CIBSE JOURNAL

The official magazine of the Chartered Institution of Building Services Engineers

CIBSE

November 2015
www.cibsejournal.com

EXTRA CPD MODULES
Get up to speed on gas-fired absorption heat pumps and intelligent circuit breakers

INSIDE KNOWLEDGE

Full directory of organisations offering CIBSE-approved CPD courses

CPD SPECIAL

FläktWoods

Continuing Professional Development (CPD)

Fläkt Woods are an **accredited approved CIBSE CPD provider** who currently offer several CPD courses. Written and presented by our **expert staff** who have a **wealth of experience** within the ventilation market.

Fläkt Woods current list of CPD presentations include:

- ✓ ***Low Carbon Air Handling Units***
- ✓ ***Reducing Total Emissions using High Efficiency Energy Recovery***
- ✓ ***Smoke Shafts: A Practical Guide***
- ✓ ***Study of the Effects of Fire within Residential Apartment Blocks***
- ✓ ***Designing a Smoke Control Car Park System***
- ✓ ***Introduction To Plug Fan Technology***
- ✓ ***Active Chilled Beams and Demand Controlled Ventilation***

To register or enquire, please email **marketing.uk@flaktwoods.com** or visit **www.flaktwoods.co.uk/cpd** for further information.

#Ventilationexperts #AHU #Axial #FireSafety #AirComfort

CIBSE CPD

JOURNAL CIBSE

Supplement

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Course of action

Welcome to our first *CIBSE Journal* CPD Directory. CIBSE is committed to maintaining and enhancing professional excellence – and continuing professional development (CPD) is integral to that.

This special supplement will help you to source companies offering CIBSE-accredited CPD training courses easily, helping you to meet your CPD requirements.

CPD is a long-term commitment – it is about learning, improving competence and skills, and generally investing in your future. Everyone should make a conscious effort to set aside time for it in their professional life, and recognise its benefits.

Every CIBSE member is required to maintain their professional competence. We provide clear guidance and support to help them achieve this and, thereby, develop their career.

CIBSE also has an online portal, **cpd.cibse.org**, which allows members to keep a record of their CPD in one place, monitor their progress and set themselves objectives.

> Everyone should set aside time for CPD in their professional life, and recognise its benefits

It's worth reminding yourself just how broad a range of activities can fall within CPD – not just training events and conferences, but also private reading, committee work, e-learning, or mentoring others. All offer their own benefits and allow for professional growth.

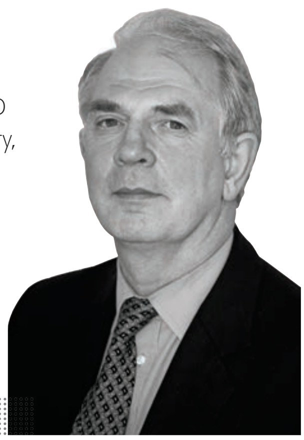
Many find the *CIBSE Journal* CPD modules invaluable resources, and you will find two extra modules to read and complete within this supplement.

Then there is our directory of CPD course providers, which includes a full list of companies by category. The directory has been compiled to assist our members in identifying suitable courses in respect of their CPD needs.

All courses offered by companies in the directory are reviewed and assessed by CIBSE to ensure that the technical content is of a high standard and offers valuable CPD to participants. Many of these companies are able to deliver the courses in-house.

Finally, I'd like to remind you that CIBSE has its own comprehensive and well-respected training courses, as well as a new online learning portal. These cover everything from introduction to mechanical engineering, fire safety and energy management. You can find full details at **www.cibse.org/training**

For more information about CPD requirements and the CPD directory, visit **www.cibse.org/cpd**



Stephen Matthews, chief executive
CIBSE

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CLEAN ENERGY

The energy efficiency of heating systems depends heavily on the condition of its thermal fluid, says Flamco technical manager **Rob Clemson**, who suggests a PPE regime for sealed systems

Zero energy is a big ask, especially when you are brought up to accept that you do not get something for nothing. That said, does it mean that we should not strive for zero energy? Currently our industry focuses on the use of water as the primary method of distributing heat energy, regardless of the heat generation source, the key aim is to move the heat energy to where it is most needed.

Water is a strange substance in that it readily absorbs gasses, which in turn reduce its efficiency as a thermal transfer fluid. Following Henry's law, heating water up will reduce its ability to hold gas in solution, meaning that bubbles can be released at the heat exchanger and this change in state costs the system in terms of energy. Vibration at the circulating pump, due to cavitation caused by free air, causes friction, wear and inefficient energy use. As the water cools, returning to the heat source, residual air bubbles become reabsorbed as they travel around the system, using up energy.

Rob Clemson

If we want to get closer to zero energy we need solutions that focus on system fluid conditioning.

Automatic topup (pressurisation), air removal, dirt (particulate) removal, automatic inhibitor dosing, combination equipment (pressurisation, air removal and automatic dosing) are all technologies to bring up the overall efficiency of the system, while increasing the anticipated service life of the equipment.

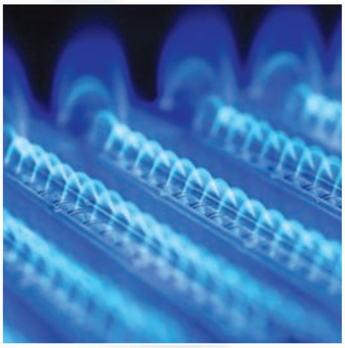
Safety is a drive in the construction industry, where PPE is a mandatory requirement. Why then can we not consider a PPE for the water we are using as a thermal fluid;

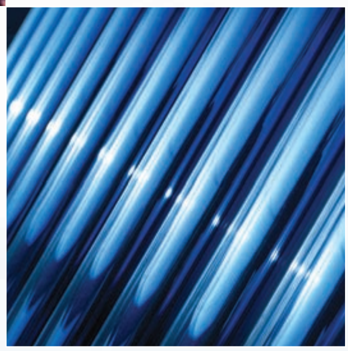
Prevention – Remove unwanted gasses from the water

Protection – Automatic topup and inhibitor dosing

Education – Provision of CIBSE approved CPD on sealed systems and conditioning.

If you have any questions please e-mail **info@flamco.co.uk** or post them on **https://twitter.com/flamcogroup**





CIBSE CPD DIRECTORY

This directory lists all the accredited organisations providing modules on a range of areas, including: electrical, fire, lighting and sustainability

All the CPD courses in this directory have been approved by CIBSE. They are reviewed and assessed to ensure that the technical content is of a high standard and offers valuable CPD to delegates.

The directory of CPD course providers has been compiled to assist members of the Institution in identifying suitable courses in respect of their CPD needs.

The directory embraces many different areas suitable for CPD and will continue to be updated to incorporate new entries and revisions.

Members of CIBSE are required by the Code of Professional Conduct to maintain their professional competence, but this should also apply to any professional working in the industry.

