional vehicles like vans or mopeds.

Another autonomous delivery start-up, Dispatch, is piloting the delivery of mail and packages on college and university campuses in California. Its four-wheeled autonomous vehicle can carry a load of 45 kg and is powered by a lithium-ion battery that allows 12 hours of use. Equipped with cameras and Lidar technology, this delivery robot absorbs data as it navigates along pavements and cycle paths at a walking pace, becoming “smarter” with each trip.

A nascent market
The US technology research company Technavio predicts the overall market for mail-sorting robots, unmanned ground vehicles (UGVs) and drones that deliver products to customers from warehouses or manufacturing locations will grow from USD 15.32 million in 2015 to USD 54.07 million by 2020. The evolution of autonomous UGVs is in the nascent stage as most of the vendors are testing these robots for end-user delivery solutions... If these equipment pass the testing phase, then we expect them to hit the UK and the US markets by early 2017,” Technavio analyst Bharath Kanniappan told e-tech.

This represents only a tiny share of the overall worldwide market for logistics robots. According to Technavio, the global logistics robots market is expected to reach USD 2.15 billion in the five years from 2016 to 2020, growing at a CAGR of over 32% during the projected period. This market is dominated by mobile factory logistics robots, with a share of 81.9%.

The costs of the sensors and computing power required by autonomous vehicles continue to fall. The price of semiconductor lasers used in 3D Lidar sensors, now USD 1,300, is predicted to fall to USD 150 by 2025. Hardware and computing power costs are likely to reduce further once the adoption of robotic technology in delivery services gains momentum.

Nevertheless, business research and consulting firm Frost & Sullivan does not expect to see fully autonomous trucks deployed on US roads for at least another two decades. From a global perspective, the firm predicts that some 8 000 autonomous-enabled trucks will be sold worldwide by 2025 for on-road applications, rising to more than 180 000 units by 2035.

A Gonna roll this truckin’ convoy
Meanwhile, April 2016 brought the prospect of fleets of larger self-driving delivery vehicles sharing public roads a step nearer. Six European truck companies each drove their vehicles in connected convoys on motorways in the continent’s first major test of autonomous “truck platooning” technology.

Platooning is seen as the first step in the autonomous vehicle process,
leading to greater road safety as well as cost savings. Trucks travel in convoy at very close distances behind one another and communicate with wireless technology, which allows them to brake and accelerate together, cutting down wind resistance and potentially saving as much as 20% on fuel costs. On-board collision mitigation and cruise control systems enable the driverless heavy goods vehicles to adapt to road conditions and enhance their ability to avoid accidents.

**Drones and robots in tandem**

Autonomous delivery trucks and robots will transform retail and home delivery, once issues like uneven delivery paths and the possibility of theft are resolved. There is potentially a big home delivery market for supermarkets, using driverless vehicles which are smaller than the current vans used to drop off groceries. New commercial services that combine driverless vehicles and aerial drones working in tandem to deliver to “the last mile” could also significantly reduce the time and costs of transporting packages direct to customers’ doors, provided they clear regulatory hurdles.

Deploying a fully autonomous vehicle, whether a passenger car or a delivery truck, will require further advances in software as well as sensor technology. Other conditions to be met before widespread adoption can occur include legislation on liability, standardization of rules across national borders and more public debate.

The consensus among most fleet operators in the US and Europe is that large-scale full automation of trucks is still some years away. Frost & Sullivan believes that while autonomous highway driving in passenger cars could become mainstream by 2020, platoons of driverless trucks will not appear until closer to 2022.

**The greening of urban transport**

The electrification of urban transport is driven by environmental concerns

*Morand Fachot*

Increasing traffic congestion and escalating air pollution are leading to schemes for cutting the number of individual passenger cars in cities and encouraging the wider use of public transport around the world. Most bus fleets, which make up the bulk of urban transport connections, are still powered by internal combustion engines. The goal of many cities is to electrify their bus fleets fully. It will be a gradual move, tied to the introduction of intermediate solutions such as hybrid drives, before it can be achieved fully.

**A tale of many systems**

Urban transport in large cities depends on different complementary systems, each with its advantages and drawbacks.
Mass transport systems such as metro, trams and suburban railway lines already rely on full electric traction.

They present two major advantages: they have a huge transport capacity (e.g. 700-1 000 passengers each for Paris Metro trains; 600-900 for London Underground trains; 200-300 for most trams) and they are zero pollution vehicles at the point of use.

However, the necessary infrastructure is very costly to build, and must be carefully designed to ensure it meets actual needs; it is also inflexible to potential route changes.

For their part, buses bring greater flexibility to public urban transport. However, with the exception of trolleybuses, they currently present a significant disadvantage: they are powered predominantly by internal combustion engines (ICE), most of which burn diesel. As a result, they are polluting and noisy. Also, buses are high on maintenance and need replacing much more frequently than metro or trams that can run for decades. As a result, their total cost of ownership (TCO) is high.

On the other hand, buses have significant advantages as they:
- ensure a close-meshed area coverage
- are very flexible as they are not dependent on a rigid infrastructure such as rail tracks
- are relatively standard and low-investment products (with the relative exception of trolleybuses, which need overhead cables)
- can be easily rerouted in case of road works or traffic obstructions

Transition to fully electric bus fleets
The electrification of urban bus fleets will be a gradual process introduced over many years. The scale of the changes is massive, as bus fleets can be extremely large in megacities (over 21 000 buses in Beijing, 16 000 in Shanghai, 8 700 in London).

The green and sustainable electrification of urban fleet buses does not imply solving technical issues alone, but also means getting a number of important stakeholders involved, such as:
- national, regional and local authorities (which draft transport and environmental directives)
- power utilities that must supply the necessary electricity – increasingly from renewable sources
- electric automotive equipment manufacturers (e.g. for batteries, fuel cells, power electronics, drives), who will see an important new market opening up
- vehicle manufacturers, who will come up with new solutions
- operators, who can look forward to lower operating costs and increased profits
- users and city residents, who can look forward to cleaner urban transport

Step by step greening
The renewal – and gradual greening – of bus fleets will vary greatly, as is currently the case with their use and predictable wear and tear. The average age of a London bus, for instance, is 7.7 years, during which it will cover some 57 000 km a year. Buses in the Paris region have an average age of 7 years and cover 38 700 km a year (2012).

