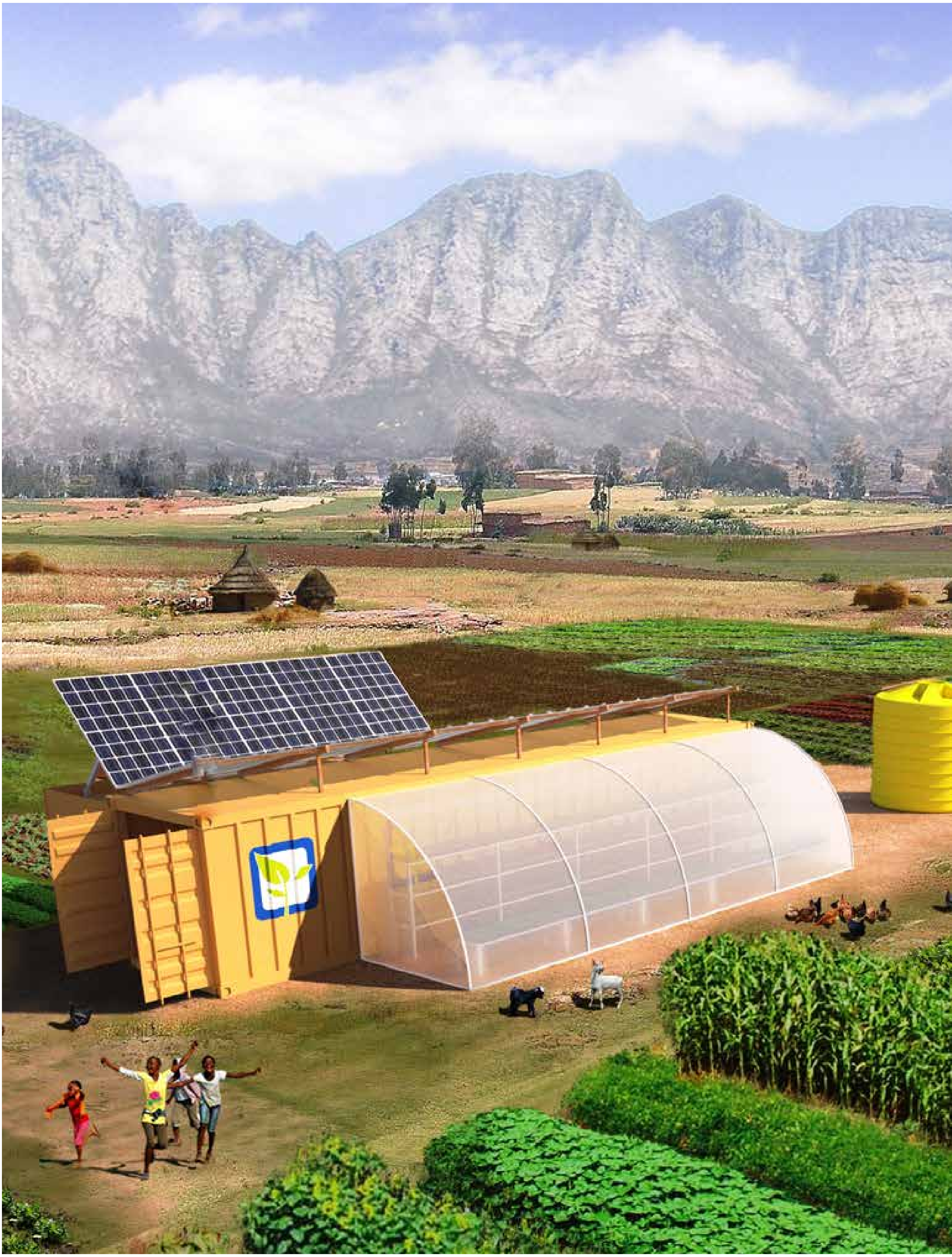
e-tech

A selection of articles from the IEC magazine

IEC work for renewable energy

International Electrotechnical Commission



IEC work for renewable energy

Countries around the world are increasingly hedging their bets on renewable forms of energy to replace polluting ones, in line with the 2015 Paris climate agreement. The global convention which has been agreed by 190 nations worldwide aims to mitigate global warming through a series of targets and measures which includes the widespread switch to renewable energies.

The IEC develops and publishes the vast majority of International Standards for renewable energy systems that generate electricity from wind, solar, marine, hydro, biofuels or geothermal sources. The Standards also provide the methodologies, metrics and processes that form the basis for testing and certification.

This brochure contains a selection of articles from our magazine, e-tech, on the work of IEC for renewable energies.

Cover photo credit: General Electric

Ten years of marine energy standardization

IEC work helps lay the foundations of an emerging renewable energy sector

By Antoinette Price

Today, a number of different technologies are being developed to extract energy from oceans, such as tidal, river and ocean current and wave power. Though only a few large-scale systems currently operate, several are being demonstrated in Asia, Europe and North America.

Slowly but surely

While marine energy has a great and often predictable source of power, important engineering challenges have restricted the scale of projects. These include operating in difficult conditions, and the effect the technology has on marine life and other marine users, such as the shipping and fishing industries. According to a report by the International Energy Agency (IEA), global ocean energy capacity in 2014 was 0,53 GW.

IEC leads the way

The growth of renewable energy (RE) globally, including the emerging marine RE sector, is dependent on the development of International Standards and the verification of compliance to these. Third-party verification to consensus-based standards reduces marine energy equipment and project risk, improves their safety, performance and reliability, which increases confidence in the marketplace.

Against this backdrop, IEC Technical Committee (TC) 114: Marine energy - Wave, tidal and other water current converters, was established in 2007 to prepare International Standards for marine energy conversion systems.

Jonathan Colby is the third Chair of IEC TC 114. His involvement with IEC began in 2008 as a Subject Matter Expert developing Technical Specification IEC TS 62600-200 on electricity-producing tidal energy converters. Colby served as the US Technical Advisor to the US Technical Advisory Group prior to his appointment as Chair. “Our work is crucial to developing the marine energy industry. If an industry can collectively establish technical standards and certification processes via global consensus, not only can international markets evaluate technology viability fairly, they can do it more efficiently and ultimately, it will lead to the confident adoption of Marine Energy technologies worldwide”, said Colby.

Powerful tidal stream devices aim to produce electricity on a commercial scale (Photo: waveenergyconsortium.com)

Achievements

Comprised of 15 participating countries and 11 observers, IEC TC 114 has seven active project teams, which are developing new Technical Specifications (TSs), two maintenance teams and six ad-hoc groups, which are working on strategies for the next steps of the eight existing TSs.

The ultimate goal is for these publications to become International Standards, which will address:

- system definitions
- management plan for technology and project development
- performance measurements of wave, tidal and water current energy converters
- resource assessment requirements, comprising:
  - design and safety including reliability and survivability
  - deployment, operation, maintenance and retrieval
  - commissioning and decommissioning
  - electrical interface, including array integration and / or grid integration
  - testing: laboratory, manufacturing and factory acceptance
  - measurement methodologies of physical parameters of the device

The work is varied and involves liaising with other IEC TCs, which cover: hydraulic turbines (IEC TC 4), systems aspects for electrical energy supply (IEC TC 8/SC 8A), wind energy generation systems (IEC TC 88), and international organizations, such as the IEA and its Ocean Energy Systems and the International Organization for Standardization (ISO).

Given that the industry as a whole continues to grow, a Task Force has been established to review the strategic business plan to take into consideration global market developments and needs.

Part of a global RE scheme for quality assurance

In 2014, IECRE, the IEC System for Certification to Standards Relating to Equipment for Use in renewable energy Applications, was created in recognition that the ever-increasing demand for electricity, and the need to reduce the share of fossil fuels in power generation, have led to rapid development and growth of the RE sector, and to address the specific requirements of the RE sector, which are not covered by the existing IEC Conformity Assessment Systems.

Marine energy technology must not harm the local environment (Photo: Activ' Company)

IECRE aims to facilitate international trade in equipment and services for use in RE in the marine, solar PV and wind energy sectors, while maintaining the required level of safety. Each of these sectors will be able to operate IECRE Schemes that cover products, services and personnel, to provide testing, inspection and certification.

Jonathan Colby has dedicated much time to setting up the marine sector of IECRE in his role as Chair of the Marine Energy Operational Management Committee (ME-OMC). Equally, the publications of IEC TC 114 will be used in the System as the benchmarks against which to assess marine energy systems. Work has begun to promote IECRE at international events, such as IRENA Innovation Week 2016, and Hydrovision International 2017.

"The ME-OMC has made significant progress outlining the rules and operating procedures for issuing Test Reports and Conformity Statements, the underlying components of deliverables such as Prototype and Type Certificates, among others. Focus will shift to the essential work of peer assessing renewable energy Test Labs (RETLs) and Renewable Energy Certification Bodies (RECBs), both with a scope in Marine Energy, following Member Body approval of the critical Rules and Operational Documents (ODs). Simultaneously, close collaboration with IEC TC 114 enables important feedback between the Standards writers and the certification community, essential for the success of TC 114, the ME-OMC and the Marine Energy Sector at large", Colby concludes.

Plug and play for refugees

Low-cost technologies are helping refugee camps get some basic comforts

By Catherine Bischofberger

Access to clean and affordable energy for all is a sustainable development goal for the United Nations and the IEC is contributing to the effort with a number of its International Standards. While access to electricity remains an issue for many of the world's poorest, refugee camps are finding that cheap solar energy is a way of overcoming the odds.