The directory will help you find suitable CPD to assist with your ongoing career development.

For guidance on what constitutes as different CPD activities and how to go about recording your CPD, visit **www.cibse.org/cpd**

CIBSE's online portal, **http://cpd.cibse.org/**, allows you to record your CPD in one place and link your progress to set objectives.

***CIBSE Journal* has more than 80 CPD modules available to complete at www.cibsejournal.com Our new website makes it easier than ever to continue your professional learning online.**

ELECTRICAL CPD MODULES

Name: **A1 Bridge Flue Systems**
Web: **www.a1flues.co.uk**

Name: **ABB**
Web: **www.abb.com**

Name: **Abtec Network Solutions**
Web: **www.abtecnet.com**

Name: **Acrefine Engineering Services**
Web: **www.acrefine.com**

Name: **Airflow Developments**
Web: **www.airflow.com**

Name: **Airmaster Applied Solutions**
Web: **www.airmaster-as.co.uk**

Name: **Altecnic**
Web: **www.altecnic.co.uk**

Name: **Anord Control Systems**
Web: **www.anord.com**

Name: **Armacell UK**
Web: **www.armacell.com**

Name: **Armstrong Fluid Technology**
Web: **www.armstrongfluid technology.com**

Name: **Axair Fans UK**
Web: **www.axair-fans.co.uk**

Name: **Biddle Air Systems**
Web: **www.biddle-air.co.uk**

Name: **Bosch Commercial and Industrial Heating**
Web: **www.bosch-industrial.co.uk**

Name: **Caice Acoustic Air Movement**
Web: **www.caice.co.uk**

Name: **Calor Gas**
Web: **www.calor.co.uk**

Name: **Calor Gas Northern Ireland**
Web: **www.calorgas.ie**

Name: **Capitoline**
Web: **www.capitoline.org**

Name: **Carlo Gavazzi UK**
Web: **www.carlogavazzi.co.uk**

Name: **Climaveneta**
Web: **www.climaveneta.com**

Name: **CNet Training**
Web: **www.cnet-training.com**

Name: **Cool Designs**
Web: **www.cdlweb.info**

Name: **DEIF UK**
Web: **www.deif.co.uk**

Name: **Delmatic**
Web: **www.delmatic.com**

Name: **Delta Controls**
Web: **www.deltacontrols.com**

Name: **Dimplex**
Web: **www.dimplexrenewables.co.uk**

Name: **Dorman Smith Switchgear**
Web: **www.dormansmithswitchgear.com**

Name: **Durapipe UK**
Web: **www.durapipe.co.uk**

Name: **Eaton's Security Business**
Web: **www.coopersecurity.co.uk**

Name: **ebm-papst UK**
Web: **www.ebmpapst.com**

Name: **Elco UK**
Web: **www.elco.co.uk**

Name: **Emergi-Lite Safety System**
Web: **www.emergi-lite.co.uk**

Name: **Emerson Network Power**
Web: **www.emersonnetworkpower.com**

Name: **Emerson Network Power – Asco Division**
Web: **www.asco.com**

Name: **EMS**
Web: **www.emsgroup.co.uk**

Name: **EnOcean Alliance**
Web: **www.enocean-alliance.org**

Name: **Euro-Diesel (UK)**
Web: **www.euro-diesel.com**

Name: **Excel Networking Solutions**
Web: **www.excel-networking.com**

Name: **Fire Safety Training Group**
Web: **www.fstg.org.uk**

Name: **Fujitsu Air Conditioners**
Web: **www.fgeurofred.co.uk**

Name: **Grundfos**
Web: **www.grundfos.com**

Name: **Helvar**
Web: **www.helvar.com**

Name: **Herz Valves UK**
Web: **www.herzvalves.com**

Name: **Hochiki Europe**
Web: **www.hochikieurope.com**

Name: **Honeywell ECC**
Web: **www.mkelectric.co.uk**

Name: **Horne Engineering**
Web: **www.horne.co.uk**

Name: **Ideal Heating**
Web: **www.idealcommercialheating.com**

Name: **IMI Hydronic Engineering**
Web: **www.tahydronics.co.uk**

Name: **Jaeggi Hybridtechnology**
Web: **www.jaeggi-hybrid.ch**

Name: **Kemper UK & Ireland**
Web: **www.kemper-olpe.de**

Name: **Kingspan Environmental**
Web: **www.kingspanenv.com**

Name: **Kingspan Industrial Insulation**
Web: **www.kingspan industrialinsulation.com**