Full electrification will take different forms, but it cannot be achieved immediately as full charging infrastructures are not available yet. Manufacturers and operators will initially adopt some form of hybridization of vehicles using one of the following systems:
- hybrid drive with an ICE (diesel, liquid or compressed gas, petrol), possibly an ICE range extender. Power comes from a generator driven by an ICE. In addition, energy recovered from braking or from energy harvesting shock absorbers is stored in energy storage devices like batteries, ultracapacitors or flywheels. A start and stop function for the ICE allows the bus to run on batteries alone, when necessary.
Advantages: low emissions and low TCO
- hybrid drive with fuel cell. Energy recovered from braking or from energy harvesting shock absorbers is also stored in energy storage devices (batteries, ultracapacitors or flywheels). Advantages: no emission and low TCO

**Batteries are the key to the future of bus electrification**
Fully electric bus fleets will rely on batteries for power (with the exception of trolleybuses, which however increasingly use these as their energy source in case of emergency). However the systems will differ.

Manfred Schmidt, from Siemens AG electric and hybrid drives, outlining a potential scenario for the future of the city bus at a presentation at a recent IDTechEx event, said that the city bus of the future would be emission free and would:
- have an energy-efficient electric traction system
- have an energy storage battery to enable charging from external energy
- be either a “project-designed bus” for specific route applications and with limited flexibility using one of the following options:
  - opportunity charging
  - smart trolley charging
  - huge battery designed for the worst case scenario
  - on-road charging
  - battery swapping
  - another solution
- or a “product bus” that is very flexible and route-independent like today’s buses with ICE. It will be equipped with a fuel cell range extender

**IEC International Standards are central to electric urban transport systems**
All existing solutions adopted for the electrification of urban mass transport systems like metros and trams or medium size vehicles depend entirely or in part on IEC International Standards developed by countless IEC Technical Committees (TCs) and Subcommittees (SCs). Transport systems include a very wide range of components and systems such as cables (Standards prepared by IEC TC 20), power electronic systems and equipment (IEC TC 22), fuses (IEC TC 32) and connectors (IEC SC 48B).

Other IEC TCs and SCs central to the development of urban electric transport are:

IEC TC 9: Electrical equipment and systems for railways, set up in 1924. It develops International Standards covering “(...) metropolitan transport networks (including metros, tramways, trolleybuses and fully automated transport systems)”.

IEC TC 21: Secondary cells and batteries, and SC 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes. Standardization work for batteries used in electric vehicles and electric industrial trucks is the responsibility of Joint Working Groups set up with IEC TC 69. These JWG are:

IEC JWG 69 Li: TC 21/SC 21A/TC 69 – Lithium for automobile/automotive applications

IEC JWG 69 Pb-Ni: TC 21/SC 21A/TC 69 – Lead acid and nickel based systems for automobile/automotive applications

IEC TC 40: Capacitors and resistors for electronic equipment; develops International Standards for electric double layer capacitors (better known as supercapacitors)

IEC TC 69: Electric road vehicles and electric industrial trucks.

IEC TC 105: Fuel cells

Standardization work by these IEC TCs and SCs underpins the widespread adoption of urban electric transport systems, which are set to improve dramatically the health and quality of life of hundreds of millions across the world as well as cutting the negative environmental impact of mass transportation systems.
What does the future of urban transport look like?

Policy, regulations and International Standards key to safety, efficiency and durability

Antoinette Price

Global authorities and industry agree that policy, regulations and International Standards must be established urgently so as to allow fully driverless vehicles and instil consumer confidence in them.

Authorities around the world are under increasing pressure to provide transport networks which are safe, efficient and durable. Two of the biggest challenges faced are road safety and congestion, as well as managing the pollution that results from the latter. The World Health Organization (WHO) Global status report on road safety 2015 cites 1.25 million road deaths per year worldwide.

Additionally, mega-cities face infrastructures which have reached full capacity and cannot be expanded. They no longer meet all the transportation requirements of highly mobile populations and goods.

During a one-day workshop entitled The future networked car, organized by the International Telecommunication Union (ITU) and the United Nations Economic Commission for Europe (UNECE) at the 2016 Geneva Motor Show, representatives of vehicle manufacturers, the automotive and information and communication technology industries, governments and their regulators discussed the status and future of vehicle communications and automated driving in a way that will address these points.

Authorities must keep up with developments and ensure safety first

The high levels of automation that are likely to be seen in the next five years are expected to improve road safety, reduce congestion and emissions. This will also provide the growing aging populations and people with disabilities with greater mobility as well as revolutionizing how people live and do business.

Eva Molnar, Director, Sustainable Transport Division, UNECE, stressed the need for policy to support IT developments for the best possible outcome of intelligent transport systems. Despite the complexity and challenges encountered, she highlighted the need for authorities to keep pace of technology innovations and respond with more timely regulatory changes if required.

Seat belts, air bags and assisted braking systems have greatly improved car safety. Connected car technology will build on this by collecting and analysing masses of data from different sources within the future intelligent transport systems, to improve road safety and save lives.

Jean Todt, UN Secretary General Special Envoy for Road Safety, noted that since safety is top of customers’ wish list, a development strategy for connected car technology must prioritize in-vehicle safety applications.

“We need to promote consumer trust. There is no margin for error with safety critical technologies – they must work perfectly every time. This is even more valid for driverless cars, which represent the natural evolution of the connected car. Consumers will not give over control of the vehicle until they are sure the car
and surrounding environment are 100% safe and reliable."

**Connected cars will save lives**

Cars connected to the Internet will be able to “talk” to other cars using vehicle to vehicle (V2V) communication (exchanging speed, position and direction data to alert drivers to possible collisions). For example, the car will be able to “see” if another vehicle is in its blind spot and alert the driver.

Vehicle to infrastructure (V2I) communication will reduce congestion. By receiving traffic updates, these cars will suggest alternative routes, avoid accident scenes and be able to predict likely jams much further ahead. They will do this by talking to sensors on signs, stop lights, bus stops or embedded in the roads. Improved traffic flow will reduce pollution, save on fuel and enable emergency services to pinpoint and reach incidents quickly to save more lives.

Cars will be able to communicate with homes, offices and other connected devices. They could eventually access all your apps and devices, programme the quickest route to your meeting, play your favourite music and remind you of upcoming events. People will be able to dictate and send emails thanks to advanced voice control capabilities like SIRI.