One of the horrendous consequences of natural disasters is that people can lose their homes and virtually all their belongings in one fell swoop. Many are then forced to live in emergency shelter situations or join the ranks of people who have fled war zones or famine situations to dwell in refugee camps. According to the Office of the United Nations High Commissioner for Refugees (UNHCR), there are 2,6 million refugees in the world who have lived in camps for over five years. While the distress of their predicament cannot be understated, several low-cost technologies are helping them find some level of comfort and solace.

Here comes the sun

Solar energy is the thread linking them together. Solar Pico Systems (SPS) are cheaper than traditional photovoltaic systems because they use much smaller compact and lightweight solar panels to generate a small amount of electricity to power low energy-requirement objects such as lamps or mobile phones. SPS are plug and play and generally cost under USD 200. The development of SPS goes hand in hand with the increasing use of light emitting diode (LED) technology: LEDs can provide bright electric light with very little electric power and are much more efficient than conventional incandescent lamps. Rechargeable batteries are also part of the mix. Lithium-ion batteries may still be a little expensive but they have a high energy density allowing for additional

Safe lighting is one way to improve housing for refugees

IKEA has teamed up with UNHCR to provide a shelter equipped with a solar panel roof (Photo: Better Shelter)

charge/discharge cycles. They are also small and provide comparatively great Energy Efficiency.

There are two types of SPS available: Pico solar lanterns which provide light but can also provide energy to charge a mobile phone or operate a radio and Pico PV Home Systems which can provide energy for several lights, mobile phones and radios. The advantage of Home Systems is that they are scalable and can meet growing electrical demands.

Ikea flat-pack

SPS technology is already improving the lives of refugees as it replaces dangerous, expensive and toxic kerosene lights in camps around the world. Examples abound, starting with the work accomplished by the Global Bright Light Foundation, a non-profit outfit which aims to bring safe, healthy and cost-effective solar power to people living without access to electricity. The foundation helped refugees in the Kiziba camp adjacent to Lake Kivu in Rwanda get access to light by supplying them with solar lanterns. As a result, women and children in the camp felt safer, especially when they had to use the camp latrines at night time.

Similarly, IKEA has teamed up with the UNHCR through its not-for-profit foundation to provide a flat-pack self-assembly refugee shelter equipped with a solar panel roof. The pack fits into two boxes and can be assembled by four people in four hours following the Swedish company's familiar picture-based instructions. The solar roof provides four hours of electric light or mobile phone charging via a USB port. The shelter, which is made of insulated polypropylene panels, costs USD 1 250. While this is more expensive than a tent, it provides a secure, weather resistant shelter which will last at least three years. Médecins Sans Frontières employed the shelters as clinics following the deadly 2015 earthquake in Nepal. Many are used in Irak and in Djibouti for refugees fleeing Yemen.

Big (solar!) farm

Plans are afoot for using solar energy on a wider scale. The UNCHR, together with the Jordanian government, has opted to develop a power grid and solar power plant for the Asraq refugee camp which is situated in the Jordanian desert. The camp is home to 50 000 Syrian refugees and while solar lanterns are used, most of the power is generated by diesel generators. The decision was taken partly

because it fitted in with the Jordanian Government's target of increasing the contribution made by renewable energy to its electrical needs. But according to the UNCHR, it will also reduce the cost of electricity in the camp as well as making it more widely available and cleaner for the environment. The plant will fully meet the electricity needs of the camp and any surplus will be sold to neighbouring communities.

Asraq is the first refugee camp to be powered by a solar plant but the UNCHR views it as an example for other camps to follow.

Crucial and renewable

The IEC has published a wide number of International Standards in the field of renewable energies and has focused its considerable expertise on solar energy. Some of this work comes under the remit of IEC Technical Committee (TC) 82: Solar photovoltaic energy systems which includes SPS. Larger installations are within the scope of IEC TC 117: Solar thermal electric plants. The TC prepares International Standards for systems of solar thermal electric (STE) plants for the conversion of solar thermal energy into electrical energy and for all the elements (including all sub-systems and components) in the entire STE energy system. Another Committee involved in the lighting field is IEC TC 34: Lamps and related equipment for general, professional and emergency lighting. On the battery front, IEC TC 21: Secondary cells and batteries works on Standards related to renewable energy, for instance the IEC 61427 series.

Quality control is also ensured thanks to the essential work carried out by the IEC in the area of conformity assessment. Global testing and certification systems offered by IECEE the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components guarantee that equipment like SPS and solar plants meets the required quality, performance and efficiency benchmarks, as defined by IEC International Standards. IECQ, the IEC Quality Assessment System for Electronic Components, has put in place the IECQ Scheme for LED Lighting that can be applied to certify manufacturers and suppliers of electronic components, modules and assemblies used in the production of LED packages, engines, lamps, luminaires and associated LED ballasts/drivers.

Smart and sustainable utilities enabled by standardization

IEC Chair for Systems Committee on Smart Energy gives keynote address

By Antoinette Price

Richard Schomberg, Chair of the IEC Systems Committee (SyC) for Smart Energy and IEC Ambassador, spoke at the Metering India - Towards smart and sustainable utilities event in New Delhi, organized by the Indian Electrical and Electronics Manufacturers' Association (IEEMA) and endorsed by IEC.

Transformation through industry digitalization

Utilities, consultants, businesses, regulators and manufacturers discussed how information and communication technology can make Indian power utilities more sustainable. Topics covered metering, communication technologies, demand-side management, IT infrastructure and sustainable business processes.

The rapid evolution of Smart Energy

Schomberg explained that in order to realize the full potential of Smart Energy, utilities need to modernize their infrastructures, improve operations and enhance cost efficiencies first, with the ultimate goal of becoming customer-centric companies that can offer more value-added services to the end-consumers.

"A strong Smart metering infrastructure with robust advanced data management is most of the time a foundation for flexibility and customer engagement. It then enables the full value of a modernized grid benefiting from digitalization, and decentralization". The fast pace of technology development, coupled with blooming Smart Energy initiatives means the electric meter now sits at the crossroads of Smart Energy and has become very critical. One of the great challenges is the complexity and deep impact of large scale deployment.

IEEMA event, Metering India - Towards smart and sustainable utilities

A systems approach is the way

Against this backdrop, systems engineering and open International Standards will be necessary to pre-resolve the complexity of smart metering technology. This would comprise the harmonization of Standards and specifications for device level interoperability across nations.

"IEC is pioneering the system approach for smart energy, and is committed to deliver an enabling portfolio of technical International Standards for sustainable development on all dimensions", said Schomberg. The work of IEC SyC for Smart Energy includes providing systems level standardization, coordination and guidance in the areas of Smart Grid and Smart Energy, including interaction in the areas of heat and gas.

Richard Schomberg, Chair of the IEC Systems Committee for Smart Energy gives keynote address

When power fails

Microgrids limit the disruption caused by large-scale power outages

By Catherine Bischofberger

Power failure recovery is a key task for governments, hospitals and private businesses to get to grips with if they want to reduce the disruption caused by power outages resulting from natural disasters. Smart and microgrids are one of the solutions and the IEC is leading the way with the appropriate Standards.

Extreme weather

The rate at which natural disasters strike different areas of our planet seems to be on the increase. Some of the worst catastrophes have occurred over the last 20 years. These include the Boxing Day tsunami in 2004 which affected a number of countries in South East Asia, the Haiti earthquake of 2010 and Hurricane Sandy which hit the North Eastern coast of the US in 2012. All three wreaked havoc, death and destruction and hugely disrupted the lives of millions of people. One of the results of such widespread disruption is large-scale and long-term power outages. These affect individual homes and businesses, of course, but even more crucially, hospitals and government bodies, hampering their efforts to bring help to the people who need it the most.

Blacked-out Lower Manhattan in the aftermath of Hurricane Sandy

The IEC White Paper *Microgrids for disaster preparedness and recovery* reports that the Japanese 2011 Fukushima disaster, for instance, killed 15 000 people and destroyed four nuclear reactors, resulting in widespread blackouts which affected at least four million homes. The number and duration of power outages in the US is driven primarily by weather-related incidents. There are only three main US power grids, East, West and Texas, with a relatively low number of underground cables, making the country particularly vulnerable on the power supply front. Australia is in a similar situation.

Even though Europe fares better on the whole, it is still not immune to the increasing problem of extreme weather. Parts of Europe are powered by a synchronous grid, which supplies more than 400 million customers in 24 countries. According to figures published by the Council of European Energy Regulators, Germany, which has one of Europe's most reliable grids, had 12 minutes and 42 seconds outage in 2015 due to disruptions caused by extreme weather, slightly up on the previous year.

One of the measures used to compare different countries is the System Average Interruption Duration Index (SAIDI). According to this benchmark, countries like Japan can have as little as six minutes outage over one year compared to more than 24 hours in Brazil, for instance. The figure is even higher in countries like Colombia or Bangladesh.

Japan bets on microgrids

Japan is an interesting case because it is regularly subjected to earthquakes and extreme weather situations but has one of the shortest outage times in the world. Even before the Fukushima disaster, the country had already invested in microgrid technology which helped it better deal with the huge challenges it faced in the wake of the earthquake and resulting tsunami.

Massive power outages are often the result of natural disasters (Photo: Tyler White/The San Antonio Express-News via AP)

In the aforementioned White Paper, the IEC looks at how Japanese infrastructure was affected and reacted during the 2011 disaster, focusing on data centres and medical facilities. The paper gives examples of how microgrid technology enabled some of the afflicted areas to continue to function. According to the IEC document, the Sendai microgrid, for instance, enabled the continued supply of services immediately after the earthquake, using energy from solar cells and storage batteries. Since the gas supply network in the city of Sendai was intact, the gas engine generators were soon able to restart after power failure at the utility grid and function as the main power supply of the microgrid. This ensured that patients in the hospital and in the medical and welfare buildings of the city survived.