Name: **Kingspan Industrial**
Web: **www.kingspaninsulation.co.uk**

Name: **LG Electronics**
Web: **www.lg.com/uk/air-conditioning**

Name: **Mark**
Web: **www.markgroup.eu**

Name: **Mobotix**
Web: **www.mobotix.com**

Name: **Paxton**
Web: **www.paxton.co.uk**

Name: **Pipe Solutions**
Web: **www.pipesolutions.co.uk**

Name: **Qinetiq**
Web: **www.qinetiq.com**

Name: **Reliance Worldwide Corporation**
Web: **www.rwc.co.uk**

Name: **Rittal**
Web: **www.rittal.co.uk**

Name: **Rochester Midland Corporation**
Web: **www.rmcorpltd.co.uk**

Name: **S & P Coil Products**
Web: **www.spcoils.co.uk**

Name: **S&S Northern**
Web: **www.snsnorthern.com**

Name: **Samsung Electronics**
Web: **www.samsung.com/uk/home**

Name: **Shenton Global**
Web: **www.shentongroup.co.uk**

Name: **Sontay**
Web: **www.sontay.com**

Name: **SPIE Scotshield**
Web: **www.scotshield.com**

Name: **Spirax Sarco**
Web: **www.spiraxsarco.com/uk**

Name: **Spirotech UK**
Web: **www.spirotech.co.uk**

Name: **Stelrad**
Web: **www.stelrad.com**

Name: **Strategic Media Asia**
Web: **www.stmedia-asia.com**

Name: **TEAM (Energy Auditing Agency)**
Web: **www.teamenergy.com**

Name: **Terasaki Electric (Europe)**
Web: **www.terasaki.com**

Name: **Uninterruptible Power Supplies**
Web: **www.upspower.co.uk**

Name: **Unitrunk UK**
Web: **www.unitrunk.co.uk**

Name: **Warmafloor**
Web: **www.warmafloor.co.uk**

Name: **Warmup**
Web: **www.warmup.co.uk**

Name: **Weidmuller**
Web: **www.weidmuller.co.uk**

Name: **Wieland Electric**
Web: **www.wielandmetalynx.co.uk**

Name: **Xicato**
Web: **www.xicato.com**

Name: **Xtralis (UK)**
Web: **www.xtralis.com**

Name: **Zehnder**
Web: **www.zehnder.co.uk**

Name: **Ziehl-Abegg Uk**
Web: **www.ziehl-abegg.com/en**

FIRE CPD MODULES

Name: **Acrefine Engineering Services**
Web: **www.acrefine.com**

Name: **Aico**
Web: **www.aico.co.uk**

Name: **Airmaster Applied Solutions**
Web: **www.airmaster-as.co.uk**

Name: **Belimo Automation UK**
Web: **www.belimo.co.uk**

Name: **Colt International**
Web: **www.coltinfo.co.uk**

Name: **Emergi-Lite Safety System**
Web: **www.emergi-lite.co.uk**

Name: **Hochiki Europe**
Web: **www.hochikieurope.com**

Name: **Saint-Gobain Isover**
Web: **www.isover.co.uk**

Name: **Spie Scotshield**
Web: **www.scotshield.com**

Name: **Victaulic**
Web: **www.victaulic.com**

Name: **Vipond Fire Protection**
Web: **www.vipondfire.co.uk**

Name: **Xtralis (UK)**
Web: **www.xtralis.com**

LIGHTING CPD MODULES

Name: **Airflow Developments**
Web: **www.airflow.com**

Name: **BPC Energy**
Web: **www.bpc-ups.com**

Name: **Calor Gas Northern Ireland**
Web: **www.calorgas.ie**

Name: **Delmatic Lighting Management**
Web: **www.delmatic.com**

Name: **Delta Controls**
Web: **www.deltacontrols.com**

Name: **Emergi-Lite Safety System**
Web: **www.emergi-lite.co.uk**

Name: **EnOcean Alliance**
Web: **www.enocean-alliance.org**

Name: **ETAP Lighting**
Web: **www.etaplighting.com**

Name: **Ex-Or**
Web: **www.ex-or.com**

Name: **Fire Safety Training Group**
Web: **www.fstg.org.uk**

Name: **Frenger Systems**
Web: **www.frenger.co.uk**

Name: **Furse**
Web: **www.furse.com**

Name: **GDL Air System**
Web: **www.grille.co.uk**

Name: **Helvar**
Web: **www.helvar.com**

Name: **Hochiki Europe (UK)**
Web: **www.hochikieurope.com**

Name: **Honeywell ECC**
Web: **www.mkelectric.co.uk**

Name: **LPA Lighting**
Web: **www.lpa-lighting.com**

Name: **Luxonic Lighting**
Web: **www.luxonic.co.uk**

Name: **Philips Lighting**
Web: **www.lighting.philips.co.uk**

Name: **Thorn Lighting**
Web: **www.thornlighting.co.uk**

Name: **Weidmuller**
Web: **www.weidmuller.co.uk**

Name: **Wila Lighting**
Web: **www.wila.com**

Name: **Xicato**
Web: **www.xicato.com**

MECHANICAL CPD MODULES

Name: **A1 Bridge Flue Systems**
Web: **www.a1flues.co.uk**

Name: **Ability Projects**
Web: **www.abilityprojects.co.uk**

Name: **Abtec Network Solutions**
Web: **www.abtecnet.com**

Name: **Acrefine Engineering Services**
Web: **www.acrefine.com**

Name: **ACV UK**
Web: **www.acv-uk.com**

Name: **Airedale International Air Conditioning**
Web: **www.airedale.com**

Name: **Airflow Developments**
Web: **www.airflow.com**

Name: **Airmaster Applied Solutions**
Web: **www.airmaster-as.co.uk**

Name: **Altecnic**
Web: **www.altecnic.co.uk**

Name: **Aluline**
Web: **www.alulinegms.com**

Name: **AmbiRad**
Web: **www.ambirad.co.uk**

Name: **Anord Control Systems**
Web: **www.anord.com**

Name: **Armacell UK**
Web: **www.armacell.com**

Name: **Armstrong Fluid Technology**
Web: **www.armstrongfluidtechnology.com**

Name: **Axair Fans UK**
Web: **www.axair-fans.co.uk**

Name: **Belimo Automation UK**
Web: **www.belimo.co.uk**

Name: **Biddle Air Systems**
Web: **www.biddle-air.co.uk**

Name: **BOA Flexible Solutions**
Web: **www.boafsl.co.uk**

Name: **Bosch Commercial and Industrial Heating**
Web: **www.bosch-industrial.co.uk**