While all this technology may be convenient, WHO statistics also show that 80% of countries around the world, notably low- and middle-income ones, still fail to meet basic international standards on vehicle safety. The challenge for governments will be to ensure that all consumers have access to connected technology, particularly safety features, both in emerging and mature markets. One way to do this is to start applying minimal UN regulations and include a first level of active safety technology.

**International Standards from the word go**

From the technology perspective, it was generally agreed by all participants that International Standards will contribute to providing safer, reliable vehicles. They will also help facilitate the transition phase by addressing compatibility issues within complex intelligent transport systems, which will reach beyond borders, for example, in Europe.

A number of IEC Technical Committees prepare International Standards for connected technology, including sensors, lighting and motor components, as well as the functional safety of computer based systems. Additionally, managing the huge amount of information expected in connected and progressively more autonomous cars will require a platform which can process, analyse and store all the data – in other words, the cloud.

As more cloud-based services and products are developed, harmonization and compatibility issues will need to be solved. Subcommittee (SC) 38: Cloud computing and Distributed Platforms, of IEC and the International Organization for Standardization (ISO) Joint Technical Committee ISO/IEC JTC 1: Information Technology, has published International Standards which offer:

- Cloud computing – definitions of common cloud computing terms and descriptions of how different elements relate to one another
- Reference architecture containing diagrams and descriptions of how the various aspects of cloud computing relate to one another, including cloud computing roles, activities, and functional components and their relationships
- The interface for accessing cloud storage and managing the data stored therein

**Testing the technology**

The US Department of Transportation National Highway Traffic Administration defines four levels of vehicle automation. Level 0, or no automation, means the driver has complete and sole control of the primary vehicle controls at all times, and responsibility for monitoring the roadway and for safe operation of all vehicle controls.
Level 4, conversely, offers full self-driving automation, where the vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip.

In France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the UK, Canada and the US, as well as China, Japan, South Korea, Australia and New Zealand, self-driving cars with different levels of automation are being tested in towns and on highways.

**A long road to full automation**

Much more still has to be done before we reach level 4. Cars will need to be able to recognize objects that cross their path, handle different weather conditions and for all the possible scenarios already mentioned, seamlessly connect between different parts of the complex infrastructure.

As is the case for any devices connecting to the Internet of Things, car manufacturers will have to ensure that consumer personal data is protected, their cars are safe from hackers, and the law must clarify accident and other liabilities.

The BMW i8 hybrid, a concept car introduced at CES 2016, features the intelligent personal assistant BMW Connected and makes use of Cloud computing to access real-time data (Photo: BMW)
Morand Fachot

In recent years consumers have benefited from the introduction of countless mobile and wearable IT and consumer electronics (CE) devices and systems. Meanwhile, public and individual means of transportation everywhere are increasingly relying on electric drives and storage for part or all of their propulsion systems. Large stationary energy storage is another area where batteries are playing a growing role. Standardization work by IEC Technical Committee (TC) 21: Secondary cells and batteries, is central to future advances in all energy storage domains.

Different applications, similar restricting issues

As IT and CE mobile and wearable devices employ ever more advanced processors, displays and audio systems and offer connectivity to an ever growing range of wireless networks and other devices, they are becoming more and more power hungry.

Likewise, the wider adoption of full or hybrid electric drives in electric vehicles (EVs) is seen as hinging on the availability of more advanced batteries (and charging systems), which will allow them to overcome the limitations of range and charge they currently face.

Different chemistries for different applications

Today’s batteries for mobile applications are based mainly on Li-ion (lithium-ion) chemistry, which offers the key advantage of being able to store large amounts of energy in comparatively light, compact and purpose-made packages. However, while these batteries may provide a reliable power supply, they can no longer keep up with the growing demands placed on them in their current form.

New trends in automotive applications

Although attention has been focusing on storage for mobile applications for a few years, trend in the automotive sector are no less interesting.

EVs rely extensively too on Li-ion batteries, but may use also nickel-metal hydride batteries. As for vehicles powered by internal combustion engines (ICEs), they depend on rechargeable sealed lead-acid starter batteries, increasingly of the valve-regulated type (VRLA).

International Standards for batteries used in automotive applications, including “for the propulsion of electric road vehicles” are developed by IEC TC 21 and its Subcommittee (SC) 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes.

As car manufacturers are striving to manufacture cars that will meet tighter emission laws in many countries and regions from 2025-2030, some are now prioritizing so-called 48 V mild hybrids as an interim solution before achieving pure electrification of vehicles. Mild hybridization relies on lithium-ion batteries and consists in adapting 48 V devices and interconnects to existing ICE powertrains. This technology has already been tested for a number of years and offers, among many others, the following benefits, according to IDTechEx Research and manufacturers’ data:

• $\text{CO}_2$ emissions reduced by 10-20%, depending on test cycles
• cheaper (50-70%) than full hybrids, according to automotive equipment manufacturer Valeo
• unlike existing 12 V and 24 V vehicles, they can accept charging from regenerative braking and other regeneration (thermoelectric, exhaust heat, suspension, etc.); and they can drive the wheels electrically and provide additional power

Stationary applications matter too
Batteries are not just central to mobile and automotive applications, but increasingly also to stationary energy storage.

Electricity being consumed as it is produced there must be sufficient supply to meet variations in demand. At times of peak demand extra capacity must be available to respond rapidly.

If demand cannot be met, the stability and quality of the power supply suffer and may result in brownouts or worse. To balance demand and supply additional generation, a certain amount of storage may also be necessary. It currently mainly takes the form of pumped hydro, which makes up the bulk of electricity storage.

Advanced batteries are set to play a major role in the future global electrical energy storage landscape and in grid management, in particular as the share of renewable energies (REs) grows.

A new generation of advanced safe, low-cost and efficient enough batteries to allow for storage on the grid has paved the way to the first instances of large-scale energy storage for the electric distribution network. The next-generation advanced batteries include Li-ion, sodium metal halide, NaS (sodium sulphur), advanced lead-acid and flow batteries.

RE storage, TC 21 and TC 82: Solar photovoltaic energy systems, set up a Joint Working Group, JWG 82: Secondary cells and batteries for renewable energy storage.

Finding the right chemistry for the right use
IEC TC 21 lists the key areas of battery standardization as starting, lighting, ignition (SLI) also named “starter” batteries, which supply electric energy to motor vehicles; automobile hybrid/ electric vehicle cells; traction batteries; and the stationary batteries of the VRLA type.