Following the 2011 disaster, the country sped up its investment in microgrid and Smart Grid deployment. Japan's Ministry of Energy initiated a programme in 2014 to encourage microgrid development in the country. It makes funding available for independent demonstration projects such as electric vehicles for mobility and storage, renewable energy production and storage systems as well as energy efficiency optimization.

China sets smart goals

According to the United Nations, China is still the world's most populous country, with 1,38 billion inhabitants although it is on the verge of being caught up by India, where numbers are rising fast. Chinese energy needs are enormous and the country is still the largest user and importer of coal. China aims to reduce its reliance on coal in an effort to reduce air pollution and become a more energy efficient economy. That means increasing the proportion of renewable energy and Smart Grid-supplied electricity. China is the world's largest power generator

Hurricane Sandy wreaked havoc in its wake (Photo: Ken Cedeno/Corbis)

in the world, as well as the largest electricity user and its electricity generation is Smart Grid-supplied electricity. China is the world's largest power generator in the world, as well as the largest electricity user and its electricity generation is controlled by state-owned holding companies, although there is limited foreign investment too.

The country is seeking to improve efficiency and facilitate investment in the power grid. A Smart Grid World Forum was held in China in 2011 and the country announced at that point that it would invest USD 250 billion in electric power upgrade over the next five years and another USD 240 billion between 2016 and 2020, including USD 45 billion in Smart Grid technologies. According to press reports, the Chinese view Smart Grid technology as the next industrial revolution and 15 pilot programmes have been initiated across the country. The same press reports indicate that China sees standardization as key in helping it address its domestic energy challenges but also as enabling it to take a critical step towards playing a larger role in global technology markets.

IEC Standards pave the way

Standards are crucial in helping such new disaster-resilient technologies become widespread. The IEC is doing pioneering work in the area of smart electricity, by adopting a systems-based approach, with Systems Committee (SyC) Smart Cities and SyC Smart Energy.

The core IEC Standards relevant to Smart Grid technology are IEC 61970, *Energy management system application programme interface (EMS-API)*, IEC 61850, *Communication networks and systems for power utility automation*, IEC 61968, *Application integration at electric utilities - System interfaces for distribution management*, IEC 62351, *Power systems management and associated information exchange - Data and communications security*, IEC 62056, *Electricity metering data exchange - The DLMS/COSEM suite* and IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems.*

LVDC for sustainable electricity access needs standardization

IEC and KEBS host first global LVDC Conference

By Antoinette Price

First ever global LVDC Conference in Nairobi, Kenya

Over 170 participants from Africa, Asia, Europe, Latin and North America attended the Conference.

How to bring electricity to every home

IEC and the Kenya Bureau of Standards (KEBS) hosted the first ever low voltage direct current (LVDC) Conference for Sustainable Electricity Access, in Nairobi on May 22-23, 2017.

The aim of the Conference was to discuss how to bring adequate, clean, affordable electricity to the 1,2 billion people who go without.

Policy makers, funding agencies, project implementers, government and non-government bodies, technology research organizations, academia and field practitioners addressed the realities, challenges, and consequences of electricity access, or lack thereof. Topics included:

- → Defining electricity access with a view to developing LVDC International Standards
- → Funding electricity access programmes
- → Implementing projects, including the gap between assumptions and reality
- → Technological solutions to realize such projects

"An important outcome of the Conference is that industry leaders from electrotechnical companies across the world were really listening and now have a clearer idea of what the global community expects of the standardization community", said Vimal Mahendru, Chair, IEC Systems Committee, LVDC and LVDC for Electricity Access (SyC LVDC), and IEC Ambassador.

From left: Vimal Mahendru, Charles Ongwae, KEBS Managing Director, and Dr Joseph Njoroge, Principal Secretary of Ministry of Energy and Petroleum

Global development is a must

Many countries in the developing world are presently far from having 100% electrification and providing adequate electricity to all citizens. These countries urgently require electricity access standards. The IEC Affiliate Country Programme aims to enable these countries to get involved in the standardization process, and to adopt IEC International Standards. Fourteen Affiliate Country Members attended the Conference and their delegates also participated in subsequent IEC plenary meetings for LVDC standardization.

"The work of the LVDC standardization community will be considered done, only when there is electricity in every hut, home, village, town, district, state and country, and it should be clean, affordable, abundant and available 24 hours a day, every day of the week", said Mahendru.

A great outcome

During the Conference wrap-up, the delegates agreed on the following nine key points:

1. Genuine and wide demand for standardization of LVDC for purposes of electricity access
2. Clean energy on demand, also for cooking
3. The Energy Sector Management Assistance Programme (ESMAP) multi-tier framework (a global knowledge and technical assistance programme administered by the World Bank), is a good basis upon which to develop Standards
4. Funding is available and viable business models are now emerging (for example, pay-as-you-go (PAYG))
5. India has urgent needs, echoed across Africa – urgency for developing LVDC Standards for electricity access (DC off-grid microgrids, solar home systems, DC devices, quality, maintenance Standards)
6. Conformity assessment is an important integral part of effective electricity access programmes
7. DC devices are safe and reasonably priced; economies of scale will further lower costs
8. Learn from lessons from the Internet and mobile phones – increase the pie – add 1,2 billion electricity users

In developing economies, policy makers, regulators, funding agencies, utilities, practitioners, implementers, DC original equipment manufacturers (OEMs), users are demanding standardization

The Conference was co-sponsored by the Kenya Electricity Generating Company Limited (KenGen), the Institute of Electrical Installation Engineers of Japan, Eaton, Legrand, Schneider and Siemens. It was supported by the African Electrotechnical Standardization Commission (AFSEC).

Find out more in the IEC brochures on LVDC and electricity access: *Electricity access - More than a promise: LVDC* and *LVDC the better way*.

Wind industry: Harmonized certification facilitates global market access

IEC Chair for Systems Committee on Smart Energy gives keynote address

By Antoinette Price

Developed with the participation of industry players, including equipment manufacturers, power producers, insurance companies, test laboratories and certifying bodies, IECRE, the IEC System for Certification to Standards Relating to Equipment for Use in renewable energy Applications, streamlines a complex process and benefits not only the wind, but other renewable energy industries such as solar and marine.

First IECRE certificate received by Vestas

The benefits of certification

"The IECRE System for certifying wind turbines harmonizes the process and makes it less costly, so that one certificate is valid for multiple markets. It's what the whole wind community has been waiting for. Based on mutual recognition, all stakeholders will have confidence and trust that devices are built to International Standards and perform as promised", said Kerry McManama, Executive Secretary of the IECRE System.

IECRE certificates are valued in many of the world's largest wind power markets, including China, Germany and other European countries, the United States, and elsewhere.

Simplifying a complex process

Previously, wind turbines had to be certified in each country by private certification bodies, according to different criteria. This was more costly, time-consuming and required repeat testing. It also took much longer to get product to market. Additionally, the IECRE System provides a common language for a very technical product, which gives greater clarity to standards developers, product manufacturers, authorities and users, as to what is being certified. The IECRE also enables broader industry stakeholder participation in defining the certification process, which guarantees the certificates will meet the needs of the broader industry.

The first certificate was issued to Vestas, a wind power solutions company, which designs, manufactures, installs, and services wind turbines around the world. Anders Vedel, Vestas Chief

Wind energy is growing rapidly with the ever-increasing demand for electricity

Technology Officer commented, "What is unique about the IECRE System is that end-users, mainly our customers, together with equipment manufacturers and other stakeholders have substantially contributed to defining the new standards against which wind turbines are evaluated. Vestas began work in 2012 with other stakeholder to create such a System, so we are especially pleased that the first certificate has been issued for a Vestas turbine".

From the Certification Body testing lab perspective, DNV GL as one of the first approved renewable energy Certification Bodies (RECBs), was instrumental in the development of the IECRE and the Certification Body that issued the first IECRE Certificate to Vestas. See the certificate.

About IECRE

IECRE has been created in recognition that the ever-increasing demand for electricity and the need to reduce the share of fossil fuels in power generation have led to rapid development and growth of the renewable energy (RE) sector.

The System aims to facilitate international trade in equipment and services for use in RE in the Solar PV Energy, Wind Energy and Marine Energy sectors, while maintaining the required level of safety. Each of these sectors will be able to operate IECRE Schemes that cover products, services and personnel, to provide testing, inspection and certification.

Currently IECRE focuses on these three energy sectors; however, the door remains open for consideration of other technologies such as concentrated solar power (CSP), geothermal energy and fuel cells.

Tackling Energy Efficiency from the start

Better energy efficiency is central to our future energy supply and to sustain growth

By Morand Fachot

Energy Efficiency represents the biggest source of untapped energy in the world and, by helping slowing down final energy consumption, one of the main contributors in the reduction of noxious gases emissions. Improved electrical Energy Efficiency is made possible by standardization work performed by many IEC Technical Committees (TCs) and starts with electricity generation, distribution and storage.

Covering all areas

Energy intensity, the measure of energy consumption per unit of gross domestic product (GDP), can be an [imperfect] indicator [1] of energy efficiency in general. In recent years, despite relatively low energy prices, energy intensity has improved greatly, contributing significantly to a slowdown in energy-related emissions of greenhouse gases (GHG), CO_2 in particular.

"Increasing mandatory energy efficiency regulation, which now covers 30% of global final energy use, played a key role in moderating the effect of low energy prices on energy use," according to an International

PS10 CSP Power Plant near Seville (Spain)

Energy Agency (IEA) report. The report indicates that some 1,5 billion tonnes (GtCO2) of GHG were not released in 2015 and 13 GtCO2 cumulatively since 2000, thanks to Energy Efficiency (EE).