Name: **Britannia Kitchen Ventilation**
Web: **www.kitchen-ventilation.co.uk**

Name: **Bronz-Glow UK**
Web: **www.bronz-glow.co.uk**

Name: **Building Controls Industry Association**
Web: **www.bcia.co.uk**

Name: **Caice Acoustic Air Movement**
Web: **www.caice.co.uk**

Name: **Calor Gas**
Web: **www.calor.co.uk**

Name: **Calor Gas Northern Ireland**
Web: **www.calorgas.ie**

Name: **Capitoline**
Web: **www.capitoline.org**

Name: **Chimney Care**
Web: **www.chimneycare.co.uk**

Name: **Climaveneta**
Web: **www.climaveneta.com**

Name: **Condair**
Web: **www.condair.co.uk**

Name: **Colt International**
Web: **www.coltinfo.co.uk**

Name: **Cool Designs**
Web: **www.cdlweb.info**

Name: **Crane**
Web: **www.cranebsu.com**

Name: **DAB Pumps**
Web: **uk.dabpumps.com**

Name: **Daikin**
Web: **www.daikin.co.uk/cpd**

Name: **Dimplex**
Web: **www.dimplexrenewables.co.uk**

Name: **Durapipe UK**
Web: **www.durapipe.co.uk**

Name: **Eastman**
Web: **www.eastman.com**

Name: **Eaton-Williams Group**
Web: **www.eaton-williams.com**

Name: **ebm-papst UK**
Web: **www.ebmpapst.com**

Name: **Elco UK**
Web: **www.elco.co.uk**

Name: **Elta Group**
Web: **www.eltagroup.co.uk**

Name: **Emerson Network Power**
Web: **www.emersonnetworkpower.com**

Name: **EnOcean Alliance**
Web: **www.enocean-alliance.org**

Name: **Environmental Treatment Concepts**
Web: **www.electronicdescaler.com**

Name: **Evinox Energy UK**
Web: **www.evinoxenergy.co.uk**

Name: **Exhausto Ventilation**
Web: **www.exhausto.com**

Name: **Flakt Wood**
Web: **www.flaktwoods.co.uk**

Name: **Flamco**
Web: **www.flamco.co.uk**

Name: **Frenger Systems**
Web: **www.frenger.co.uk**

Name: **GDL Air System**
Web: **www.grille.co.uk**

Name: **Grinnell Grooved Piping Solutions**
Web: **www.grinnell.com**

Name: **Gripple**
Web: **www.gripple.com**

Name: **Grundfos**
Web: **www.grundfos.com**

Name: **Halton Foodservice**
Web: **www.halton.com**

Name: **Hamworthy Heating**
Web: **www.hamworthy-heating.com**

Name: **Herz Valves UK**
Web: **www.herzvalves.com**

Name: **Hitachi Air Conditioning Europe**
Web: **www.hitachiaircon.com**

Name: **Horne Engineering**
Web: **www.horne.co.uk**

Name: **Hydrotec (UK)**
Web: **www.hydrotec.co.uk**

Name: **Hygromatik UK**
Web: **www.hygromatik.co.uk**

Name: **Ideal Heating**
Web: **www.idealcommercialheating.com**

Name: **IMI Hydronic Engineering**
Web: **www.tahydronics.co.uk**

Name: **Interflow UK**
Web: **www.interflow.co.uk**

Name: **IV Produkt**
Web: **www.ivprodukt.com**

Name: **Jaeggi Hybridtechnology**
Web: **www.jaeggi-hybrid.ch**

Name: **Jaga Heating Products UK**
Web: **www.jaga.co.uk**

Name: **JS Air Curtains**
Web: **www.jsaircurtains.com**

Name: **KE Fibertec UK**
Web: **www.ke-fibertec.co.uk**

Name: **Kemper UK & Ireland**
Web: **www.kemper-olpe.de**

Name: **Kingspan Environmental**
Web: **www.kingspanenv.com**

Name: **Kingspan Industrial Insulation**
Web: **www.kingspan industrialinsulation.com**

Name: **Kingspan Insulation UK**
Web: **www.kingspaninsulation.co.uk**

Name: **LG Electronics**
Web: **www.lg.com/uk/air-conditioning**

Name: **Lochinvar**
Web: **www.lochinvar.ltd.uk**

Name: **Mann+Hummel Vokes Air**
Web: **www.vokesair.com**

Name: **Marflow Hydronics**
Web: **www.marflowhydronics.co.uk/events**

Name: **Mark**
Web: **www.markgroup.eu**

Name: **Marley Plumbing & Drainage**
Web: **www.marleypd.co.uk**

Name: **Medem UK**
Web: **www.medem.co.uk**

Name: **Micronics**
Web: **www.micronicsflowmeters.com**

Name: **Mikrofill Systems**
Web: **www.mikrofill.com**

Name: **Munters**
Web: **www.munters.co.uk**

Name: **Nalco**
Web: **www.nalco.com**

Name: **Nuaire**
Web: **www.nuaire.co.uk**

Name: **Oventrop UK**
Web: **www.oventrop.co.uk**

Name: **Panasonic UK Heating and Cooling**
Web: **www.aircon.panasonic.eu/GB_en**

Name: **Paxton Access**
Web: **www.paxton.co.uk**

Name: **Pegler Yorkshire Group**
Web: **www.pegleryorkshire.co.uk**

Name: **Pentair Thermal Management**
Web: **www.thermal.pentair.com**

Name: **Pipe Solutions**
Web: **www.pipesolutions.co.uk**

Name: **Polypipe Ventilation**
Web: **www.polypipe.com/ventilation**

Name: **Remeha Commercial**
Web: **www.remeha.co.uk**

Name: **Reznor**
Web: **www.ambirad.com**

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Web: **www.rielloburners.co.uk**

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Web: **www.rinnaiuk.com**

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Web: **www.rittal.co.uk**

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Web: **www.rmcorpltd.co.uk**

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Web: **www.ruskinuk.co.uk**

Name: **S & P Coil Products**
Web: **www.spcoils.co.uk**

Name: **S&S Northern**
Web: **www.snsnorthern.com**

Name: **Saint-Gobain Isover**
Web: **www.isover.co.uk**

Name: **Samsung Electronics**
Web: **www.samsung.com/uk/home**

Name: **SANHA UK**
Web: **www.sanha.co.uk**

Name: **SAS International**
Web: **www.sasint.co.uk**

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Applying integrated gas-fired absorption heat pumps to bridge the energy performance gap in non-domestic buildings

This module examines application of gas absorption heat pumps as the lead heating source in 'bivalent' heating and hot water systems. Since the interest in this topic is rising, Remeha was keen to support another chance for building owners, designers and operators to learn about this robust technology through a refreshed version of this CPD article

Measured building performance in new non-domestic buildings often reveals a significant gap between the energy usage predicted at the design stage and the actual energy consumption, often with consumption many times higher than predicted, according to assessments of real building performance by CarbonBuzz.[1] This performance gap also applies to refurbishment projects, where heating equipment frequently fails to achieve the headline efficiencies quoted by manufacturers.

This CPD will consider the application of gas absorption heat pumps (GAHP) as the lead heating source in 'bivalent' heating and hot water systems.

Renewable technologies are increasingly specified as the lead source of energy – often supported by gas-fired condensing boilers – for heating and hot water provision on new developments to meet the low carbon requirements of UK building regulations, and to help towards renewable energy generation targets. In refurbishment projects, 'low or zero carbon' (LZC) technologies, such as heat pumps, are increasingly specified alongside replacement condensing boilers to maximise the opportunity for low-carbon operation and potential operational savings.

Bivalent applications

In new and refurbishment projects, these 'bivalent' systems – so called because they have two heat sources – can often fail to deliver the predicted energy and carbon savings. This can be due to poor design of the systems and failure to consider its operation as a whole, plus the specific control requirements. This can result in the two technologies competing against each other – producing unexpectedly high operating costs when the lower-carbon technology fails to perform as expected.

Modern condensing boilers are typically 105% (net) efficient,[2] and achieving a significantly higher efficiency (towards a potential maximum of 111%) in future developments is likely to be prohibitively expensive. By way of comparison, currently available gas-fired absorption heat pumps can provide efficiencies of up to 165%. Used as the main 'boiler' (in a cascade arrangement with condensing boilers), the GAHP may operate for long periods of time – so its high efficiency results in significant gas savings, with carbon emissions reduced proportionately.

Heat pumps

The principal technologies used in heat pumps are based on either vapour compression systems or absorption systems. Both vapour compression systems – that can be powered by electric motors or gas engines – and absorption systems – powered principally by heat from gas combustion – act to move heat from one location to another using 'work'.

The absorption process works by applying a pair of chemicals that have a strong affinity to dissolve in one another. In GAHP, this is normally a mix of ammonia and water, with the ammonia acting as a refrigerant (known as the 'solvent') being absorbed and transported through the 'thermal compression' process by the water (known as the 'solute'). Referring to the GAHP system in Figure 1 on page 14, heat is supplied to the generator **(1)** by the gas burner to vaporise the refrigerant (ammonia) from the water.