TC 21 has broadened its scope to include technology and chemistry for flow batteries, which are starting to be deployed in the market and, as such need international standardization regarding performance, performance tests and safety.

Flow batteries are rechargeable batteries in which electroactive chemical components dissolved in liquids (electrolytes) stored externally in tanks and pumped through a membrane convert chemical energy into electricity.

To develop standards for flow batteries that cover safety, performances, installation, terminology and other necessary requirements, TC 21 set up JWG 17: Flow battery systems for stationary applications, with IEC TC 105: Fuel cell technologies, as flow batteries and fuel cells share certain characteristics.

TC 21 was created in 1931 and currently brings together 25 Participating countries and 17 Member countries. Around 215 experts are active in its standardization work.

In view of the fast expanding energy storage needs from mobile, e-mobility and stationary applications, IEC TC 21 and IEC SC 21A are unlikely to see any reduction in their workload in the foreseeable future.
Electric motors have many uses, in heavy industry, hospital generators, power tools, pumps to clean swimming pools, and many transport vehicles. Yet, they are the single biggest users of electricity, driving pumps, fans and other machines.

Manufacturers need consumers to trust their products
The International Energy Agency (IEA) says electric motors account for 45% of electricity consumption worldwide, but if they can be made more efficient, electricity savings of 20-30% would be possible.

In an attempt to increase electric motor efficiency, governments have introduced Minimum Energy Performance Standards (MEPS), which set obligatory minimum energy efficiency levels for motors. IEC has established four classes of energy efficiency for motors found in IEC 60034-30-1, which are IE1 Standard efficiency, IE2 High efficiency, IE3 Premium efficiency and IE4 Super premium efficiency. It has also produced IEC 60034-2-1 for testing electric motors. Today, MEPS are most often based on these International Standards.

In today’s global supply chains, since many electric motors and their driven equipment are made and shipped worldwide, it is difficult for consumers to be sure that these International Standards have been applied. Additionally, testing and verification processes and requirements vary in different countries. So how can consumers trust products?

The best way for manufacturers to inspire consumer confidence is to apply harmonized International Standards, which ensure that wherever they are in the world, they follow the same principles when defining, measuring and publishing motor efficiencies.

A globally harmonized programme for checking and certifying motor efficiency
In order to address the trade barriers which can occur because of differing country regulations, IECEE, the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components, has developed the Global Motor Energy Efficiency Programme (GMEE) for motor efficiency.

It is based on the international IECEE CB Scheme, which in turn is based on International Standards. GMEE aims for one product, one test and one certificate, by promoting the harmonization of national standards with International Standards.

More information on IECEE: www.iecee.org

The IECEE GMEE is a globally harmonized programme for checking and certifying motor efficiency
Powering devices and equipment

Very strict constraints for batteries, their containers and battery-powered devices in Ex areas

Claire Marchand

Batteries come in all forms and shapes and are probably the most common and widespread means of energy storage. From the AA or AAA type you buy at your local supermarket to the highly-sophisticated new generation of batteries used in smart portable devices, there are millions of products on offer. Not to forget electric vehicles (EVs). To increase their capacity and minimize their size, the batteries that power them are the focus of intense research and development throughout the world.

Extensive use

Whether off-the-shelf or specially-designed cells, primary or secondary (rechargeable) batteries are all built on the same model: one or more electrochemical cells that convert stored chemical energy into electrical energy.

Lead/acid batteries or alkaline (nickel-cadmium, nickel-metal hydride or lithium ion) rechargeable batteries are used in all kinds of small devices, such as computers, smartphones, tablets and cameras. Their large-capacity counterparts are commonly used in transport (EVs, industrial EVs, buses and trucks) and in UPS (uninterruptible power supply) systems.

Ex environments multiply the risks

These same batteries are used extensively by the explosive (Ex) industry sector. The people working in flammable and potentially explosive conditions depend on battery-powered portable and fixed equipment such as walkie-talkies, lamps, gas detectors and air-monitoring devices. They may also operate electric forklifts and other industrial EVs within large facilities, plants and mines.

IEC and IECEx: mitigating risks

While the recharging of batteries, large and small, can be hazardous in itself – hydrogen and oxygen are usually produced inside the battery when charging – the risks are much higher in Ex environments.

This is why, in some cases, the batteries themselves, although very similar to their off-the-shelf counterparts, or the battery pack/box/container have to be designed and build in compliance with the very strict requirements enunciated in standards and specifications, most notably in IEC International Standards developed by IEC Technical Committee (TC) 31:

Equipment for explosive atmospheres. This is valid for small-capacity cells as well as for traction batteries (used in EVs).

Battery-operated devices are submitted to the same constraints. Their design and manufacture must be able to withstand the harshest and most extreme environmental conditions. They have to be well insulated and explosion-proof.

Certification needed

Designing and building batteries and containers in compliance with IEC International Standards is not enough. To ensure that any piece of equipment meets the required criteria, it has to be tested and certified. Products associated with a certificate of conformity can be used safely in hazardous environments.
Claire Marchand

In the past, a little knowledge in mechanics was all it took to do minor repair on your car. Nowadays you probably need a degree in IT engineering to perform even the most mundane type of maintenance on your vehicle.

From the beginning...

Automotive electronics appeared in the 1970s to control engines. The first electronic control units (ECUs) handled basic functions such as ignition timing and transmission shifting. Thanks that makes a real difference. They know that they operate in the best possible conditions and minimize the risks inherent to Ex sector.

United Nations endorsement

With its three Schemes, IECEx covers all aspects of conformity assessment in the Ex field. In addition to equipment and personnel, the System also provides testing and certification for service facilities that repair and overhaul Ex equipment. Its global scope has been reinforced by the endorsement it received from the United Nations through the UN Economic Commission for Europe (UNECE) as the internationally-recognized certification system for promoting the safety of equipment, services and personnel associated with devices, systems and installations used in explosive areas.

Increased level of security

Manufacturers who rely on IECEx for the testing and certifying of their equipment, who have their staff go through the steps necessary to obtain a Certificate of Personnel Competence, have that additional level of security that makes a real difference. They know that they operate in the best possible conditions and minimize the risks inherent to Ex sector.