Electrical energy efficiency (EEE), which is central to overall energy efficiency, ranges from electricity generation, improved electricity distribution and storage infrastructure, to the introduction of more energy efficient equipment and systems in industry, buildings, transport and consumer goods.

Generation first…

EEE starts with energy generation, the conversion of primary energy (from hydropower, fossil fuels, nuclear, renewables, such as wind, solar, marine or geothermal sources) into electricity.

Hydropower was the first source of electricity, it represents now some 15% of electricity production in OECD countries, which is 75% more than the share of electricity generated by other renewable sources. Modern hydro turbines can convert 90% of all available energy into electricity.

IEC TC 4, established in 1913, develops International Standards for hydraulic turbines. TC 4 develops and maintains publications that assess the "hydraulic performance of hydraulic turbines, storage pumps and pump-turbines." Hydropower installations are robust and reliable but they need rehabilitation after 30 to 50 years of operation. TC 4 works on a new edition of a Standard that deals with the various options to increase power and efficiency in rehabilitation projects.

Burning fossil fuels – coal or oil – in thermal power plants is the second oldest form of generating electricity. The share of electricity generated from fossil fuels was 67% in 2014, according to the IEA. A significant amount of primary energy is wasted in the conversion of fossil fuels into electricity in thermal plants (up to 60-65%). One way of reducing waste is to recover waste heat generated in cogeneration Combined Heat Power (CHP) installations to use in industry or for urban heating systems.

Thermal power plants use steam turbines to convert heat and steam into power. International Standards for steam turbines, which are used also in nuclear power plants, geothermal installations, solar thermal electric and CHP plants, are developed by IEC TC 5. IEC TC 2: Rotating machinery, develops International Standards for rotating electrical machines, including motors, used, for instance in "generators driven by steam turbines or combustion gas turbines". This work includes aspects aimed at improving the EE of motors.

Renewable sources are set to play a central role in EEE efforts, by reducing the share of fossil fuels. All IEC TCs involved in renewable sources installations work on developing new more EE systems and in improving the EE of existing ones. These TCs include:

IEC TC 82: Solar photovoltaic energy systems, which also develops International Standards for various measurements and performance parameters of PV devices.

IEC TC 88: Wind energy generation systems. TC 88 prepares, for instance, International Standards "for power performance measurements of electricity-producing wind turbines". In wind power generation, drivetrain, voltage optimization, use of high voltage direct current (HVDC – IEC TC 115) and advanced control systems (IEC TC 57) contribute to better EEE.

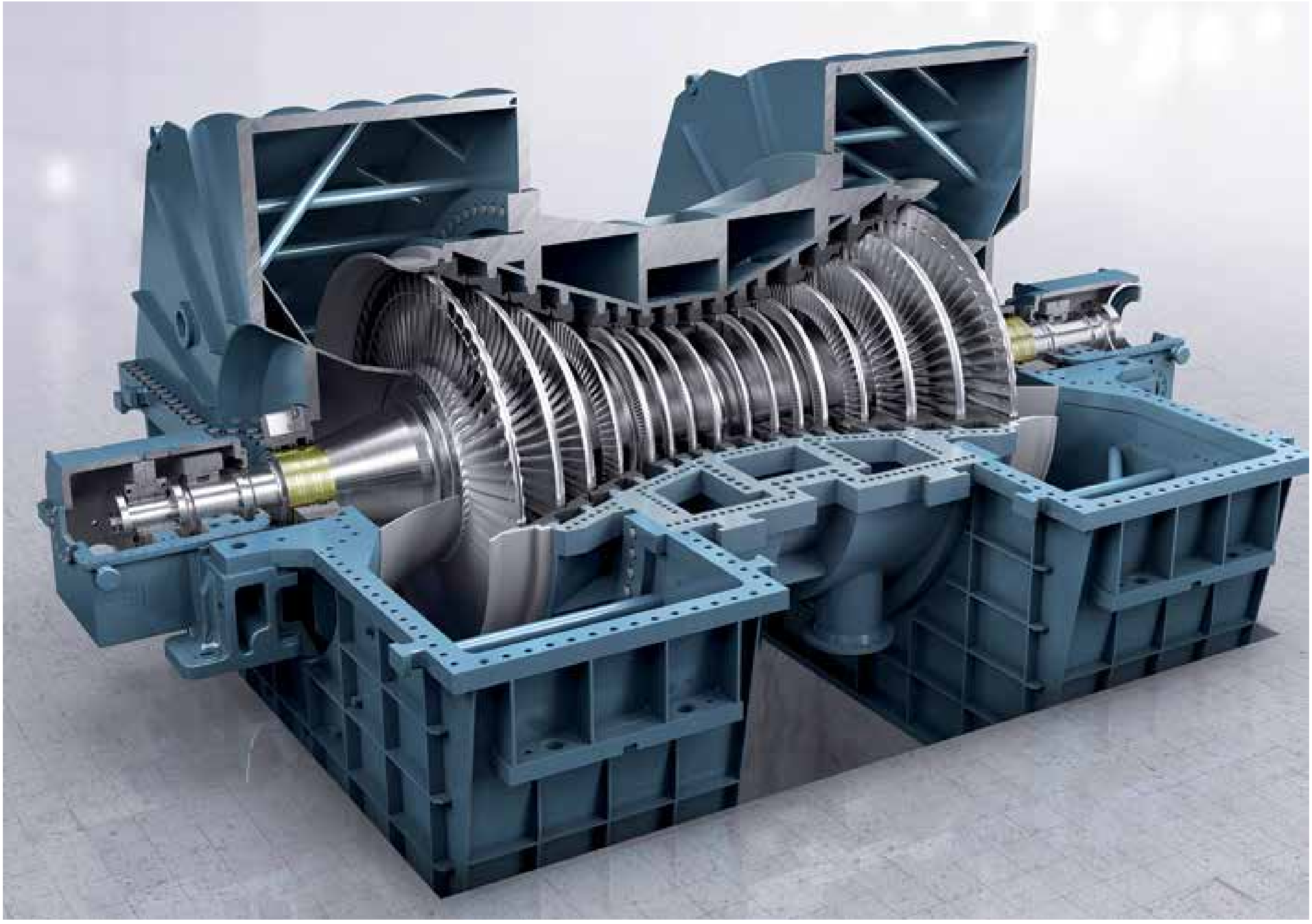
IEC TC 114: Marine energy – Wave, tidal and other water current converters, is a recent IEC TC, but the potential of harnessing marine energy is very promising. Much of the work of this TC focuses on power performance assessment of these converters.

IEC TC 117: Solar thermal electric plants, also covers a fairly recent area, which is fast expanding and showing a significant potential.

Upper and lower basin of Limberg II pumped storage plant, Austria (Photo: Voith)

…followed by distribution

Electricity distribution is also an area where EE is addressed by developing new technologies and systems or improving existing ones. Electrical energy produced by power plants in medium (MV 20 000 V) or low (LV 1 000 V) voltage is elevated to HV (up to 400 kV) by a step-up substation before being transmitted across long distances by high-tension power lines. A step-down station converts HV to MV to transport it to feed MV or LV transformers for use by households, factories, commercial buildings, etc. The efficiency of large transformers in step-up and step-down substations is very high and can reach 99%. The efficiency of MV and LV transformers may range between 90% and 98%. IEC TC 14 develops International Standards for power transformers. Losses in cables are higher than in transformers, but EE is improving there as well. IEC TC 20 develops and maintains International standards for electric cables and incorporates improved efficiency and durability in its maintenance procedure. Ultra high voltage (HUV) distribution of both DC and alternating current (AC) is seen as allowing the EE transmission of power generated by renewable energy sources in sites far away from the main load centres, e.g. in offshore wind farms, large hydropower plants or large solar installations in deserts with acceptably low transmission losses. International Standards for HV and UHV transmission systems for DC and AC are being developed by IEC TC 115 and IEC TC 122, respectively.



Cutaway of Siemens SST-500 GEO steam turbine for geothermal power plants (Photo: Siemens)

Storing electricity for later use

Energy storage is an important component of EE projects. It helps reduce transmission losses and help balance power from intermittent RE sources. By allowing electricity to be stored for later use, it can eliminate the need for the expensive (and polluting) use of generators and idling power plants. It is also an essential ingredient in so-called microgrids and off-grid rural electrification. International Standards for electricity storage systems are developed by:

IEC TC 4: Hydraulic turbines: Hydropower, in addition to generating electricity, makes up some 90% of installed storage capacity worldwide, in the form of pumped storage hydro (PSH) installations. In PSH, water is pumped in a reservoir uphill when electricity is cheap and plentiful (excess electricity from wind or solar power installations) and released downhill to generate electricity, when needed. It is highly efficient (80% or more). IEC TC 4, prepares also International Standards for “storage pumps and pump-turbines”.
IEC TC 21: Secondary cells and batteries, prepares International Standards for all types of batteries used in energy storage, including stationary (lead-acid, lithium-ion and NiCad/NiMH) batteries and flow batteries.

IEC TC 120: Electrical Energy Storage (EES) Systems, develops International Standards in the field of grid integrated EES Systems, focusing on system aspects rather than energy storage.

Into the future…

In many countries, electricity grids were designed based on technology that was modern more than 100 years ago. Standardization work by several IEC TCs makes it possible to update these legacy systems in order to transform them in “Smart Grids”. This is essential to reduce distribution losses and identify energy efficiency opportunities. This means updating the ageing infrastructure to allow the integration of intermittent renewable energy sources, ensure the security of supply and increase in energy use.