While the high-temperature ammonia vapour goes off to the condenser **(4)** to provide heat to the building system and condense into liquid ammonia, the water (now less diluted by ammonia) passes through a throttling valve **(2)** that reduces its pressure (and temperature) to enter the absorber. The ammonia – having rejected heat in the condenser, flowed as liquid through the throttling valve **(5)** been heated by the outdoor air in the fan-assisted evaporator, and reached the outlet of the evaporator **(6)** as a low pressure vapour – is then drawn into the water that is in the absorber **(3)**. This part of the absorption process will reject heat (which can be usefully employed by the system) as the ammonia vapour is drawn into the water.

From there, the mixture is pumped **(7)** to the higher pressure of the generator **(1)**, where the cycle starts again. The energy required to pump the liquid is small compared with the heat supplied to the generator, and so this process is thought of as 'thermal compression' as opposed to 'mechanical compression'.

To ensure high performance, units will incorporate generator-absorber heat exchanger technology that boosts the efficiency of the unit by recovering the heat that is released when the ammonia is absorbed into the water. The gas burner is also arranged so that the water vapour in the flue gases can condense by exchanging heat with the cooler low-pressure ammonia.

Defining performance

The heat delivered by a heat pump is theoretically the sum of the heat extracted from the heat source plus the energy needed to drive the cycle. Practically, there will be losses from the system, and the performance of heat pumps is typically expressed as the coefficient of performance (COP). Because of Carnot[3] efficiency limits, this will approach 1.0 as the outdoor-to-indoor temperature difference increases.

The COP of any heat pump is also related to the temperature lift – the difference between the temperature of the heat source and the output temperature of the heat pump. When there is a high temperature differential (for example, on a cold winter's day), it takes more work to move the same amount of heat to meet the building load than when the temperature differential is smaller. Since the COP is dependent on the operational conditions, the more representative seasonal performance factor (SPF) is often used – which considers the sum of the annual heat produced divided by the annual energy supplied to power the heat pump.

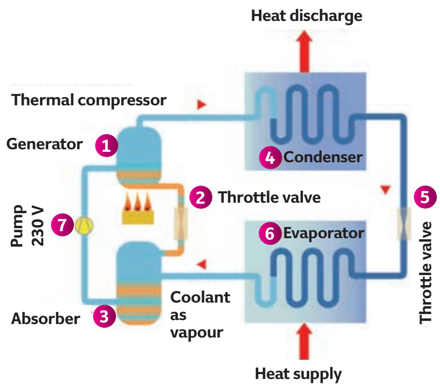

Figure 1: Simplified gas absorption heat pump cycle (Source: Remeha)

The primary energy ratio

This ratio is a measure of the overall efficiency of heating device, taking into account the energy losses related to the generation of electricity. A higher primary energy ration (PER) corresponds to a more energy efficient system.

PER = useful output energy/primary energy input

The average efficiency of European thermal power stations is approximately 50%,[4] so two primary energy units are required for one unit of electrical energy.

An electrical vapour compression air-source heat pump is likely to have a seasonal performance factor (seasonal COP) of approximately 3 so, for this example, the PER = 3/2 = 1.5.

In the case of a GAHP (or any direct combustion product), the energy is supplied directly in the primary form of gas, so the PER is simply the seasonal performance factor for a particular GAHP.

(This excludes transmission losses in both gas and electrical distribution.)

The primary energy ratio (PER – see box) can provide a useful common baseline for comparing heat systems that are fuelled by different energy sources.

The seasonal performance factor and the carbon emission factor for the energy source will determine direct (and indirect) operational CO_2 emissions from the energy source used for powering the heat pump. Currently,[5] UK grid-supplied electricity has an emission factor of approximately 0.5 $kgCO_{2e}\cdot kWh^{-1}$, natural gas 0.184 $kgCO_{2e}\cdot kWh^{-1}$ and LPG 0.214 $kgCO_{2e}\cdot kWh^{-1}$.

So, for example, heat produced from an electrically-powered vapour compression heat pump with an SPF of 3.0 would nominally produce 0.5/3 = 0.16$kgCO_{2e}\cdot kWh^{-1}$. Similarly, a GAHP with a SPF of 1.15 would have an emission rate of 0.184/1.15 = 0.16 $kgCO_{2e}\cdot kWh^{-1}$.

An application of GAHP

As an example, a GAHP (Figure 2) is fitted as part of a bivalent system in a building. The other source is a condensing boiler and – potentially for use at higher external temperatures – an optional electric heat pump. Considering data from the example building (based on external conditions at a Dutch site) in Figure 3, the PER of the GAHP is consistently above 1. At outdoor temperatures below −3°C, the flow temperature of the weather-compensated heating circuit (shown by the red line) requires temperatures of greater than 65°C. At this point, the condensing boilers – which make up the other half of the bivalent system – would work in a 'cascade' arrangement to increase the flow temperature above 65°C. However, this would be for a limited number of hours per year (as indicated by the area shaded yellow).

For comparison, an indicative PER for a typical electrically-powered vapour compression air-source heat pump is also shown. The heavy, blue dashed line illustrates the best PER of the two heat pumps. At 8°C and below, the GAHP is likely to outperform the air-source heat pump (in heating area shaded green) – the PER for the GAHP remains relatively constant across its operational range. Above 8°C, the electric heat pump PER is higher (the heating region in red).

The GAHP capacity would be selected to match the base thermal load of the building, with the condensing boilers modulating online when the load requires a flow water temperature higher than 65°C. Such GAHP installations can achieve seasonal COPs of around 1.25, with carbon reductions of up to 40% compared with traditional gas equipment.

Meeting heating loads of new and refurbished projects

GAHPs can be particularly effective for installation in heating systems with a traditional heating curve, as would be experienced in northern Europe. During winter periods, when the heat is in most demand, GAHPs can operate efficiently at sub-zero external temperatures, while still being able to deliver flow temperatures up to 65°C.

They can provide a particularly beneficial and energy-effective solution where a gas

Figure 2: A 35kW externally mounted gas-fired absorption heat pump (Source: Remeha)

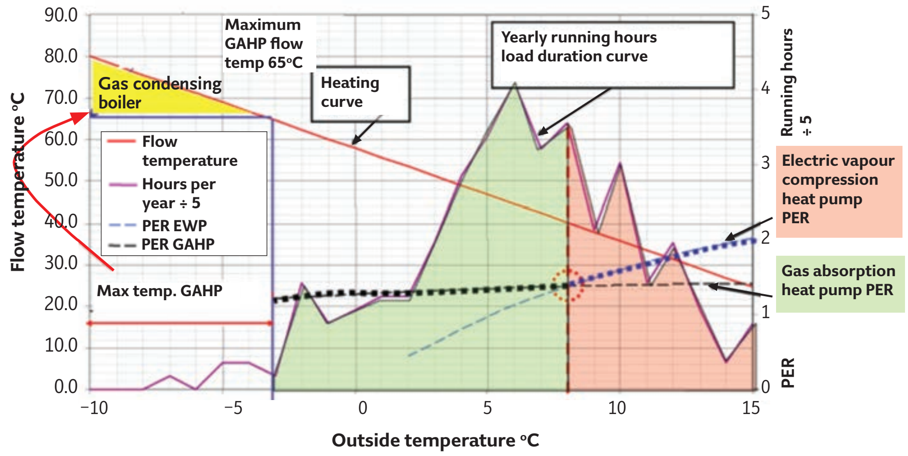

Figure 3: Example frequency of building heating load related to outdoor temperature, with comparative performance (PER) of electric vapour compression and gas absorption air sourced heat pumps (Source: Remeha)

supply is present but significantly upgrading the electrical installation would be challenging. In renovation projects, this can be attractive – as GAHP consume relatively small amounts of electricity – and the outside air is used as the heat source (compared with the more expensive, and potentially disruptive, ground source).

