THE EMA MAGAZINE

www.theema.org.uk | ISSUE JULY–AUGUST 2018

ENERGY MANAGEMENT
in legacy data centres

Career Interview
with Caroline Holman

REDUCING WATER USE
at the University of Reading

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Welsh Water

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contents

INDUSTRY FOCUS

by RUPERT REDESDALE
CEO at Energy Managers Association

Dear Reader,

Summer is upon on us, the temperature is rising to record levels and colleagues disappear for weeks at a time. You may be reading this on-line in some exotic place like Brighton or, for the more daring, Skegness. Wherever you are, this issue has some interesting highlights.

First off, thank you to all those who took part in our Employment and Pay Gap Survey, there are some interesting results and we will continue with this topic in the next issue.

One of the interesting results is that the gender pay gap amongst our respondents is not as pronounced as in other industries. However, women are far less likely than men to ask for a rise.

We are always looking for a diverse range of topics and this issue has articles from Jaguar Land Rover through to climate change. However, if you have an issue that might be of interest to the energy management community then please pen something whilst on the sun lounger with hopefully something cool, refreshing and alcoholic to hand.

When you get back or in those quiet periods when the office is deserted, a speaker submission for EMEX could be just the thing to round off the summer.

THE EMA MAGAZINE

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FRONT COVER
Photo Courtesy of of Jaguar Land Rover

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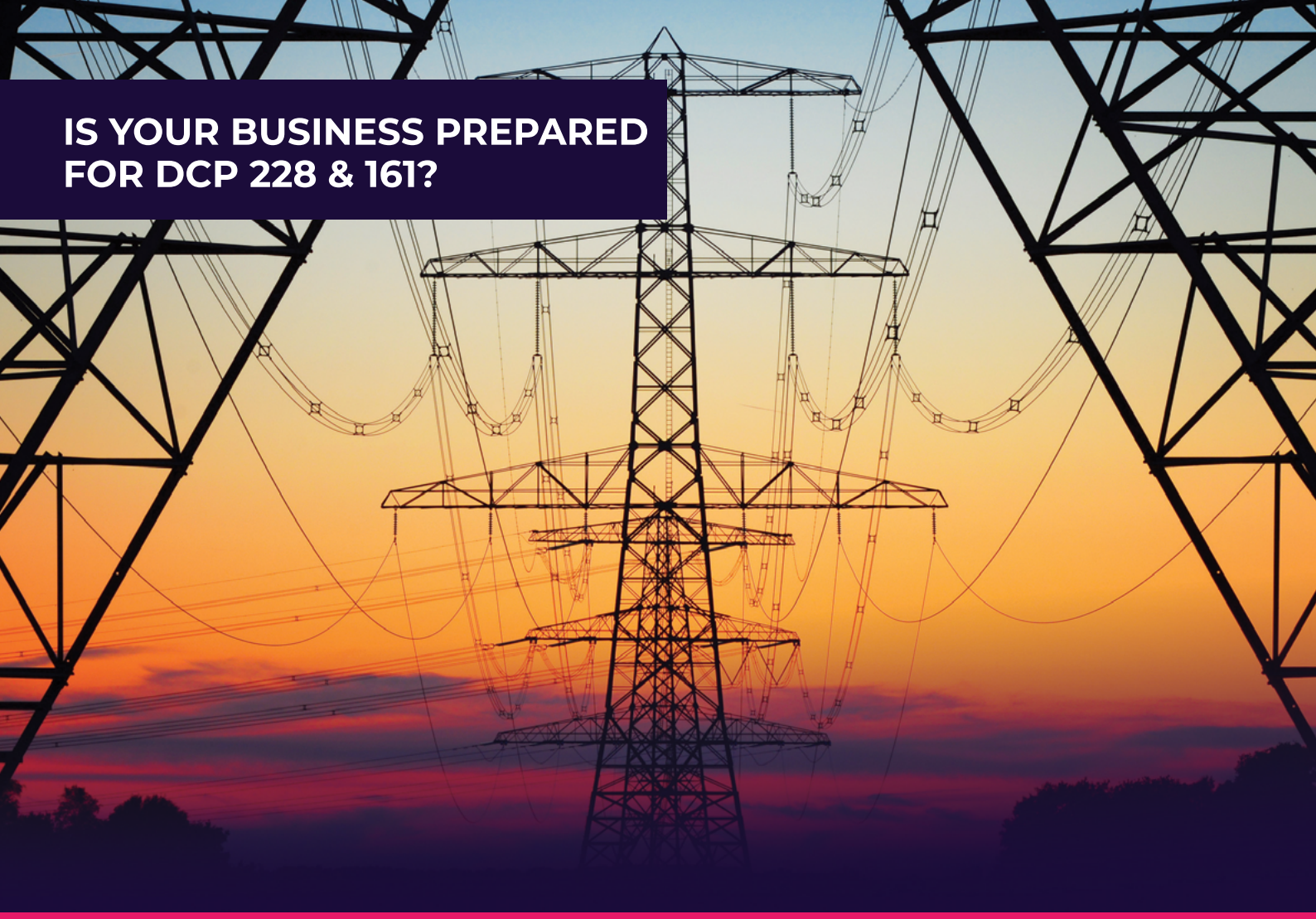
The EMA Magazine is published bi-monthly on behalf of the EMA by HEELEC Limited, the organisers of the annual energy management exhibition, EMEX.