[ ] “For instance, a small service-based country with a mild climate would have a lower intensity than a large industry-based country in a cold climate, even if energy was used more efficiently in the latter country.” (IEA)

Smart Energy

A global path towards Energy Efficiency and sustainable development

By Ricardo Luis Nava Garibay, IEC 2015 Young Professional Leader

Nava provides insights into a Mexican programme that aims to increase Energy Efficiency with consumers and the need to encourage the take-up of Renewable Energy sources.

The challenge of the 21st century

The relatively recent demographic and economic growth of the world's population started 200+ years ago and nowadays represents an immense challenge – especially in many developing countries – in terms of energy generation, transmission, distribution and management. Not to mention all the large investments in public transport infrastructure to fulfil the travel needs of an increasingly urban population.

There is also plenty of room to talk about sustainable food production, distribution and waste management, as well as ecological problems related to pollution, resource use, over-population, inadequate infrastructure and hygiene problems.

Mexico hosted a domestic appliance exchange programme where consumers were able to exchange old fridges and air conditioners...

...a clear example of standards helping drive a positive change towards Energy Efficiency at a national level

Cities are key

It is demonstrated that cities around the world hold the key to a smart and sustainable future for many reasons. One of the most important is that cities nowadays produce at least 70% of the world's CO_2 human emissions and they house around 50% of the world's population. This last number will rise to 80% by 2050. Cities also play a dominant role in global consumption, production and pollution (Sukhdev, 2009).

It may seem that the milestones are still far away from our reach, so how can we help shape a smart and sustainable future from a standardization and conformity assessment standpoint?

The answer to this question comes in two parts:

1. Energy efficiency
2. Renewable energies

Energy efficiency – a perspective from Mexico

Each year, around 30% of the world's electricity is wasted in net losses, heat losses, inadequate infrastructure, non-efficient (or old) residential, commercial and industrial equipment and other factors. Smart Grid is part of the solution to efficient energy management but a strong cooperation of different stakeholders such as government, manufacturers and population is also required to drive positive changes.

Energy-saving product exchange

Five years ago, in Mexico there was a national programme called "Cambia tu refri viejo por uno nuevo" (Change your old fridge for a new one) when 1,7 million refrigerators and 200 000 air conditioners were exchanged. This gave the most vulnerable, and not so vulnerable, Mexican population the opportunity to take advantage of governmental support to replace their old fridges and air conditioners for new, more energy-efficient ones.

This programme was coordinated by several stakeholders – government, through its Energy Secretariat, the National Commission for Energy Efficiency Use, CFE – Utility and FIDE; the Environment Secretariat; and the Treasury Department; manufacturers, distributors and the public.

Which products were part of this programme? Only the ones that complied with International Standards such as the IEC 60335 series on safety for household and similar electrical appliances and the NOM for Energy Efficiency were included in this programme.

Lighting, screens, vehicles and more…

More recently, 42 million incandescent bulbs in residential buildings were replaced by energy-efficient lamps. It's worth mentioning that electricity in Mexico is subsidized for consumers using under 250 kWh/month. This is a clear example of how, at a national level, standards help shape and drive a positive change towards energy efficiency in collaboration with other stakeholders.

There are also many other electric devices such as lamps, lighting towers, screens, vehicles, transportation and heavy duty machinery that nowadays are much more efficient than those of previous years. It is a demonstrated solid business case that the investment in new, energy-efficient equipment gives both consumers and industries a fast ROI and more than 50% of energy bill savings in a 10-year period exercise, using the new devices.

The need for smartness

Being efficient is not enough to secure sustainability. We need to realize that most of our energy is still obtained from burning fossil fuels such as coal, oil, gas and shale gas. The residues of our civilization are mainly greenhouse gases which certainly heat up our planet and contribute to the alteration of the water and carbon cycle – commonly known as climate change. Being efficient is an on-going evolution of technology and how we use it to optimize our energy consumption habits, but being smart is also to rely on energy from natural and renewable sources which do not impact negatively on the earth's delicate balance.

Renewable energies

There are many examples of countries which have adopted governance policies to foster large investments in renewable energies, such as Germany. Actually, only a few months ago during a series of sunny days and abundant winds, more than 70% (during a short period of time) of the electricity generated within the country came from existing photovoltaic and wind power infrastructures. It is also true that during these days the national grid was overloaded so additional measures had to be executed to secure the grid's correct operation and the safety of the population.

The role of standardization

Standardization and conformity assessment provide four of the biggest assets for successful international trading: reliability, compatibility, quality and safety. These elements are vital to manufacturers of solar modules and inverters for they represent one of the fastest growing markets in the electrotechnical field. If there were no Standards like IEC 61730, IEC 60904, IEC 62257, IEC 62446 or IEC 61727, the global compatibility, performance and safety of these devices would be virtually impossible to achieve in a safe, sustainable way.

It is the combination of Smart Grid, for energy management, and the use of renewable energies that will drive a sustainable urban transformation and make our energy consumption much more efficient. Also, the Internet of Things is a major actor that will involve even more the final consumers into this race for a sustainable future using smart energy.

Ricardo Luis Nava Garibay, of Mexico, IEC 2015 Young Professional Leader

Ready for the Smart Grid?

The IEC is updating Standards which have wide repercussions on Smart Grids

By Catherine Bischofberger

With 250 members, TC 57/WG 10 is the largest Working Group in the IEC

As the use of Smart Grids escalates around the world, the IEC is busy updating some of its most requested International Standards. Technical Committee (TC) 57: Power systems management and associated information exchange, is working on the IEC 61850 series of Standards.

Energy saving

Smart Grids are increasingly used across the world to save energy and because they are more resilient than traditional grids when power fails. The key technologies behind a Smart Grid are sensors that measure the relevant parameters such as temperatures, voltage and current; communications that allow a two way dialogue with a device; control systems that allow a device to be reconfigured remotely; and user-interface and decision support systems that provide an overview of asset status and perform advanced analytics on data to provide information.

The IEC 61850 series of Standards deals with communication networks and systems for power utility automation. It has many uses, including for Smart Energy and Smart Grids and is therefore continually being updated and perfected. TC 57 is busy working on these various systems.

The technical committee oversees the largest working group inside the IEC, WG 10: Power system IED communication and associated data models, which comprises a massive 250 members.

A little history…

IEC TC 57 was set up in 1964 under the title “Line traps”. It initially started up because there was an urgent need to produce International Standards in the field of communications between the equipment and systems for the electric power process, including telecontrol and teleprotection. As system aspects gradually became more important, together with the increasing requirement for Smart Grids, the technical committee changed its title and scope, and is now IEC TC 57: Power system management and associated information exchange.

It has always been a very active TC, with 166 valid publications to date, including several International Standards but also Technical Specifications and Technical Reports. It currently has 65 active projects in its work programme.

WG 10 was set up in 1995, under the title WG 10: Communication standards for substations: Functional architecture and general requirements. It evolved over time as other working groups were disbanded and their activities transferred to WG 10 which was given its current title of Power system IED communication and associated data models in 2003.

How to be foolproof

WG 10 has worked – and is still working – on the IEC 61850 series of International Standards, which includes more than 20 different Standards dealing with communication networks and systems for power utility automation.

Part of the challenge is to continue implementing the Smart Grid as an evolution of successive projects spread over several decades. New equipment that has a lower life span than traditional network assets needs to be integrated – three to five years for consumer electronics and telecommunications, compared to more than 40 years for lines, cables, and transformers.

The Smart Grid represents a technical challenge that goes way beyond the simple addition of an IT infrastructure on top of an electrotechnical one. Each device that is connected to a Smart Grid is, at the same time, an electrotechnical device and an intelligent node. Today's "connection" Standards need to address both aspects concurrently.

Meeting in Geneva

Members of WG 10 met at the behest of the IEC in Geneva. Over five days in February, 80 members from countries as varied as Canada, China, Finland, France, Germany, Italy, Japan, Korea, Switzerland and the US organized into different Task Forces progressed in writing drafts of Standards, Technical Specifications and Technical Reports related to the IEC 61850 series of Standards.

Convened by Christoph Brunner from it4power with the help of IEC Technical Officer Charles Jacquemart, participants were reminded of the history and work accomplished by TC 57.

Specific presentations were given by other IEC staff members including Alisdair Menzies on the drafting of IEC Standards, Guilaine Fournet on the copyright aspects for code components and Alexandre Bobb on IT strategy.

"The IEC Central Office was keen to organize and host this meeting here in Geneva to show our support for the essential work done by that group," said Charles Jacquemart.

The event was sponsored by ABB, it4power, Helinks, Electrosuisse and Infoteam.

Members of WG 10 will next meet in June in the Republic of Korea.

WG 10 met in Geneva in February

Moving cities to greater smartness

IoT brings back some degrees of independence to those who require assistance in everyday life

By Gabriela Ehrlich

The first World Smart City Forum was held on 13 July 2016, co-located with the World Cities Summit in the Marina Bay Sands Expo and Convention Centre in Singapore. More than 300 participants joined the live event and listened to world experts who addressed, discussed and accepted live questions from audiences in the room and online. The event was simultaneously live-streamed to close to 1 000 online participants and IEC tweets reached well over half a million city stakeholders. The online community www.worldsmartcity.org has more than 1 000 active members.

Four pain points hold back Smart City development

During the Forum, discussions shaped around four pain points that are currently holding back Smart City development. Those include energy, water, cyber security/privacy, as well as mobility.

