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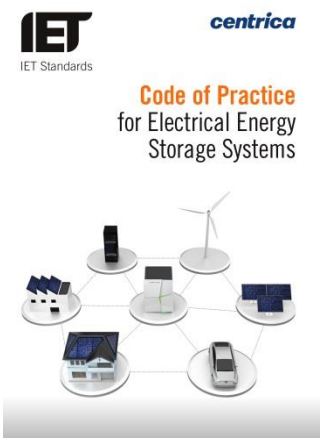
Code of Practice for Electrical Energy Storage Systems – the thought leaders behind the new publication

In August the IET publishes Code of Practice Electrical Energy Storage Systems *– an invaluable resource for those involved in the planning, procurement, design, installation, commissioning and maintenance of electrical energy storage systems. The work behind the Code of Practice required the industry's thought leaders to come together and interrogate the overall framework of operations for energy storage systems, so perhaps it is no wonder that this work already achieved a streamlined and cost-effective connection process between building and DNO – before the Code of Practice had even gone to print!*



We introduce some of these thought leaders – including engineers, installers, trainers, manufacturers and academics – interview them to find out about what this Code of Practice means for them and for the industry at large.

EUR ING Graham Kenyon BEng(Hons) CEng MIET TechIOSH, Principal & Director – G Kenyon Technology Ltd
(One of the Lead Authors of the Code of Practice)

Graham, you're one of our popular authors, both for our IET Standards work and our Wiring Matters articles. What personal benefit is there in working on Codes of Practice and Guides?

The principal benefit is the ability to meet other professionals from a very broad spectrum of backgrounds and professional interest, and work on something that will be of benefit to as wide a variety of practical applications as possible.

A common set of guidance must ensure that the various challenges presented by different applications can be addressed. It is sometimes far from easy to achieve this without revisiting the same problem from a variety of practical perspectives. Overall, I feel that in doing this, I am able, at the same time, to both use my own broad experience, and learn and develop individually.

Finally, it must be acknowledged that, in working to develop and maintain standards, Codes of Practice and guidance, you are ensuring you are keeping up to speed with the latest developments in the industry.

This committee work on this Code had the unusual consequence of making a significant change to the process of installing energy storage systems. Can you explain that change?

There has been a variety of approaches to notification of generation that falls under the scope of ENA Engineering Recommendation G83. In conjunction with colleagues across the industry, including the electrical supply industry, the Code of Practice has been able to clarify the requirements. It is hoped that this will help ensure that the right notification process is used for each system.

What electrical installation safety challenges had to be considered for the Code of Practice?

When an electrical installation with energy storage moves from 'on-grid' (connected to the public supply) to 'island mode' (stand-alone operation, with the public supply disconnected from the live conductors in the installation), there are two main challenges for a designer.
First, the characteristics of supply alter. The prospective fault current drops (often dramatically) and earth fault loop impedances increase accordingly, because the supply is from a power converter rather than a public supply transformer. The challenge was to look at guidance for designers to ensure that required disconnection times continue to be met for electrical safety. In addition, the supply earthing arrangements may change, for example to TN-S in island-mode, from TN-C-S or TT, and the guidance had to address that also. The Code of Practice therefore discusses design options for protection against electric shock and faults in island-mode.

Second, in island-mode, it is not possible to rely on the supplier's means of earthing, and indeed BS 7671 requires alternative or supplementary earthing arrangements are in place. With smaller (lower power) electrical energy storage installations, it is not always practicable to achieve low earthing resistances. Practical guidance was developed for system earthing of low power electrical energy storage systems. This may be an enabler for increased take-up of safe electrical energy storage.

Paul Chandler MEng MSc MIET MEI, Director – T4 Sustainability Ltd

You've played a significant role in making sure that energy storage batteries are fit for purpose, having helped to test the installation of 35 domestic energy battery systems last year, and so far this year 10 for an EU-funded university research project. What was this experience like – and what is your view of energy storage battery systems?