Access to certificates anytime, anywhere

IECEx has developed mobile applications for iOS, Android tablets and smartphones, that can be found at the Apple App Store and Google Play. They install simplified versions of the main IECEx online Certificate System covering the three Schemes and allow the user to synchronize the Ex mobile apps with the IECEx online Certificate System, as required. The offline mode provides advanced search capability and certificate abstracts (simplified details), while the online version gives the full details of the Certificates.

For more information on IECEx: www.iecex.com

Intrinsically safe indicator for explosive environment with Ex-proof battery pack (Photo: Optima Scale)

Electronic fuel injection systems appeared in the early 1980s (Photo: StreetTrucks/Brandon Lillie)

Battery-powered explosion-proof LED flashlight (Photo: Larson)

Intrinsically safe indicator for explosive environment with Ex-proof battery pack (Photo: Optima Scale)
to the development of sensors and microprocessors, mass-produced vehicles began to be equipped with electronic fuel-injection systems in the early 1980s. Over the years, active safety systems – anti-lock braking, traction and skid control, suspension control – were added first to luxury models before becoming the norm for all types of cars.

...to smart cars
Since the early 2000s, automotive electronics has seen major developments, linked to sonar, radar and laser emitters performing a wide array of functions, e.g. blind spot detection, adaptive cruise control and park assist systems, automated braking and distance-keeping via smart cruise control. But they haven’t stopped at safety and driver-assistance issues. Passenger comfort and infotainment systems are now fitted in many new models.

This is just the beginning as we have now entered into the world of smart autonomous, always-connected vehicles.

Communication between vehicles and with infrastructure
Not a day goes by without news of driverless vehicles being tested in traffic somewhere around the world. They’re not quite ready yet but should become reality probably sooner than we think.

Meanwhile, car-to-car (V2V) and car-to-infrastructure (V2I) communication is developing at a rapid pace and in the near future could help avoid traffic jams and accidents, making the roads safer than ever.

Reliability is a must
At the basis of all these developments, as is the case for all electronic devices and equipment, are electronic components. As the technologies that allow cars to become smarter by the day and to communicate with one another and with infrastructure take off, people will come to rely on the signals and warnings their car gives them. It is therefore of the utmost importance that the components that underpin these technological advances be of highest quality. The use of substandard or faulty components may have dire, if not lethal consequences.

Safer components for smart technologies
To ensure that the technologies being developed for vehicles around the world are reliable, IECQ, the IEC Quality Assessment System for Electronic Components, created a programme that gives the automotive industry a standardized way of testing the components in those technologies. The IECQ Automotive Qualification Programme (IECQ AQP) helps automotive manufacturers avoid multiple tests and related costs. It can also be used by independent, third-party certification bodies to make sure that components meet automotive industry standards.

Organizations that hold IECQ Automotive Qualification Programme Certification show the international market that they and their facilities comply with the requirements of the IECQ System. These organizations are also demonstrating that they comply with the relevant declared technical Standards and specifications for their scope of activity.

The future may bring us cars that help keep us safe and speed up our trips during rush hour and IECQ will continue to ensure that the electronic and electrical components in our vehicles do not fail us when we need them most.

More information: www.iecq.org
The “Internet” of Energy
Building one global grid with electricity superhighways

Gabriela Ehrlich

On 30 and 31 March 2016, the first International Conference on Global Energy Interconnection (GEI) took place in Beijing, China. The event was initiated by State Grid Corporation of China (SGCC), the International Energy Agency (IEA), the Edison Institute and Caring for Climate (C4C), and co-organized among others with the IEC. Dr Shu, IEC Vice President and President of SGCC, and Frans Vreeswijk, IEC General Secretary & CEO, both presented how such a vision can be brought to reality, to an audience of more than 500 people.

At the United Nations Sustainable Development Summit held on 26 September 2015, China’s President Xi Jinping proposed the establishment of a global energy network to facilitate efforts to meet the global power demand with clean and green alternatives.

Electricity consumption will double
According to the OECD, by 2040, developing countries will use double the electricity developed countries use today. Electricity is central for food production, poverty reduction, better healthcare and overall economic development. However, one in five people still lacks access to modern electricity. Three billion people rely on wood, coal or animal waste for cooking and heating.

Fossil fuels still preferred
The current and projected large-scale development and use of fossil fuels for energy generation in developing countries results in serious problems. Those include a heavy financial burden, environmental pollution and climate change, all of which negatively impact often weak economies. The burning of fossil fuels is responsible for 56.6% of greenhouse gases and 73.8% of total CO₂ emissions.

Limited reserves
Fossil fuel reserves are limited. According to statistics, at present rates of consumption, coal reserves will last 113 years, oil 53 years and natural gas 55 years. For oil, some estimates are as low as 25 years.

Clean energy for all
With this backdrop in mind, it becomes clear how important this vision for global energy interconnection really is. GEI opens up an unprecedented opportunity to globally share the resources of the whole planet and achieve a greener, more sustainable future. It could guarantee the effective exploitation of clean energy to ensure a reliable energy supply for everybody, anywhere in the world.

Always on
Sun, wind and ocean power offer immense power reserves, many times more than we will ever need. The vision of GEI pictures that all power grids would be linked. Rather than balancing a power grid at the local level, energy integration could be coordinated at the global scale: the sun shines 24/7 and wind always blows somewhere. By interconnecting grids, renewable energy could be used as a primary energy source. Electricity could be consumed immediately for electric vehicles, electric heating and cooling, replacing coal and oil in most applications.

At the UN Sustainable Development Summit in September 2015, China’s President Xi Jinping proposed the establishment of a global energy network

Three billion people still rely on wood, coal or animal waste for cooking and heating
Huge complexity
GEI comes with an augmented set of challenges; it is technically highly complex. International Standards will be indispensable to pre-address this complexity and provide the building blocks that innately contain solutions that will enable this vision.

The need to build confidence
In GEI infrastructures will be highly interdependent. To give nations the confidence to consider the opportunities, GEI offers require a standard way of designing and building the many infrastructure layers that will have to interact.

Dependability will be key
While dependability is to be expected as a basic characteristic of all energy infrastructures, GEI will require a level never seen before. This level will have to result from explicit decisions regarding overall availability – the number of 9s to be achieved – and directly embedded into infrastructure design, from the start. Measuring it after the fact or adding it later will not be an option. International Standards will play a crucial role in mastering this level of dependability upfront.

System of many systems
GEI will probably become the most complex system ever built.