Energy

Cities are giant systems with countless subsystems which require electricity for almost everything. Electricity fuels cars, subways and trains. It cools, heats and lights homes and businesses. It pumps water and processes food. It energizes telecommunications, web servers and data centres. Modern city management as well as efficient urban infrastructure would be impossible without a reliable electricity access and the ability to horizontally interconnect individual city systems and all the hardware that collects and shares data. In short: no electricity = no Smart City. The discussion can be viewed here.

Water

Going forward, cities need to be water resilient and make responsible use of resources. Appropriate water management will not only preserve and improve the environment; it also increases social welfare and the well-being of citizens. A smart, integrated set of technologies, solutions and systems can enable continuous monitoring, diagnosis and prioritization as well as facilitate maintenance and the management of issues. Among other things, the expert panel highlighted how data can help optimize all aspects of water production, distribution and treatment allowing cities to reach those

objectives. The discussion can be viewed here.

Cyber security and privacy

Cities increasingly depend on information and communications technology (ICT). With it the cyber security threat landscape for cities is evolving, from breaches of city data to more malicious assaults on urban infrastructure. The potential impact of cyber security attacks is of a magnitude that rivals major natural disasters. The panel discussed latest policies and essential governance priorities every mayor and city administrator needs to know to be confident their city is positioned for vibrant growth. The discussion can be viewed here.

Mobility

Cities need to successfully re-engineer the way goods and people move into and out of the city. The panel discussed successes and failures as well as emerging solutions for transportation and mobility in cities. The discussion can be viewed here.

Many standards from many organizations

Policies, regulation, citizen involvement and standards are all key components needed to build a viable Smart City. While all are important, in a path towards smarter cities, standardization will play a key role in ensuring consistent outcomes. Standards are relevant in the physical world, where they allow for the interconnection of hardware and technologies, but also in the virtual space where they facilitate data collection/sharing, as well as city operation.

The World Smart City Forum took place on 13 July 2016 at the Marina Bay Sands Expo and Convention Centre in Singapore

They can considerably facilitate the development of tailor-made solutions that are adapted to the particular circumstances of a given city. Standards are essential enablers that assure an expected performance llevel and compatibility between technologies. They embody strong technical and process expertise, facilitate the replication of outcomes and propose common metrics that permit the comparative analysis and benchmarking of solutions.

Cities are complex, multi-dimensional systems of systems. No single standards organization will be able to provide everything cities need. Here, as elsewhere, broad collaboration is required.

The World Smart City Forum took place on 13 July 2016 at the Marina Bay Sands Expo and Convention Centre in Singapore

Smart City standardization: first global meeting of major standards organizations

On 14 July 2016, in the wake of the World Smart City Forum, representatives of IEC, ISO, ITU, IEEE, CEN, CENELEC and ETSI gathered for a meeting initiated by the IEC. More than 70 participants from national standards organizations also joined the meeting as observers. This was the first time these different standards organizations from around the world met to examine how to work together for the greater good of cities and citizens.

No single organization can provide all the standards

The vision of the IEC was to give an impulse that helps accelerate and better align Smart City standardization work. The fact is: no single organization can provide all the standards that are needed. Greater cooperation among standards organizations offers the prospect of more efficient, inclusive standards development for cities.

The IEC vision is that sometimes one organization will lead an effort and at other times it will share its expertise while another one leads.

Participants of these standards organizations expressed their commitment to uphold principles of mutual respect, transparency, openness and sharing of new work information. Discussions looked at gaps; where standards are needed but work is not yet advanced; overlaps, where different organizations may be active; and, how the standards world can collaborate to better serve the needs of cities and citizens. Over the coming months the organizations develop a viable framework for cooperation in order to optimize outcomes and reduce duplication, wasted time and expense. A follow-up meeting organized by ISO is planned for 2017.

Greater cooperation among standards organizations offers the prospect of more efficient, inclusive standards development for cities

Smart Energy moves ahead

Systems Committee on Smart Energy Technical Committee Forum

By Janice Blondeau

Smart Energy can be described as connecting many points of generation with many points of consumption, from end-to-end, not limited to just the electric grid. Smart Energy is also about all energy needs for Smart Cities. The IEC Systems Committee (SyC) on Smart Energy aims to create one international platform for a comprehensive portfolio of Standards – efficient and easy-to-use Standards that can be used by any project working on Smart Energy. The work of SyC Smart Energy includes wide consultation within the IEC community and a broader group of external stakeholders, in the areas of Smart Energy and Smart Grid, also including Heat and Gas.

IEC TCs are key

The SyC Smart Energy TC Forum, held in Geneva on 26 April 2016, aimed to engage Smart Energy-related IEC technical committees (TCs) and subcommittees (SCs) to collect and share advanced information for the coordination of future Standards development. More than 20 IEC TC representatives, experts and SyC Smart Energy members participated in the Forum, including TC 3, TC 8, TC 13, TC 57, TC 65, TC 69, SC 77A/TC 8, TC 95, ACEE Chair and a conformity assessment (CA) representative.

This is the first time that the SyC has met with IEC Technical Committees, through Advisory Group 1 (TC Forum), although since 2010, around 30 IEC TCs have worked with SyC Smart Energy predecessors, namely Strategic Group (SG) 3 and the Systems Evaluation Group (SEG) 2, via workshops, contributions to the mapping solution and the roadmap.

In their words

Says Ralph Sporer, IEC Advisory Committee on Energy Efficiency (ACEE) Chair: "In the area of Smart Energy there is a great risk in doing parallel work in the individual TCs. I am sure SyC Smart Energy will provide a good

Richard Schomberg, Chair SyC Smart Energy

More than 20 IEC Technical Committee representatives, experts and SyC Smart Energy members participated in the Forum

service and value with its deliverables to reduce the overlap in TC work and generally market the IEC achievements inside and outside of IEC."

Says Toru Ishikuma, TC 65: Industrial-process measurement, control and automation, expert: "The TC Forum is a valuable project where SyC and TCs can learn their standardization activities for the common subject of Smart Energy and collaborate together through coordinating them effectively. Although we have challenging actions in front of us, this kick-off showed us a positive direction with practical steps."

Says Dustin Tessier, TC 57: Power systems management and associated information exchange, expert: "It was encouraging to see the establishment of a platform where technical committees can collaborate and exchange visions, challenges, and high-priority initiatives as it relates to Smart Energy systems. The energy industry will be the ultimate beneficiary from these harmonization activities, and it was refreshing to see the open-dialogue among the technical committee officers."

Future work

Richard Schomberg, Chair, SyC Smart Energy, has this to say: "What we are going to be is a convergence platform to help the TCs who are the factory of Standards for the IEC. We want to create conditions to support the activities of the TCs – so that very early on they have more information than they had up to now. Then it's up to the TCs to manage the way that they develop their Standards and the direction they want to follow."

Adds Peter Lanctot, Secretary, SyC Smart Energy, "Hopefully we are going to gather TCs representatives with an expertise within a technical committee, who also have a good, broad overall understanding of what's happening inside their own committee. Then the System Committee on Smart Energy will help to see where there are overlaps and where Standards gaps exist."

The job of the SyC is to take the Systems perspective and to coordinate and engage the TCs, and have them work with each other where it's relevant. All together, they are processing bottom up standardization needs with top down system needs. Closing the loops and repeating the process are two other key tactics. SyC Smart Energy will bring the relevant players around the table – National Committees, IEC Technical Committees, regulators, regional organizations, industry and other standards development organizations (SDOs).

IEC is taking the lead…it is working outside the silos for a truly Systems overview of the Smart Energy domain.

The rise of renewable energies

The falling cost of equipment and installation together with increased investment are driving the growth of renewable energies

By Antoinette Price

During the United Nations Climate Convention – 2015 Paris COP 21, it was recognized that renewable energy (RE) is a key part of the answer to achieving sustainable development and reducing the impact of climate change. Global electricity networks must adapt and include RE technologies.

IRENA innovation week

For the sixth consecutive year, renewable energy (RE) generation capacity increased by 8,3% during 2015, according to the International Renewable Energy Agency (IRENA). In this context, IRENA held its first Innovation Week in May, with the theme The Age of Renewable Power. Key industrial and political players discussed how technological, operational and systemic innovations in policy, regulation and business, interact and reinforce each other. IEC representatives presented and discussed the role of standardization and quality assurance in RE technology, as well as how it can help more people get access to electricity.

Solar panels help power homes, cars and even the International Space Station

A framework for providing renewable energy safely

Like any products and services, equipment used to produce renewable energy, such as solar panels, wind turbines or wave energy convertors, must be safely installed and maintained, as well as function reliably.

IECRE, the IEC System for Certification to Standards Relating to Equipment for Use in renewable energy Applications (IECRE) was set up in 2014 to provide a global framework for independent assessment of equipment and services related to RE applications. The System uses IEC International Standards developed by various technical committees (TCs) including IEC TC 82: Solar photovoltaic energy systems,

The motion of ocean surface waves is used to create electricity (Photo: Siemens)

IEC TC 88: Wind energy generation systems, and IEC TC 114: Marine energy - Wave, tidal and other water current converters. One of its goals is to facilitate international trade of the equipment and services.

During the session entitled Energy systems modelling and planning, Frank Ormel, Chair of IECRE-Wind highlighted some of the benefits of the system. "IECRE aims to offer a harmonized application around the world, which ensures uniform implementation and mutual recognition between certification bodies and test labs."

The System structure comprises national member bodies and experts from industry who make up the working groups and stakeholders. These include certification bodies, test laboratories, original equipment manufacturers (OEMs) and end users.

Ormel highlighted the fact that IEC-recognized Certification Bodies and Test Laboratories themselves fulfil high-level requirements, so as to be able to carry out the quality assessments. This is in line with the goal for IEC-certified equipment and services to be widely accepted, for example, by local and national authorities.