Depending on the required heating load, heat pumps may also be suitable as a direct retrofit solution for systems using fan coil units. The design of such an existing system will likely be based on the cooling loads, so there will normally be an inherent heating overcapacity, enabling the GAHP 65°C flow temperature to be used to fully meet the heating load.

Similarly, in all-air mechanical ventilation systems, heat pumps may help to reduce energy requirements for heating, particularly where fabric improvements have reduced the peak heating requirements.[6]

Heat pumps can be designed specifically for the lower-grade heat loads (underfloor heating and hot water pre-heat), with the condensing boilers serving the higher temperature radiator circuits or main hot water calorifier. There are GAHPs available that are particularly optimised for low-temperature applications.

As with any other air-sourced heat pump technology, the GAHP requires frost protection to prevent the evaporator coils icing up when the outdoor air is cold and humid. Typically, the integral control system has two-stage frost protection, with the circulating pump being switched on for the first stage and, if necessary, the burner fired in conjunction with the circulating pump for the second stage. If the gas or electrical supplies cannot be guaranteed during colder weather, then a water/antifreeze mixture should be considered (as recommended by the manufacturer).

Maintaining control

Clearly, there is a need to control bivalent systems properly to ensure that they may run most effectively. As well as the normal requirements of safety, temperature compensation and modulation (for comfort and efficiency), frost control and legionella protection, in a bivalent system there is the integration of the two (or more) heating sources. This has been a challenge in some existing bivalent systems, leading to poor overall performance and loss of confidence. However, manufacturers have recognised this difficulty and some are leading the market by offering systems integration with control – and, in some cases, remote monitoring – that is bespoke to a particular application. Together with simplified control interfaces, this should provide greater opportunity to apply GAHP in suitable projects.

The future growth of GAHP is predicted in the model produced for UK DECC's *The Future of Heating: Meeting the Challenge* report[7] (as shown in Figure 4). This suggests a growing role for more efficient gas appliances, with GAHPs (shown in light blue) – as part of bivalent systems – playing a significant part in the supply of heat to buildings.

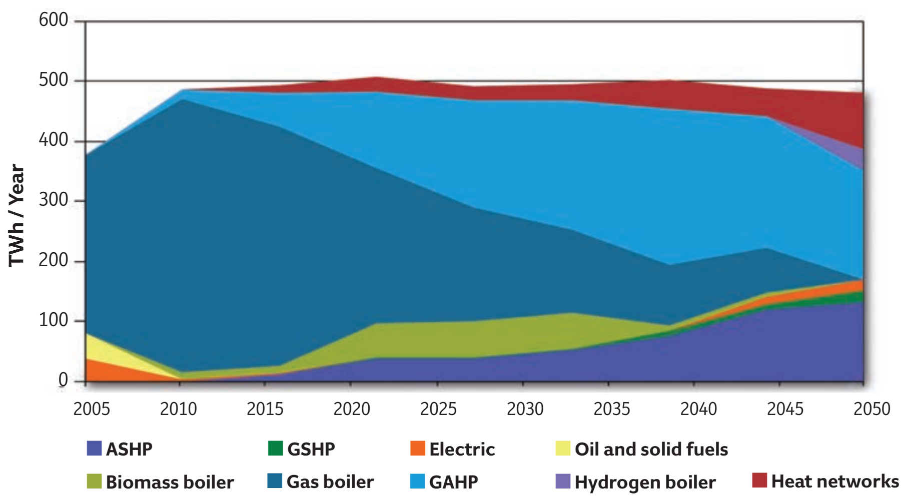

Figure 4: Predicted domestic and non-domestic buildings heat output by technology in 2050, as modelled for *The Future of Heating: Meeting the Challenge* (Source: DECC[7])

References:

1 **www.carbonbuzz.org** (accessed 15 September 2015).

2 ECA list maintained by ETL – **www.eca.gov.uk** (accessed 15 September 2015).

3 Khan Academy, 'Carnot efficiency 3: Proving that it is the most efficient', **bit.ly/1RcxDY0** (accessed 15 September 2015).

4 European Environment Agency, 'Efficiency of conventional thermal electricity and heat production' **bit.ly/1jqk4Kb** (accessed 16 September 2015).

5 Conversion factors – **www.ukconversionfactors carbonsmart.co.uk** (accessed 16 September 2015).

6 TM53 *Refurbishment of non-domestic buildings*, CIBSE, 2013.

7 *The Future of Heating: Meeting the Challenge*, Evidence Annex, DECC, 2013.

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Module 85

November 2015

remeha commercial

1. What is currently an achievable seasonal COP for a commercial GAHP?

☐ A 1

☐ B 1.05

☐ C 1.11

☐ D 1.25

☐ E 1.65

2. What happens to any heat pump in winter as the outdoor-to-indoor temperature difference increases to an extreme value?

☐ A The COP increases to a maximum

☐ B The COP approaches 1

☐ C The COP will be limited by the fuel type

☐ D The COP will be 0

☐ E The COP becomes impossible to evaluate

3. Which of these components has the most concentrated refrigerant vapour at their inlet?

☐ A Absorber

☐ B Condenser

☐ C Generator

☐ D Pump

☐ E Throttle valve

4. At what maximum temperature can water be effectively produced by a GAHP?

☐ A 35°C

☐ B 45°C

☐ C 55°C

☐ D 65°C

☐ E 85°C

5. In the graphical example, at what temperature are the PERs of the vapour compression heat pump and the GAHP the same?

☐ A 2°C

☐ B 4°C

☐ C 6°C

☐ D 8°C

☐ E 10°C

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Applying intelligent circuit breakers to move closer to net zero energy buildings

This module considers the potential for higher levels of building sustainability, energy efficiency and intelligence offered by the latest generation of low-voltage circuit breakers

Every building is equipped with low-voltage circuit breakers, or 'breakers'. Their role is to control and protect the distribution of power at low voltage for essential services such as lighting, heating, air conditioning and power for IT systems.