It will further elevate the concept of “systems of systems”. The good news: it will fully benefit from the unique and unprecedented systems approach that was pioneered in the IEC; an approach that aims to combine the global expertise of many experts from many standards organizations.

A systems testbed
Jeju island signs MoU with IEC and KATS

Gabriela Ehrlich
On the way to the COP21 climate talks in Paris, Jeju Governor Won Hee-ryong made a stop at the IEC in Geneva. During the meeting the idea surfaced to sign an MoU to simplify the development of a carbon-free infrastructure for the Korean island, notably with the help of IEC International Standards.

The Jeju Special Self-Governing Province presented its ambitious vision to lead global low carbon green growth in Paris. By 2020, the island is planning to put in place a carbon-free infrastructure comprising a Smart Grid, broad electric vehicle (EV) network, renewable energy generation and more.

Giving preference to International Standards
As part of this engagement Jeju will – whenever applicable – give preference to IEC International Standards for its infrastructure development. Jeju experts will also participate in IEC standardization activities via the Korean IEC National Committee, which is hosted by the Korean
Agency for Technology and Standards (KATS).

The MoU was signed during a special ceremony that was held on 21 March during the 3rd International Electric Vehicle Expo (IEVE), in the presence of the media. The IEC was represented by Dr Junji Nomura.

Limit variations
One of the reasons for this agreement is to avoid proprietary industry specifications, for example for EVs. These tend to make charging infrastructure development more costly and more complex than necessary. They can also create a dilemma: which plugs should be given preference when it is impossible to install all of them? In Governor Won’s experience, such a situation can quickly become a source of conflict in neighbourhoods where some car owners may have trouble finding a charging station that fits their needs.

Help identify gaps
As part of the agreement, the three partners plan to regularly exchange information on standardization and conformity assessment for EVs, Smart Grid, Smart Cities, microgrids, renewable energy generation and other relevant IEC standardization and conformity assessment work. Jeju plans to participate in IEC standardization through KATS and to provide feedback that could be useful for IEC Systems Standards, notably in identifying gaps, facilitating use case collection and generally act as a testbed for new Systems Standards.

Underlined IEC work for EVs
During his stay in Jeju, the IEC President – at Governor Won’s invitation – also helped officially open the 1st International Conference on Electric Vehicle Smart Grid and Information Technology that started on 21 March 2016.

Dr Nomura provided an overview of IEC work for EVs and for the overall electric infrastructure, which was well received by an audience of more than 500 people.
CAV driving into the future
Update on connected, self-driving vehicles

Fatima Ahmed Alkhoori, UAE, IEC 2015
Young Professional Leader

One of the most innovative transportation developments today is Connected and Autonomous Vehicle (CAV) technology. According to U.S. Department of Transportation’s National Highway Traffic Safety Administration (NHTSA), CAV is defined as “operation of the vehicle occurs without direct driver input to control the steering, acceleration, and braking; and designed so that the driver is not expected to constantly monitor the roadway while operating in self-driving mode.”

CAV technology is taking off
The development of this technology falls under the Intelligent Transport System (ITS) category, an advanced innovative application that aims to provide smarter modes of transport and traffic management. The main objective of ITS is to enable users to have safer trips and to have smarter, more coordinated use of transport systems.

According to a recent Boston Consulting Group study, the autonomous car market is estimated to hit USD 42 billion by 2025 and reach USD 77 billion by 2035. The Group projects that by 2025, 0.5% of cars on the roads will be self-driven, while by 2035 this is predicted to reach 9.8% of the market.

Advantages and disadvantages
As with any innovation, CAV technology brings both advantages and disadvantages. The main advantage is creating a safer environment through:

- Reduced congestion: applying CAV technology will enable larger road capacity as cars would be able to travel closer to each other.
- Improved emissions: according to a report published by the Intelligent Transport Society of America (ITSA) Projects, ITS could achieve a 2-4% reduction in oil consumption and related greenhouse gas emissions each year. The vehicles are likely to be electric powered to save on operating costs.
- Equity: the use of CAV technology will enable everyone to use cars without any difficulties, for example, people with disabilities, younger or elderly could use them.

One disadvantage of applying CAV technology is cost – as an advanced technology, the cost of CAV is considered to be within the high range. This might restrict some users from entering the market.

Another disadvantage is labour force implications – since CAV technology is fully automated, it would replace millions of drivers.

Furthermore, security and privacy need to be considered. Through the Internet, anyone with the right skills and resources could pinpoint the exact location of a person by tracing the vehicle when it is in motion and could then create a log of the person’s movements.

First international forum in Abu Dhabi
The first International Intelligent and Integrated Innovation Transport Systems Forum was held in Abu Dhabi in September 2015, hosted by the Department of Transport (DoT). The forum had a significant focus on CAV technology. ITS experts from all over the world actively
participated and discussions covered the latest developments, applications and solutions of connected and autonomous vehicles.

Regional moves
One of the major recommendations of the forum was to develop a Middle East ITS organization to assure that CAV technology develops in a standard and equitable way throughout the Middle East. Also it will help ensure that this entity is able to stand alongside similar organizations from the other continents and regions across the world.

The proposed Middle East ITS organization’s main mission is to represent all national and regional transport organizations (including, in the UAE, Federal and individual Emirate transport ministries or authorities) in order to develop a common vision of the CAV technology, enhance the mobility of people and goods, and further develop the region’s economy.

It is planned that the proposed Middle East ITS organization will present its strategy and future plans at the 2016 ITS World Congress, to be held in Melbourne, Australia, in October 2016.

The role of International Standards in CAV Technology Development
International Standards can play an increasing role in the faster adoption of CAV technology. As innovation increases, the chance of using CAV technologies across countries will increase. Therefore, the need for unified standards among countries is essential in order to increase the accessibility of this technology.

The IEC has currently several Technical Committees (TCs) which develop Standards related to CAV technology, for example, TC 69: Electric road vehicles and electric industrial trucks and TC 48: Connectors and connecting devices. Also ISO/IEC Joint Technical Committee (JTC) 1: Information technology, and its Subcommittees (SCs) develop International Standards for vehicle-to-grid communication, interconnection of ICT equipment, user interfaces, data management and security. IEC work ensures that Standards related to Electronic Vehicles (EVs) are developed with the knowledge of electrotechnical experts from around the world. IEC TCs are also studying and addressing important elements related to CAV technology such as safety and security.