A new way of delivering electricity

Vimal Mahendru, IEC Ambassador and Convenor of the IEC Systems Evaluation Group for low voltage direct current (LVDC) applications, distribution and safety for use in developed and developing economies (SEG 4), participated in the session entitled, The future grid: electric highways.

Putting LVDC in context, Mahendru explained that one in five people does not have access to electricity. "LVDC bridges the distance between the solar photovoltaic (PV) and the home, without conversion losses and expensive, elaborate and cumbersome grids. LVDC networks are quick to erect, energy efficient and cost effective, enabling speedy electrification of homes and villages."

LVDC also supports much technology used today, from electric vehicles, RE technology, kitchen appliances, lighting, transport, smartphones, tablets, to systems with data and embedded electronics. The Internet of Things (IoT), smart homes and smart cities run on it.

IEC SEG 4 is tasked with evaluating the status of standardization in the field of LVDC applications and products, as well as identifying new areas for standardization work. It is also assessing LVDC usage in different integration environments in developed and developing economies with the objective to enhance energy efficiency and develop new ways to utilize LVDC power.

Wind turbine systems produce clean, renewable energy

The growing importance of global-scale renewable energy

IEC provides a framework to test and certify renewable energy technology

By Antoinette Price

Over the last five years, the cost of renewable power generation technologies has dropped while the technology has improved. Biomass for power, hydropower, geothermal and onshore wind can all now provide electricity competitively compared to fossil fuel-fired power generation, according to the International renewable energy Agency (IRENA).

During the 2015 Paris COP 21 meeting, a number of important commitments were agreed to in order to tackle climate change by reducing emissions. Increasing renewable energy production is part of the solution and will help provide growing world populations with clean, affordable and sustainable energy. Moreover, a report by Bloomberg, says that by 2040, renewables will account for just under 60% of the world's new power-generating capacity.

Lowering risks and inspiring confidence in the technology

Investment in renewable energy (RE) is vital to achieving the above-mentioned goals. Investors must be sure that the technology is safe, reliable and durable. Against this backdrop, the IEC provides International Standards for technical performance and safety for renewable energy systems.

The IEC System for Certification to Standards Relating to Equipment for Use in renewable energy Applications (IECRE) provides a framework within which to test and certify that solar PV technology, wind, and marine energy conversion systems fulfil the requirements of these Standards.

Established recently in June 2014, the IECRE sectors have been working to put rules, processes and structures in place. Testing is underway for what will be the first certificate for wind power, which may still happen this year.

Who develops the Standards?

The following IEC technical committees (TCs) produce International Standards for RE:

IEC TC 4: Hydraulic turbines (water power – rivers)

Focusing on turbine runners and pump impellers; hydro turbine acceptance tests; control systems testing; evaluating cavitation pitting and discharge measurement methods as well as hydraulic turbine efficiency; vibration, stability, upgrading and rehabilitation.

From sunshine to power (Photo: Siemens)

IEC TC 114: Marine energy – Wave and tidal energy converters (water power – oceans)

Covers system definition; performance measurement of wave, tidal and water current energy converters; resource assessment requirements; design and survivability; safety requirements; power quality; manufacturing and factory testing; evaluation and mitigation of environmental impact.

IEC TC 82: Solar photovoltaic energy systems

For all the elements in the entire photovoltaic energy conversion system, including the interface with the electrical system(s) to which energy is supplied. For example, defining terms and symbols; salt mist corrosion testing; design qualification and type approval of crystalline silicon and thin-film modules as well as for methods to evaluate PV module performance in different conditions during the year; new technology storage systems; system commissioning, maintenance and disposal; system and component safety issues, also for grid-connected systems on buildings and utility-connected inverters; and aspects of environmental protection.

IEC TC 117: Solar thermal electric plants

For systems of Solar Thermal Electric (STE) plants and all the elements of the entire STE energy system, define terminology, design and installation requirements; performance measurement techniques and test methods; safety requirements; "power quality" issues for all systems and address issues of connectivity and interoperability with power grid connections.

IEC TC 88: Wind turbines

Covers safety, measurement techniques and test procedures for wind turbine generator systems, design requirements, performance; acoustic noise measurement techniques; measurement of mechanical loads, and communications for monitoring and control of wind power plants. It also works on design requirements for offshore wind turbines, for gearboxes and wind farm power performance testing.

Cooling data centre energy demand

Cutting energy needs for operating and cooling data centres emerges as a priority for the future

By David Appleyard

Data centres may be installed in places where Renewable Energy is available, for example the Bjarnarflag geothermal power plant in Iceland (Photo: Landsvirkjun)

Continuing global growth in the on-line sector and so-called cloud services means a comparable and significant increase in the power use associated with those services. Major Internet-based businesses such as Google, Amazon, Facebook and Microsoft are pushing for more dedicated renewable energy to meet their specific needs, but systems efficiency can also make a major contribution to curbing energy use. Emerging standards have a key role to play.

Driven by the inexorable rise of web-based services in the digital age, data centres – effectively giant racks of servers and digital storage capacity – begin to place an increasingly significant load on national power systems. Clearly this demand will continue to show dramatic growth in the coming years. Industries such as the medical and healthcare sector are increasingly outsourcing data services, commercial transactions through web-based retailers and the financial services sector are soaring and consumer services such as streaming video are all contributing to spectacular growth in the number of data centres and their use.

While tablets, laptops and phones may appear to consume relatively little power, collectively the IT infrastructure required to support them represents a major source of power demand. Doug Alger, Cisco IT Architect, told e-tech: "Data centres are unique environments because you have a significant amount of power density within them – a room filled with cabinet after cabinet of computing equipment".

US-based environmental NGO, the Natural Resources Defense Council (NRDC), found data centres alone consumed upwards of 91 TWh in the US in 2013. This figure is expected to increase by more than 50% by 2020 to roughly 140 TWh, the equivalent annual output of 50 power plants. Putting this into perspective, the US generated around 4100 TWh in 2013.

With data traffic set to triple in three years, according to Lux Research analysis, data centre demand for energy and corresponding cooling capacity is set to follow close behind. The research firm calculates that for each 100 W of server capacity power demand, some 50 W of cooling capacity is required. The demand for cooling equipment, already worth USD 1 billion per year globally, will rise by more than 60% in the next five years, it concludes.

Addressing data centre energy demand

Recognising the burgeoning energy demand represented by their services, major players in the data centre sector have established their environmental credibility by securing renewable energy supplies or upgrading energy supply and cooling systems to improve system efficiency.

For instance, new research from Emerson Network Power found that around half of all data centre cooling systems in North America will be upgraded before the end of 2016 for improved reliability and efficiency.

In a survey of IT, facilities and data centre managers, Emerson reveals that 40% of data centres have been upgraded in the past five years, nearly 20% are in the process of being improved and about 31% will be upgraded in the next 12 months. “Reliable performance and efficiency have always been critical to large data centre performance,” said John Peter Valiulis, vice president of thermal management marketing for Emerson Network Power in North America. “As edge and cloud computing become ubiquitous, ensuring the health of cooling systems at smaller, localised data centres and computer rooms is crucial. Thermal upgrades are allowing companies to improve protection, efficiency and visibility within all these spaces.”

Standards have a key role to play in cooling system performance. For example, IEC 60335-2-40:2016 deals with the safety of electric heat pumps, including air-conditioners, and of dehumidifiers incorporating motor-compressors. It also applies to electric heat pumps, air conditioners and dehumidifiers containing flammable refrigerant. Similarly, IEC subcommittee (SC) 61D considers appliances for air-conditioning for household and similar purposes. It has the scope to prepare international safety standards dealing with electrical equipment used in commercial or light industrial applications, primarily for the purpose of conditioning air.

The Emerson survey also revealed that 40% of data centres were also said to be adding economisers to provide ‘free cooling’ when outside temperatures allow.

Location, location

In a bid to reduce cooling loads, some major players have relocated to regions with typically lower ambient temperatures, such as Nordic countries. For example, Google has a data centre located in Hamina, Finland, which uses sea water from the Bay of Finland in its heat exchangers to reduce energy use from the server cooling load.

Taking this concept a step further, Microsoft recently concluded a trial programme of a data centre deployed under the sea. Project Natick seeks to understand the benefits of and difficulties in deploying subsea data centres worldwide. After a series of tests, the Leona Philpot server was lifted out of the water late last year for assessment. Power to the server was supplied by submarine power cables.

Although IEC International Standards do not specifically cover submarine power cables, major submarine power cable manufacturers like ABB or Nexans rely heavily on IEC International

Standards when manufacturing high quality products. Mentions such as "the continuous current ratings are calculated according to IEC 60287 series of Standards" (ABB XLPE Submarine Cable Systems), or "Maximum value to IEC 60228" and "Calculated in accordance to IEC publication 60287" (Nexans Submarine Power Cables) are present throughout their marketing literature as evidence of compliance with internationally-recognized Standards.

Achieving more

Even with such high profile developments, Ory Zik, VP of Analytics at Lux Research, argues that much more could be achieved with coherent analysis. He explains that, despite their sophistication, leading IT and computing giants in the US use crude and outdated information to calculate the carbon footprint of their data centres. He claims this leads to a shortfall of roughly 25% in emissions reporting.

“Data centres comprise the fastest-growing energy buying sector and the companies that run them have the most advanced data analytics tools at their disposal, as well as high-minded public commitments to sustainability. They should lead rather than lag, by using more accurate data to report on their emissions – and to inform the actions they take to reduce them”, he says.