Until recently, breakers have been straightforward 'dumb' switches, based on long-established technology. While there is nothing inherently wrong with these existing implementations, new developments in circuit-breaker technology are introducing the potential for energy saving, space saving, and better connectivity and control.

This article will consider the opportunities for new-generation circuit breakers in buildings, and how such technology can save space, reduce energy consumption and increase building 'intelligence'.

Electricity consumption in commercial buildings

The Energy Performance of Buildings Directive (EPBD) requires that all new buildings should be 'nearly zero energy' after 31 December 2020 – net zero energy being different from zero carbon. A 'nearly zero energy building' (NZEB) means a building that has a very high energy performance, and the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including those produced on-site or nearby.[1] Performance of NZEBs will be measured by energy consumption in kWh per square metre per year, with the proportion of renewable energy being expressed as a percentage of consumption.

While policy-makers encourage energy saving and energy efficiency, what is often more important to building owners and occupiers is that saving energy also reduces energy bills.

All the electrical power flowing to the loads in a building passes through the building's breakers, which are located in a plantroom or an electrical cabinet (as shown in the example in Figure 1). More recent models incorporate higher levels of 'intelligence', logic and connectivity, increasing opportunities to save energy. They are also smaller in size and several can be stacked in a single panel, freeing up space to use for other services or as 'lettable space' for a building's occupants. Equipment suppliers are competing to help building managers increase energy efficiency – and because all energy consumed by a building flows through its circuit breakers, they are a good starting point when looking for opportunities to save energy and costs.

Meeting the standard

Low-voltage switchgear must comply with IEC 61439[2], which came into full effect in June 2010 and superseded standard IEC 60439 in late 2014.

The standard covers low-voltage switchgear and control gear assemblies – which describes a combination of low-voltage switching devices plus associated equipment for control, measurement and communication, along with mechanical and electrical interconnections and structural parts.

It applies to enclosures with rated voltage of less than 1,000 volts AC or 1,500 volts DC, and includes significant changes compared with its predecessor. New requirements have been added to ensure equipment performance when exposed to sunlight for long periods, or when operating in potentially corrosive atmospheres. Other new requirements cover confirmation of equipment fault ratings and mechanical performance.

The latest edition of IEC 61439 provides a more extensive explanation of equipment operational temperature rise, and makes clarifications, including the role of control panel, component and switchgear manufacturers. (See 'Further reading' at the end of this article for more on IEC 61439.)

Improvements in technology

As with most areas of commercial technology, 'air' circuit breakers – which use air to extinguish the arc when the contact is broken – are the subject of continuous and ongoing research and development.

Conventionally, circuit breakers have the role of switching loads and electrical generators on and off. They need to maintain reliability over a long life, so are based on tried and tested technology. To provide additional features – such as measurement, control and communication – operators have normally needed to install separate equipment.

While these breakers performed well for conventional commercial buildings, building managers are increasingly calling for electrical distribution systems that are suited to nearly zero energy and intelligent buildings. This requires greater levels of sophistication, as building managers are not simply minimising energy use, but also contributing to a building's income through demand management or by selling excess renewable energy to the grid.

At the same time as the drive towards sustainability, there is a growing expectation for buildings to act intelligently, using building management systems to monitor and control essential functions, including HVAC, lighting, access and security systems.

Modern circuit breakers can support this with enhanced built-in communication and intelligent decision-making, and with enhanced control that does not require specialist programming skills – so enabling building operators to access more control over day-to-day operations.

Space saving

Not only is the latest generation of switchgear smaller in size, but it is also possible to stack it in columns, so that multiple breakers can be housed in a single panel. This can improve the use of space in refurbishment projects where older breakers are replaced, at the end of their useful life, and the required plantroom space reduced. The plantrooms in new buildings will require less space than older projects with similar power requirements.

An example of the potential value is in a typical data centre for a financial services organisation. A data centre's electrical infrastructure must be sized not only to support the critical load of the servers and computing equipment, plus auxiliary systems such as cooling, lighting and power conditioning, but also to leave the maximum usable footprint for the racks of servers. Modern circuit breakers allow switchboards to be built as much as 25% smaller than conventional switchboards. A data centre in Israel has recently been fitted with 130 modern-generation breakers, ultimately saving 15m^2 of footprint when compared with previous technology. For a typical data centre operator, 15m^2 of floor space is equivalent to six additional server rack enclosures, with a total data storage capacity of 1,584 terabytes (TB).

Accurate measurement and analysis

The ability accurately to measure and communicate is now built into devices, removing the need for additional instrumentation and wiring. Typically, modern circuit breakers can integrate measurement to a tolerance of 1% of the actual value of current, 0.5% of voltage and 2% of power and energies, and measurements can often be read directly on the unit's display, so reducing the need for extra devices.

As well as the more straightforward measures, the new generation of circuit breakers can act as a network analyser to monitor power quality. They can be set up to monitor average voltage, short voltage interruptions and spikes, slow-voltage sags and swells, voltage unbalance and harmonics.

Continuously monitoring the state of the electrical systems can enable the protection of sensitive electronic equipment and, from interrogation of alarms, events and measurements, operators can prevent system faults, or disconnect effectively as necessary.

Load shedding

The intelligence in modern circuit breakers has the potential to assist in reducing peak loads. For example, during a hot summer day, all air conditioning systems might start working at the same time, leading to a peak in consumption and potential challenges with the energy supply. This can also affect the building's peak electrical load, so incurring costs and potentially needing more investment in electrical plant.

The latest circuit breakers integrate power controller functionality. This manages the power flowing through the breaker and keeps it below a limit set by the operator, by disconnecting non-priority loads. It can also be linked to bring backup power generators online. One manufacturer's experience has shown that load shedding can reduce peak power consumption by up to 15% and is usually invisible to building occupants who, for example, may not notice that air conditioning, heating or electric car charging stations have been switched off for a short period. A prioritised list of building loads and constant power monitoring can manage loads automatically with no need for additional control systems or bespoke software.

It is thought that replacing existing traditional breakers globally with the latest technology has the potential to achieve annual energy savings of 5.8m megawatt-hours (MWh) – equivalent to the typical annual electricity consumption of 1.4m European households, and consequent emission of 4m tonnes of CO_2 per year.