Where to from here?
Today there is a far higher level of connectivity and autonomy in vehicles compared to 10 or 20 years ago. Wider use of CAV technology would help create an innovative environment, which will enable end-users to have easier smart trips. However, for end-users to adopt this technology it might take a long time. Cities
IEC FAMILY

need to continue to prepare digital communications infrastructure and technical infrastructure to facilitate wider use of CAV technology.

Moreover, commercial Connected and Autonomous Vehicles are not yet in the market, and before they arrive, a set of standards and regulations must be agreed among the countries worldwide to ensure that all industrial companies will have the same basic characteristics (e.g. Health and Safety standards) when it comes to CAV technology.

IEC Young Professionals Programme
This programme brings together the world’s upcoming expert engineers, technicians and managers and provides them with opportunities to shape the future of international standardization and conformity assessment in electrotechnology.

More information: http://www.iec.ch/members_experts/ypp/

IEC Young Professionals – 2016 Workshop, Frankfurt, Germany
The IEC Young Professionals – 2016 workshop will be held in Frankfurt, Germany, from 10 to 12 October, in parallel with the IEC 2016 General Meeting. Please contact your NC for further information.

More information: http://www.iec.ch/members_experts/ypp/workshop/

Recent nominations
The latest Chair nominations to IEC TCs approved by the SMB

Antoinette Price
Several IEC Technical Committees (TCs) have new Chairs, approved by the Standardization Management Board (SMB), who took up their nominations in March and April this year.

Theodor Connor
On 1 April 2016, Theodor Connor took up his nomination as Chair of IEC TC 99: System engineering and erection of electrical power installations in systems with nominal voltages above 1 kV AC and 1,5 kV DC, particularly concerning safety aspects. With a background in electrical engineering, Connor has worked at Siemens since 1999 in various positions and is currently strategic relationship manager. Since joining the TC, he has been a convenor and member of a number of groups. He brings with him expertise in strategic planning of transmission and distribution networks, grounding and interference as well as Smart Grids.

Connor has been voted Chair of IEC TC 99 for the period 2016-04-01 to 2022-03-31.

Akira Ono
Akira Ono took up as Chair of IEC TC 113: Nanotechnology standardization for electrical and electronic products and systems, on 1 March 2016. Holding a PHD in Solid State Physics, Ono is currently Special Advisor for the National Institute of Advanced Industrial Science and Technology (AIST). With an illustrious career in standardization spanning over four decades, Ono has been involved in different types of measurement technology, working at the National Metrology Institute of Japan (NMIJ) for 30 years. He has been a member of the Japanese national mirror committee to IEC TC 113 since 2007.

Ono has been voted Chair of IEC TC 113 from 2016-03-01 to 2022-02-28.

Fabio Gargantini
Fabio Gargantini began his term as Chair of IEC TC 61: Safety of household
and similar electrical appliances, on 1 April 2016. With a degree in electrotechnics, Gargantini has over 30 years of experience working for IEC and other standardization organization technical committees. Among these he was Chair of IEC TC 59: Performance of household and similar electrical appliances from 2006 to November last year.

Gargantini has been voted Chair of IEC TC 61 for the period 2016-04-01 to 2022-03-31.

Gianosvaldo Fadin
On 1 April 2016, Gianosvaldo Fadin began his term as Chair of IEC TC 9: Electrical equipment and systems for railways. Graduating with a degree in electronics engineering, Fadin is highly experienced in ICT systems and technologies, particularly for transport and energy management, with specific focus on railways. In addition to his participation in working groups in different standardization organizations, he is currently Chair of the IEC National Committee of Italy mirror committee TC 9, a technical advisor to the Italian Railway Industries Association, and member of technical group TRAM-TRAIN in the Ministry of Transportation.

Fadin has been voted Chair of IEC TC 9 from 2016-04-01 to 2022-03-31.

Arnaud Ulian
Arnaud Ulian began his term as Chair of IEC TC 57: Power systems management and associated information exchange, on 1 April 2016. Ulian currently heads up EDF R&D Department MIRE (Smart Grid and Smart Meter). Since 2012, he has been heavily involved in Smart Grid standardization activities at European and international levels. In particular, he has been Convenor of Working Group (WG) 6 of Systems Committee (SyC) Smart Energy, in charge of publishing generic Smart Grid use cases which will serve as references for developing Smart Grid Standards.

Ulian has been voted Chair of IEC TC 57 from 2016-04-01 to 2022-03-31.
Charging EVs at home safely and reliably
New IEC International Standard covers residential charging

Morand Fachot

As sales of personal electric vehicles (EVs), and in particular of plug-in EVs, expand rapidly, trust in the safety and reliability of charging equipment components is important for users. Several IEC Technical Committees (TCs) and Subcommittees (SCs) develop International Standards for all components in the EV charging chain. The latest one prepared for residential charging installations has just been published.

Long-time involvement
IEC TC 69: Electric road vehicles and electric industrial trucks, has been developing International Standards for EV charging for a long time. The first edition of its IEC 61851-1, Electric vehicle conductive charging system – Part 1: General requirements, was published in 2001, with three other Standards in the series following later. It is working on developing additional Standards in the series.

IEC TC 69 has also recently published an International Standard for wireless power transfer (WPT) for EV charging. For its part, IEC SC 23H: Plugs, socket-outlets and couplers for industrial and similar applications, and for electric vehicles, has published three International Standards in the IEC 62196 series of Standards for plugs, socket-outlets, vehicle connectors and vehicle inlets for conductive charging of EVs. The first, IEC 62196-1, which covers general requirements, came out in 2003. IEC SC 23H is also working on developing additional Standards in the series.

A new entrant to the development of International Standards for EV charging is IEC SC 23E: Circuit-breakers and similar equipment for household use, which has just published IEC 62752:2016, In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD).

Significant Standard
IEC 62752 is a highly significant International Standard as it concerns the safety of EV charging installations for Mode 2, the recharging mode defined for residential charging. According to IEC 61851-1, Mode 2 charging refers to the “connection of an EV to the AC supply network (mains) not exceeding 32 A and not exceeding 250 V AC single-phase or 480 V AC three-phase, using standardized single-phase or three-phase socket-outlets [...]”

This is important in view of the growing popularity of plug-in EVs. By mid-September 2015, the global number of plug-in EVs had broken the one million mark, with all-electric EVs accounting for 62% of the total and plug-in hybrid EVs making up the remaining 38%.