It has been very exciting to be involved in something new which has the potential to change the energy landscape. Prices, specifications and understanding has changed a lot over the last year and with continued improvements in efficiency and price we could see a large number of systems installed. There is still some uncertainty about the environmental benefit of storage systems at present, but the UK will need more storage as we continue to move away from fossil fuels.

As part of the committee for this Code of Practice, were you able to contribute this experience and so shape the development of the Code?

My experience installing systems meant I could offer opinions on the draft Code and provide examples of typical system configurations and installation issues based on practical experience.

Do you think that this Code of Practice will make it easier for installers to fit energy storage systems?

As the technology is new in the UK, there has been a limited understanding in the electricity industry and little technical guidance on best practice. In my mind there is no doubt that the Code of Practice will help installers design systems correctly.

Dani Strickland, Lecturer Loughborough University

Dani, you've been very involved with researching energy storage for many years. How much academic research has gone in to energy storage?

A significant amount of academic research has been undertaken into energy storage in recent years. This is more apparent in the USA where the energy market is different and it makes more commercial sense to include energy storage within a domestic and grid environment. However, there is significant work being undertaken within the UK. The research in academia is very much divided into chemistry based research looking at new battery chemistries and more applied research, for example, looking at grid connection issues including both modelling and hardware prototyping. This academic research into grid connection issues is clearly evidenced by the introduction of academic papers on energy storage within IET-run conferences, such as PEMD, RTDN and ACDC, and journals. There is also a much greater emphasis on larger scale hardware related research, for example, the Willenhall energy storage system funded by the EPSRC, to help with innovation in this area.

How far did this research, and an academic understanding of energy storage, help to shape the Code?

From my perspective, I've been closely involved with energy storage research for several years, including working on the Western Power Distribution run FALCON project and the ongoing EPSRC Willenhall project. The knowledge gained from working with batteries in a grid environment, in my opinion, was very important to helping to shape the Code. There was a significant amount of learning that transferred across into the Code from all parties, including myself, who have previously worked on batteries, even down to issues such as terminology.

Would this book be useful for engineering students?

There is an increasing trend in Universities to deal with project based learning. I'm a strong advocate of this and my personal opinion is that students should understand much more about practical issues like connecting energy storage. I think that where students cover issues relating to practical issues, including, for example, aspects of the IET wiring regulations, this would be a valuable addition to their learning. Unfortunately, many students do not cover such material in their courses and would probably find it quite dry reading.

Serkan Kaniturk MSc BSc CEng MIET, Head Of Engineering – Distributed Energy UK&I at Centrica

Serkan, as Head of Engineering at Centrica, do you see a consumer shift towards renewables and energy storage?

There are significant changes expected to our electricity systems in the near future. The EU, for example, unveiled its climate change targets of cutting greenhouse gas emissions by 40 % by 2030 compared with 1990 levels, with 27 % of energy to be met by renewable sources. By 2050, greenhouse gas emissions should be reduced by 80 % and the electrical power sector will need to be almost entirely decarbonised. Noticeably, fossil fuel generation is already being replaced with renewable energy systems, such as wind and solar power. Such generating technologies are characterised by intermittent output that is correlated with the variable wind and solar resource. This introduces further variability to the system, and adds further challenges to system balancing. Furthermore, if electric vehicles are adopted in large numbers, then the transport sectors will become increasingly electrified. This could lead to more peaky demand; as everyone gets home from work around the same time, plugs in their electric vehicles to charge, and switches other loads to warm up their homes, etc.

If these issues are left unmanaged, electric vehicles and other loads could result in demand profiles that are difficult to supply. These future scenarios indicate that the task of matching supply and demand will become increasingly challenging for the network. We certainly believe that introducing more energy storage to the network system is one way of mitigating this challenge.

Centrica sponsored the IET's Technical Briefing Electrical Energy Storage: An Introduction and has been very involved with the Code. What benefits does this Code provide Centrica?

Centrica aims to help customers take control and be more informed about how, where and why they use their energy and we are already doing this by encompassing a mixture of technologies and services across our group. Energy storage is one of those mixtures of technologies that we provide. Thus, it was essential for us to be able to participate in the development of this Code. The immediate benefit of the Code came about through access to technical resources, communication and networking with experts in the industry. Due to knowledge and experience shared among participants, our engineering and commercial risks are already reduced through lower development costs and the Code provides assurance that the energy storage systems can be designed and installed safely when the Code is followed correctly.