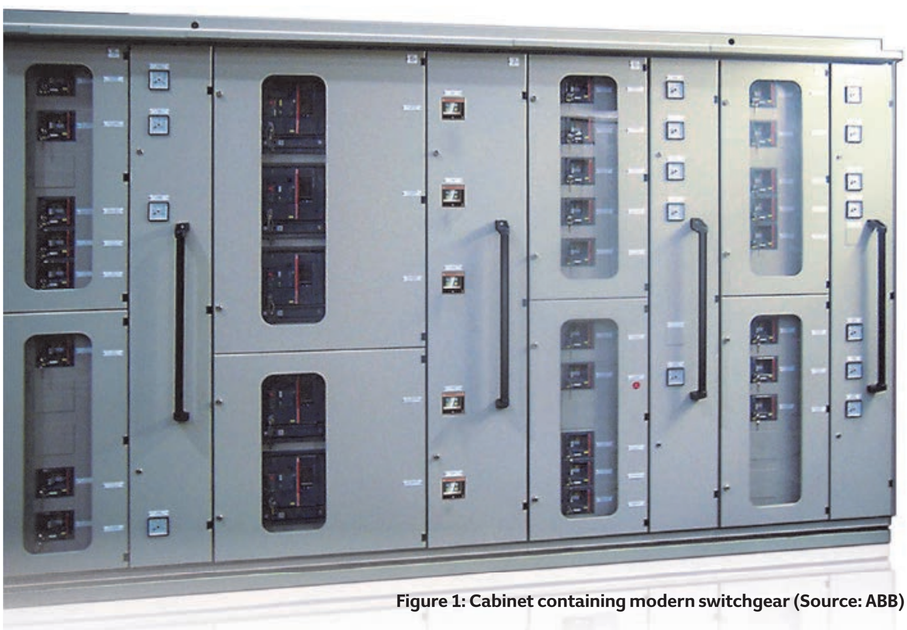

Figure 1: Cabinet containing modern switchgear (Source: ABB)

Figure 2: Front panel employing touchscreen digital display with selectable outputs, including a visualisation of an analogue meter (Source: ABB)

Connectivity and control

As well as direct control using the front panel – potentially using touchscreen navigation (as in the example shown in Figure 2) – control is also available through specialist apps for smartphones, tablets, PCs and so on, as well as through general web interfaces. This can provide swift access that can be particularly beneficial when there is a fault or an emergency. Smart circuit breakers can integrate with smart grid-electricity distribution systems by, for example, participating in demand-management schemes, or by exporting power to the grid when it is most beneficial to do so. The newer breakers have compatibility with the most common communications protocols, such as Modbus, Profibus, Devicenet, Modbus TCP, Profinet, BACNet and Ethernet IP, as well as the IEC 61850[3] smart grid communications protocol. This means that breakers are simple to integrate into smart buildings through, for example, supervisory control and data acquisition (SCADA) systems. Using industry-standard protocols means they will have a better chance of being compatible with both existing and future infrastructure.

The enhanced communication and intelligence in modern breakers can inform predictive maintenance, too, with the circuit breaker signalling when it is in need of routine maintenance. This can help avoid incidents or shutdowns and extend the life of equipment.

It is possible to have centralised control of new-generation low-voltage switchboards, either from the front panel or remotely – through local networks or web connectivity. By connecting circuit breakers together with standard ethernet components (cables and network switches), a collection of breakers can be linked, with no need for a separate – and potentially costly – supervision system.

Generator protection

Backup power generators are vulnerable to damage from internal faults or surges arising from the electrical system to which they are connected. The protection required depends on the type of plant and application, which makes standardisation of protection systems and applications difficult. This has meant that operators rely on sophisticated electrical protection systems, which can be complex to calibrate and control. In the past, generators required installation of multiple relays tailored to each installation. However, today's circuit breakers can be equipped with trip units that contain the functionality needed to protect generators and monitor their critical parameters. By programming the protection unit with the relevant protection against over- or under-voltages, over- or under-frequency, overloading, earth faults and other issues, these circuit breakers can deliver reliable generator protection, whether the generator is paralleled with the network or working in isolation.

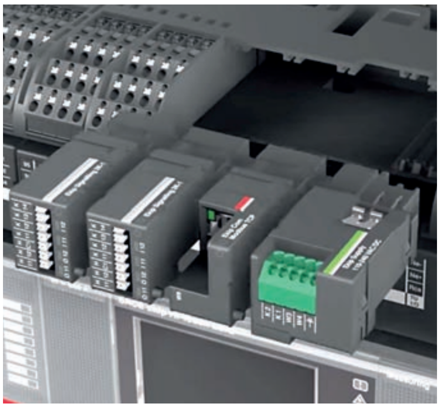

Figure 3: This modular mounting method allows safe and reliable connection, as well as the maintenance of communication even while in the 'racked out' position (Source: ABB)

Installation and maintenance

New-generation breakers have been designed to enable safe, simple and robust mechanical installation. For example, the configuration of the circuit breaker's terminals can be readily site-altered to fit different busbar configurations, providing simple and safe installation of the wiring and accessories without specialist tooling. Typically, such systems incorporate a wide range of options for communications and the ability to add functionality simply so that installers/operators may make changes to the installation, even at a later project stage.

Circuit breakers (such as the example shown in Figure 3) should be constructed to allow simple and safe maintenance. For example, this can be done by including dedicated guide rails for withdrawable circuit-breaker components to simplify movement and allow correct, locked and clearly identifiable positioning. Mechanical interlocking and shielding is used to ensure safe maintenance. Circuit-breaker units should include lockable shutters that protect operators by preventing access to live parts during maintenance, and it should be possible to install accessories without having to access compartments that contain live components.

● Our thanks to ABB for providing core information and images for this article.

Further reading:

The changes to the requirements introduced in IEC 61439 are covered in more detail in *Introduction to IEC 61439*, available online at **http://bit.ly/1OsjJU9**.

References:

1 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings (recast).

2 IEC 61439:2011 *Low-voltage switchgear and controlgear assemblies*, International Electrotechnical Commission (IEC), 2011.

3 IEC 61850:2015 *Communication networks and systems for power utility automation*, IEC, 2015.

Turn over page to complete module

Module 86

November 2015

1. Which IEC standard is most applicable to circuit breakers?

☐ A IEC 61366

☐ B IEC 61378

☐ C IEC 61400

☐ D IEC 61439

☐ E IEC 61467

2. What is the specific relevance of the word 'air' in 'air circuit breakers'?

☐ A The new generation of breakers are lightweight

☐ B The communication can be through the air

☐ C Air is used to control the spark when the circuit is broken

☐ D The circuit breaker is not suitable for mounting in wet areas

☐ E It is simply a convention and has no specific meaning

3. In the example of the data centre in the text, approximately how much extra server capacity could be added for each square metre of available space?

☐ A 1 TB

☐ B 1.2 TB

☐ C 1.4 TB

☐ D 1.6 TB

☐ E 1.8 TB

4. What tolerance of voltage measurement is available through the new generation of commercial devices described in the article?

☐ A 0.5%

☐ B 1%

☐ C 1.5%

☐ D 2%

☐ E 3%

5. Which of these statements is *least* likely to be true for the new generation of circuit-breaker assemblies?

☐ A They can inform predictive maintenance procedures

☐ B They can monitor voltage, current and power

☐ C They take up less space than their predecessors

☐ D They require dedicated, bespoke network systems to communicate

☐ E By using lockable shutters, they protect operators during maintenance

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