Vital part in the charging chain
The in-cable control and protection device (IC-CPD) is “an assembly of linked parts or components including cables, plug and vehicle connector for supplying electric vehicles in charging mode 2, which performs control functions and safety functions”. These control and safety functions are integrated in appropriate enclosures – function boxes – which form part of the IC-CPD. The function boxes are located in detachable cable assemblies, connectors or plugs that are not part of the fixed installation.

Comprehensive Standard
In addition to the usual relevant terms and definitions, IEC 62752 covers:
• the different types of IC-CPD classification, i.e. according to supply, construction, method of connecting the cable(s), protective conductor path and behaviour in case of open conductor
• the characteristics of IC-CPDs according to rated quantities (rated voltage, rated and residual currents, breaking capacity, etc.) and standard and preferred values (of rated operational voltage and current, breaking capacity)
• standard conditions for operation in service and for installation
Miners had learnt the hard way that their jobs were fraught with risks – fire damp, methane accumulation or suspended coal dust – when electric power was introduced. All it took to ignite methane for instance was a spark emitted by a lighting fixture or a motor. And the rapid growth of the oil and gas industry in the 20th century and the numerous accidents and explosions that occurred in oil drilling operations and refineries raised awareness of the dangers facing those working in this sector.

The need to develop specific techniques to reduce or eliminate the risk of explosion for electrical equipment used in hazardous areas involving gases, vapours and mists led the IEC to establish Technical Committee (TC) 31: Equipment for explosive atmospheres. That was in July 1948.

Early involvement of the IEC
The TC and its Subcommittees (SCs) have published International Standards – the IEC 60079 series – covering the life-cycle of electrical equipment from design and manufacture to installation, maintenance and repair. Area classification and inspection are also addressed in TC 31 publications.

For close to 70 years, the TC and its Subcommittees (SCs) have published International Standards – the IEC 60079 series – covering the life-cycle of electrical equipment from design and manufacture to installation, maintenance and repair. Area classification and inspection are also addressed in TC 31 publications.

Comprehensive tests covering all the above conditions and requirements, plus others such as a hot damp test for tropical environments or the capacity of the function box to resist damage if driven over by a vehicle.

The very comprehensive scope of IEC 62752 means that users of EV residential charging installations meeting this Standard can be confident that their equipment is safe, reliable and well suited to their needs.

Extended scope
To meet industry needs, the mining sector in particular, decision was made in 2007 to initiate standardization work addressing non-electrical equipment used in explosive atmospheres.

In 2007, a joint decision made by the IEC and the International Organization for Standardization (ISO), through the IEC Standardization Management Board (SMB) and the ISO Technical Management Board (TMB), led to the establishment of SC 31M: Non-electrical equipment and protective systems for explosive atmospheres.

Non-electrical equipment is defined as “equipment which can achieve its intended function mechanically”. Protective system is defined as “devices other than components of the equipment which are intended to halt incipient explosions immediately and/or to limit the effective range of an explosion”.

SC 31M is authorized to produce both ISO and ISO/IEC International Standards within IEC and IEC TC 31. The development process occurs according to IEC procedures but voting on Committee Draft for Vote (CDV) and Final Draft International Standard (FDIS) documents is conducted in parallel.
with each organization following its own rules for voting.

While all International Standards developed by IEC TC 31 and its SCs follow the IEC numbering, i.e. IEC 60079-x, SC 31M publications are in the ISO/IEC 80079-x series. The first Standard issued by SC 31M was ISO/IEC 80079-34, Explosive atmospheres – Part 34: Application of quality systems for equipment manufacture, in 2011.

**Electrical and non-electrical for the mining sector**

Most of the electrical equipment used on mining machinery is certified as an individual item of equipment, e.g. the motor or the switchgear, and meets its own marking requirements. This certification, however, does not deal with the interconnection of these items of equipment by cables or with the machine electrical power system as an entity. The equipment and components, including their interconnections, should be assessed, from an ignition point of view, by the manufacturer. Both non-electrical equipment and the interconnection of electrical/non-electrical equipment require an ignition hazard assessment.

**New publications**

New International Standards were added to the series in February 2016. Two were dual logo:

- The first, ISO/IEC 80079-20-2, Explosive atmospheres – Part 20-2: Material characteristics – Combustible dusts test methods, describes the test methods for the identification of combustible dust and combustible dust layers to permit classification of areas where such materials exist. This in turn allows the proper selection and installation of electrical and mechanical equipment in the presence of combustible dust. This first edition cancels and replaces the first edition of IEC 61241-2-1 published in 1994, the first edition of IEC 61241-2-2 published in 1993 and the first edition of IEC 61241-2-3 published in 1994, combining the requirements into a single document.

- The second, ISO/IEC 80079-38, Explosive atmospheres – Part 38: Equipment and components in explosive atmospheres in underground mines, specifies the explosion protection requirements for the design, construction, assessment and information for use (maintenance, repair, marking) of equipment that may be an individual item or form an assembly. This includes machinery and components for use in mines susceptible to explosive atmospheres of firedamp and/or combustible dust. It also deals with the prevention of ignitions of explosive atmospheres caused by burning (or smoldering) of combustible material such as fabric fibres, plastic “O”-rings, rubber seals, lubricating oils or greases used in the construction of the equipment if such items could be an ignition source.

Two others were published under the ISO logo:

- ISO 80079-36, Explosive atmospheres – Part 36: Non-electrical equipment for explosive atmospheres – Basic method and requirements
- ISO 80079-37, Explosive atmospheres – Part 37: Non-electrical equipment for explosive atmospheres – Non electrical type of protection constructional safety “c”, control of ignition source “b”, liquid immersion “k”
Augmented reality / Virtual reality

Augmented reality (AR) and virtual reality (VR) technologies are still at an early development stage but evolving at an extremely rapid pace. Will one prevail over the other in future? Will they develop in parallel, serving different purposes and need? Time will tell.

Issue 04/2016 of e-tech will focus on a number of issues related to augmented reality and virtual reality. Among those the use of VR in the aviation and maritime sectors to train crews, AR/VR as assets in the leisure and tourism industry, in multimedia and entertainment, in manufacturing and in healthcare. The issue will also look closely at how to ward off cyberthreats in industry installations and shipping at a time when the evolution of automation and new technologies is faster than ever before.