Do you think that this Code might make it easier for building owners and installers to consider energy storage solutions?

Adherence to standards helps ensure safety, reliability and environmental care. The Code will raise user confidence, increasing sales and the take-up of energy storage technologies. Besides that, there will be significant business benefits for both installers and consumers. The Code will provide a solid foundation for energy storage development and will enhance existing practices. It will increase awareness of technical developments and initiatives amongst installers and help them open up market access as well as encouraging innovation in the

energy industry. More importantly, the Code is aimed at contributing to the enhancement of our daily lives and energy system.

Allan Burns, Founder and Director – Telemental

Allan, you've participated in two committees – one for the Guide to Energy Management, and this one, for the Code of Practice Electrical Energy Storage Systems. How valuable do you find participation in these committees, and how much influence can you have on the work that the IET does in these areas?

The value of participating in these committees, for me, is getting the wider context of the field in question.

As a practitioner, that context helps me to understand what influences best practice recommendations. This increases my confidence, particularly when I have to implement solutions where there is no black-and-white answer. The best engineering can take one off-piste, depth of understanding will keep you buoyant on fine powder, rote learning and following prescriptions can sometimes leave you up to your waist a long way short of the finish line.

As a campaigner for sustainability in construction, contact with the kind of individuals and organisations inclined to participate in the forums that the IET creates has been inspirational and illuminating. I'm a fringe operator, geographically, technologically and intellectually. Participation in all of the IET activities in the last year has helped me to connect to, and integrate with, other operators, some fringe, some not but we all add value to each other when we come together.

What is your vision for the installer market in five or ten years' time – do you foresee this Code helping to change attitudes towards renewables and energy storage?

Well, if I consider both committees I've been party to, my vision for ten years' time is that there will be a significant merge between energy management and energy storage. I think microgeneration and storage will be the norm, if not a requirement, for new build in 10 years' time. Forces that will drive this include innovation enhancements, political changes, digitisation and online availability of resources and the ongoing work of organisations such as the IET, in developing best practice.

Dr Aikaterini Chatzivasileiadi, Research Associate – Cardiff University

Energy storage is a fast moving technology. What kind of academic research has been taken on the topic?

In light of the move towards a low carbon economy and the higher uptake of renewable energy technologies, energy storage – both electrical and thermal – has been attracting interest and is being researched in a number of universities around the globe. Research is being undertaken for different technologies and at different scales, i.e. from materials research, through applications in electrical devices, electric cars and homes to regional level and grid applications. Although energy storage is currently a complex and expensive challenge, it is considered a promising growth sector in the UK

economy and so academic capacity and funding has been gaining increasing support. It is thus essential that the research outputs are accessible and disseminated in order to assist with future endeavours in this area and increase public awareness.

Cardiff University's inter-disciplinary research in energy storage draws expertise from engineers, architects, building physicists and social scientists, among others, and is considered to have a far-reaching impact on future energy innovation. The Welsh School of Architecture in Cardiff University, in particular, has partnered with industrial and other organisations, leading cutting-edge projects on practical applications. In these projects, researchers investigate the energy storage and renewable energy technology systems' integration in the built environment in respect to the end-users' energy demand profiles.

What applications do you think this technology might have in future?

It is likely that there will be a diverse mix of storage technologies and applications, matching the changing energy needs in a future low-carbon built environment. This could provide the required flexibility in terms of energy quantity and time frame. Using storage devices, such as batteries, in-demand response applications including peak shaving and peak shifting, in single buildings, communities or the grid could strengthen this flexibility.

An example where demand response and thus storage could play a key role is the smart grid, which is an electricity network integrating the behaviour and actions of all users connected to it in a cost-efficient way. In addition, complementary battery technologies could be coupled to form hybrid systems, so as to increase the range of services that a single storage system can provide. Hybrid storage systems would be expected to provide increased operational safety, greater efficiencies, improved lifetime and reduced costs. Moreover, the electrification of the transport sector could have a significant impact on the electricity system, both as a flexibility solution where electric vehicles would be considered as mobile modular units for energy storage, but also as an additional load.