However, Zik believes that consumers will demand better transparency and traceability from companies. “I think that as we move forward, with more data devoted to understanding our environmental impact, consumers will have this coherent picture and once they have it, they will demand greener products like data from an environment perspective. This will force companies to improve their performance, because otherwise they will be losing customers.”

Interior of cloud data centre (Photo: ABB)

He emphasizes the key role that emerging standards will play in benchmarking environmental performance: "We need to look at this more holistically and just apply data and calculate it [environmental impact] properly. I definitely see standards playing a key role".

This is a point noted by NRDC, too. It concludes that "to move forward, systemic measures such as the public disclosure of efficiency metrics are necessary to create the conditions for best-practice efficiency behaviours across the data centre industry".

One measure that may support this goal is ISO/IEC 19395:2015, an International Standard for smart data centre resource monitoring and control, which was prepared by ISO/IEC JTC 1 SC 39: Sustainability for and by Information Technology. ISO/IEC JTC 1 is the Joint Technical Committee set up by the International Organization for Standardization (ISO) and the IEC to develop International Standards for Information Technology.

Microsoft research project puts cloud server in the ocean to keep it cool (Photo: Microsoft)

Changing standards

Jack Pouchet, Vice President of Business Development and Energy Initiatives, Hyperscale Solutions, at Emerson Network Power, argues that improved standards are a key route to greater energy efficiency. He cites 80 Plus, a voluntary certification scheme designed to promote efficiency in computer power supply units and launched in 2004 by Ecos Consulting. It certifies products that have an energy efficiency of more than 80%. Pouchet sets out a call for a similar standard focused on idling energy use, which he couches as '10 Minus'. "They're starting to focus on driving down the idle energy demand, but there is really no industry-wide push that these things should consume less than 10%, or less than 5%, or less than 1% [at idle]. There are no goals, there are no targets", he told e-tech.

Pouchet calls for a data centre equivalent of an X-prize for a production server that uses less than 10% of energy at idle.

As standards evolve to reflect more accurately the reality of data centres, other avenues to Energy Efficiency are emerging too.

For example, ASHRAE, the American Society of Heating and Refrigeration and Air-Conditioning Engineers, has produced updated standards for temperatures and humidity for computing equipment in data centres. Says Alger: "Over time they have gradually broadened what they consider to be acceptable ranges. As those ranges expand, this opens up more flexibility. You can start to bring in outside air cooling, which is one of the ways in which people are being more efficient. The more comfortable you are running your equipment warmer or cooler within these different ranges, the greater is the number of days that outside air can work for you and you can let mother nature cool your system for you, rather than having to run the condensers in your air conditioning system".

Alger adds: "I certainly think standards can play a key role in the behaviours that they can encourage for people as they are designing and operating data centres".

TC work underpins mobile and stationary energy storage

Batteries are driving growth in mobile devices, e-mobility and stationary energy storage

By 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.

- 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

8 MW Li-ion battery grid storage system in New York State (Photo: AES Corporation)

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.

To prepare International Standards for rechargeable batteries used in RE storage, IEC TC 21 and IEC 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.

IEC 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, IEC 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.

IEC 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.

Reverse mode fuel cells for energy storage

Using fuel cell modules in reverse mode will improve energy storage for renewables

By Stephen J. McPhail, IEC TC 105

A sense of collective responsibility is required to cope with the growing dependence on energy, given the fundamentally unpredictable nature of primary energy supply, the intermittent nature of renewable energy sources and changing energy consumption demands and patterns. The growing need for decentralized (local or remote, residential or commercial) power generation calls for systems that maximize small-scale electrical efficiency. Fuel cells (FCs) are ideal candidates for fulfilling this demand. In fact, at 60% proven net electrical efficiency for generators with a power output as low as 1 kWe, FC systems are head and shoulders above any other fuel conversion technology. If they are to succeed in being deployed widely, FCs for stationary applications should be able to use any locally available fuel. When and if production volumes manage to cover the extensive need for small-to-medium scale generation – which will also depend on the realization of anticipated reductions in cost – there is no reason why FCs should not also be used on the largest scales of power production.

Fuel cells are being introduced in the automotive sector (Photo: Hyundai)

Energy storage is key to renewable energy

The growing penetration of wind power and solar photovoltaic farms is a positive consequence of government incentives and industries working together in a worldwide context. This has succeeded in bringing down the cost of the technologies and greatly increased their deployment. However, the implication of large volumes of power emanating from variable and intermittent renewable sources being fed into conventional grid structures is often the reason why the use of these forms of energy is curtailed in favour of grid stability. Smart grid solutions can only partially adapt electricity demand to these unpredictable patterns. In order to avoid installed capacity and clean primary energy going to waste, it is crucial to be able to store the electricity produced from these renewable sources. Using water electrolysis to produce hydrogen is a weight-efficient (compared to batteries) and location-flexible (compared to

pumped hydro) method to convert and store surplus electricity.

Hydrogen offers multiple benefits

Hydrogen can be converted back to power effectively in commercial, low-temperature FCs. It is particularly suited to mobile applications in fuel cell electric vehicles (FCEV), where the electricity that has been stored as hydrogen can add value by supplying energy for transportation.

Similarly, hydrogen is a highly valuable primary substance for the chemical industry, when used in conjunction with industrial processes to produce substances such as ammonia, chlorine and steel. It is also used in the refining of fossil fuels as well as in the food industry. The electrochemical production of hydrogen has enormous potential for the profitable matching of large-scale renewable energy generation and economic development. Although it requires the hydrogen handling infrastructure to be set up, the use of fuel cell systems in reversing mode for alternating power storage and power generation within a unique system boundary is a readily available engineering solution to the issues currently connected with distributed energy management. Furthermore, the interesting prospect of using high-temperature, solid oxide cells which are capable of being operated directly as both power generators and power storing devices simply by inverting polarity, has prompted IEC Technical Committee (TC) 105: Fuel cell technologies, to look into the need for standardizing developments in this direction.

Bringing FC and electrolysis operation standardization together

The present standardization work on FC and electrolysis operation does not yet cover reversing FCs. Similarly, systems designed to meet power storage and power generation needs within a unique solution – even if composed of separate FC and electrolysis modules – are not currently within the mantle of standardization. Given the potential of the application, this represents a promising area for standardization. A generic system approach is advisable (power in, power out, by-product heat and grid connections) for industry use. It should be noted that power-to-gas-to-power systems could combine different FC technologies for hydrogen and power generation, but a specific task on test procedure development for reversing FCs needs to be undertaken as this currently constitutes a gap in the standardization portfolio.

FC-based reversing power storage and generation systems already deployed

Across the world, industries are already demonstrating systems based on FCs for the reversing storage and generation

Fuel cells are being introduced in the automotive sector (Photo: Hyundai)

of renewable power. In Japan, Toshiba has had a system for buffering solar PV in operation since April 2015 (polymer electrolyte membrane, or PEM, electrolyzer, hydrogen storage and PEMFC at throughputs of 1-2,5 m3/h of hydrogen). In Germany, Sunfire is developing reversing (or regenerative) solid oxide fuel cell (SOFC) systems of 10-500 kWe. In addition to these, FuelCell Energy is ramping up SOFC/SOEC (SOEC = solid oxide electrolyzer cell) installations for energy storage in the US and, in Italy, ElectroPower Systems has already deployed a significant number of PEM-based systems for remote, off grid, constant powering of telecom masts with PV hybridization.

IEC leads standardization work

The IEC is keeping abreast of this rapidly evolving scenario, and TC 105 has approved new work proposals for the development of International Standards on energy storage systems using FC modules in reverse mode. IEC TC 105 ad hoc Group (ahG) 6 will be responsible for this, encompassing the prenormative activities on the definition and validation of testing and characterization procedures of these modules being carried out in the European collaborative project SOCTESQA (Solid Oxide Cell and stack Testing and Quality Assurance, supported by the Fuel Cells and Hydrogen Joint Undertaking). The objective is to develop performance test methods for power storage and buffering systems based on electrochemical modules (combining electrolysis and fuel cells, in particular reversing fuel cells), taking into consideration the options of both re-electrification and substance (and heat) production for the sustainable integration of renewable energy sources.

The proposed Standards which are considered the most important and will come under IEC 62282-8 for Energy storage systems using fuel cell modules in reverse mode, are:
62282-8-101: Solid oxide single cell and stack performance including reversing operation;

62282-8-102: PEM single cell and stack performance including reversing operation

62282-8-201: Power-to-power systems performance

The call for experts for these projects is open. The project leaders are Dr Stephen McPhail (Italy) for 62282-8-101, Prof Hongmei Yu (China) for 62282-8-102 and Dr Tsuneji Kameda (Japan) for 62282-8-201. The convenor of AHG 6 is Stephen McPhail, assisted by Dr Kazuo Shibata (Japan) as Secretary.

Target dates for the first Committee Drafts and finalized International Standards are the end of 2016 and mid-2019, respectively.

About the IEC

The IEC, headquartered in Geneva, Switzerland, is the world's leading publisher of International Standards for electrical and electronic technologies. It is a global, independent, not-for-profit, membership organization (funded by membership fees and sales). The IEC includes 171 countries that represent 99% of world population and energy generation.

The IEC provides a worldwide, neutral and independent platform where 20 000 experts from the private and public sectors cooperate to develop state-of-the-art, globally relevant IEC International Standards. These form the basis for testing and certification, and support economic development, protecting people and the environment.

IEC work impacts around 20% of global trade (in value) and looks at aspects such as safety, interoperability, performance and other essential requirements for a vast range of technology areas, including energy, manufacturing, transportation, healthcare, homes, buildings or cities.

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renewable energies: e-tech 2017-06(en)