However, for the above applications to become viable, there are techno-economic challenges that would need to be addressed. These could be tackled through coordinated efforts and collaborative research between universities and industrial partners at a national and international level.

How well do you think the Code of Practice can tally with such a fast-moving technology?

The Code of Practice covers currently available types of electrochemical energy storage systems in domestic, commercial and industrial applications and addresses technical, operational and safety issues. I believe it provides an excellent reference to practitioners on the safe, effective and competent application of energy storage systems. Furthermore, it is an essential document, as not only does it include common terms and operating modes of storage systems, but it also provides detailed information on the their specification, design, installation, commissioning, operation and maintenance. It is the result of the successful contribution by academic and industrial experts in the field, as well as manufacturers, practitioners, certification and regulatory bodies, which covers a vast spectrum of energy storage stakeholders. As a result of the accelerated pace of innovation and development, energy storage is a fast-moving technology. Hence, this Code provides an effective tool to consolidate current practices and support future planning, while establishing a robust foundation informing decision-making and embracing new technologies and applications.

Yselkla Farmer, International Policy Manager – BEAMA

What does BEAMA do and what is its role in the development of energy storage systems?

BEAMA is the leading trade association which represents manufacturers of electrical infrastructure products and systems from transmission through distribution to the environmental systems and services in the built environment. We therefore represent companies who supply storage systems into the market at varying scales, and across a wide range of applications, including heat, hot water, phase change and electrical battery storage. Our members also manufacturer the systems required for the integration of storage assets (for example, inverters, controls).

BEAMA's role is therefore to represent our members in developing a market for storage across the range of applications. We represent our members in the development of policy, regulation and technical standards to ensure they are fit for purpose, remove existing market barriers and ensure the growth of the UK supply chain for export.

What did you bring to the committee for this Code?

BEAMA represented the interests of our members on the committee for the Code of Practice to ensure the guidance met the requirements of the industry.

You are part of the Emerging Markets team at BEAMA. How helpful will this Code be in bedding down energy storage systems and allowing the market to work with this new technology more easily and with greater confidence?

This Code will be very helpful in providing clarity on the installation procedures for electrical storage systems, especially as we hope that in coming years the number of installations will grow and the application of storage in the built environment will become common place.

Frank Gordon, Policy Manager – REA

One of the aims of the REA is to promote the use of renewable energy in the UK. How do you think the Code might contribute to this?

The Code is a very important tool in better equipping the industry to roll out energy storage installations. It will enable better connection of innovative storage devices and provide consumer safety and greater peace of mind. This is especially the case when considered in conjunction with the REAL/RECC Consumer Protection coverage that now also extends to selling storage devices. So overall, the best practice and consumer protection is being put in place and that will help grow the market in the right way.

Where renewables fit in is that many 'behind the meter' domestic storage devices are associated with on-site renewables like solar PV and wind, allowing homeowners to maximise

the self-consumption of the power they have generated. Renewable energy and storage are a natural combination because storage can balance out the supply of power from variable sources such as solar and wind, and also generate and store heat, for example, from excess electricity generation, to be used when needed. So energy storage will help us move to a more efficient, lower cost, cleaner energy system – the independent National Infrastructure Commission estimate that 5 GW of storage in conjunction with more renewables could save us billions every year by 2030.

How long do you think it might be before energy storage systems become commonplace in both domestic and non-domestic buildings?

I think this will depend a lot on prices, which are too high for many at the moment – these are rapidly falling and analysis we published last year projected reductions of 30 % in the next three years, and 50 % in the next five, for lithium ion battery prices. Policy is the other big barrier and we have identified and made recommendations for removing many of these, which there is rhetorical support for from Government, at least, with some progress already, although grid access charge reform remains a large concern.

For some larger scale, commercial sites, it already makes strong commercial sense to install storage and for domestic setting, it is exciting to consider the prospects of on-site renewables, energy storage and electric vehicles. There are hundreds of thousands of homes with solar PV installed and this is likely the early market, which will reach a tipping point for installations when prices fall, and then likely take off very rapidly.

Why is a Code such as this important to the energy storage and renewable energy market?

We were very keen to see a Code such as this developed, which is why we worked with the IET, having approached them about writing it. The reason being that as a fast growing industry, energy storage installations need to happen in the right way to prevent the current lack of clear guidance damaging the reputation of the industry. This would not only lead to bad consequences for consumers, but also risk stalling deployment of really promising technologies which can offer great benefits to the UK energy market.

Andrew Crossland, Energy Storage & Microgrid Engineer – Solarcentury

As an engineer for Solarcentury, you must be witnessing first-hand consumer attitudes towards renewables and energy storage. Has there been an increase in building owners wanting energy storage systems?

There is a marked increase in energy storage enquiries and confidence. This extends from residential products all the way through to large commercial customers. It is clear that the reduced costs in energy storage, strong warrantees from suppliers and investor confidence are all creating a market for distributed energy storage.

Will this Code make it easier for engineers such as yourself to speak to consumers and design and install energy storage systems?

The Code is key to providing consumer and installer confidence in how to install energy storage safely in properties around the UK. It is a landmark document.

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Ian Murray, CEO – Powerflow Energy

You're the CEO of Powerflow Energy, a company that manufacturers energy storage products. What is the market for energy storage like, and do you think this is likely to increase?

The current market is growing. PowerFlow has seen its turnover double in the last year due to the success of launching our AC battery storage system 'Sundial' in January 2016. Sales of over 450 units in year 1 gives PowerFlow a 20 % share in the domestic storage market, highlighting the current market size to be over 2,000 units. I think the storage market for us will grow at the same rate over the next 12 months, but is set to increase at a much faster rate within 24 months as we introduce cloud-based off-peak charging and energy trading tariffs to the Sundial portfolio.

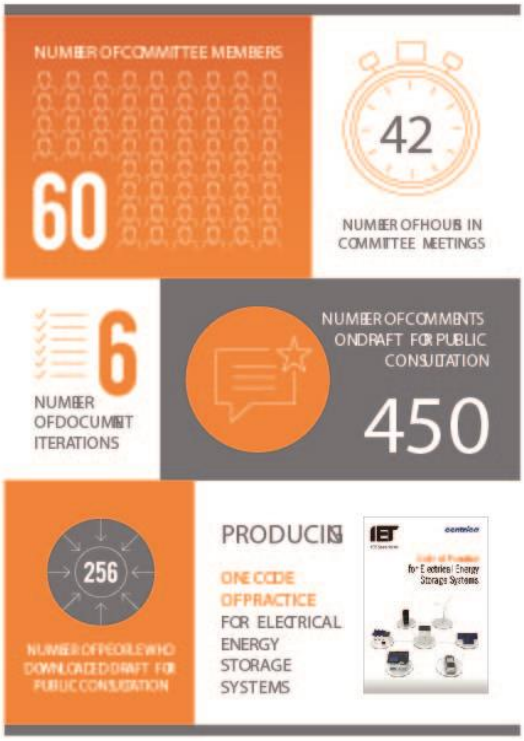
What questions do installers and designers usually come to you with?

A common question refers to system setup during installation. With so many products on the market designed for global sale, setting them up for a particular UK installation can be difficult and time consuming. Automating setup is key and why the Sundial system has no software setup requirement. Automating this process ultimately leads to quicker more reliable installation and eliminates the risk of inputting incorrect parameters.

Can the Code answer these questions?

Yes, absolutely. The Code has been written to help highlight the important factors that determine the correct selection of equipment and to guide the installer on how to implement these correctly and most importantly safely.

With a huge array of storage equipment available, a deeper understanding of which equipment, how it operates, and how it can be integrated is vital for the continued success of integrating storage technologies.



What next?

The Code of Practice has been carefully developed by the committee and was published for public comment, receiving 450 comments.

It is now available for pre-order.