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by DAN FERNBANK
Energy & Sustainability Manager at University of Reading

Reducing Water Use at the University of Reading

The University of Reading is a leading institution in teaching and researching the impacts and solutions to major environmental problems worldwide, and we are committed to demonstrating strong leadership by example in environmental management. With over 19,000 students and 3,000 staff across our estate, managing the University's utilities consumption and costs are also key in delivering financially sustainable operations.

Water is a precious resource, but when compared to energy, is relatively cheap and can lead to its conservation taking a back seat, a position which had historically been evident at Reading. We are pleased to have turned that position around, and taken the lessons from our carbon management programme to apply to our water management programme too, delivering a 28% reduction in water consumption since 2011/12.

Is metering a pre-requisite?

One of the most fundamental challenges and lessons from our Carbon and Water Management Programme has been the need for good data; a position we recognised early on and are continuing to address even now. Our main 123 hectare Whiteknights campus is our principal site, accounting for 71% of our water consumption, and yet our main source of consumption data has historically been monthly manual readings. Clearly better metering could help improve our understanding of where our water goes and how we can reduce it.

> "RATHER THAN WAITING TO GET OUR METERING SPOT ON, WE HAVE TAKEN A MORE PRAGMATIC APPROACH TO IMPROVING DATA ALONGSIDE DELIVERING REDUCTION PROJECTS."

We faced similar challenges with our carbon management programme, but recognised that the time, cost and disruption to get every building individually metered could mean it would be years before we delivered any tangible savings. Even where we had meters in place, understanding exactly what was fed from each supply has been an additional challenge. Rather than waiting to get our metering spot on, we have taken a more pragmatic approach to improving data alongside delivering reduction projects, keeping checks on the headline numbers to ensure reductions are being delivered whilst simultaneously chipping away at improving our metering.

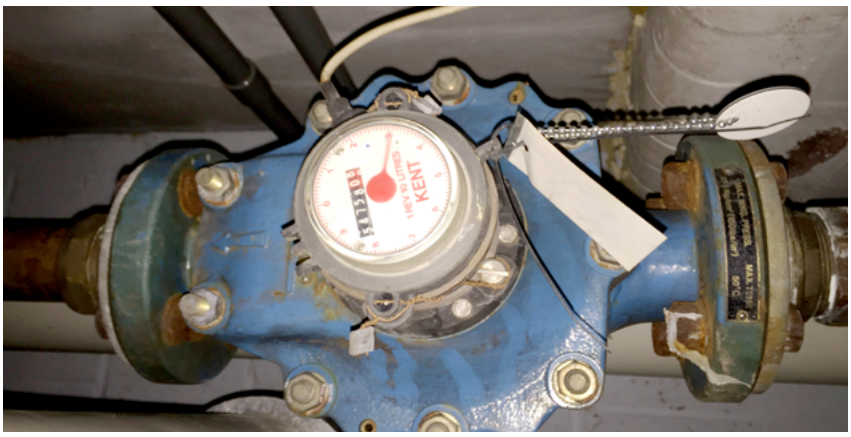
We particularly benefited from an early partnership with our water company in installing AMR devices on our main supplies to the site, which provide half-hourly profiles of consumption. We now also have a rolling programme to install half-hourly meters on each building, often delivered alongside other maintenance work, which feeds data into our utilities database.

Detecting leaks!

In 2013, we commissioned a number of leak detection surveys across our main Whiteknights campus.

This identified a number of areas for improvements/repairs, and the subsequent repair work delivered 16,000 m^3 (6%) annual savings in our water use. This really brought home to us the potential impacts of persistent leakage, and we have become increasingly reliant on our AMR data to give us early warnings of potential leaks. In the last year alone, we have identified a number of major leaks, which we have been able to get fixed quickly to prevent major leakage. This is an obvious sign that some of our ageing pipework needs updating and our maintenance team are about to begin a rolling programme of upgrades. This will provide us with further opportunities for improved metering.

This spring, we have begun piloting a new points-based behaviour change rewards scheme, and have included an activity to encourage staff and students to report leaks/drips to us for timely investigation, giving a good opportunity for localised user actions to contribute to our goals.



> WE PRIORITISE POTENTIAL SAVING INITIATIVES THROUGH A COMBINATION OF THEIR SAVING POTENTIAL, IMPLEMENTATION COST, EASE OF IMPLEMENTATION AND REPUTATIONAL BENEFITS TO GIVE THEM AN OVERALL WEIGHTING THAT THEN FORM THE BASIS OF OUR ANNUAL DELIVERY PROGRAMMES.

What's the plan?

In 2016, we were pleased to meet our initial carbon reduction target of 35% compared to a 2008/09 baseline and in 2017, we launched our new combined Carbon & Water Management Plan; setting targets to reach 45% carbon reduction and 35% water reduction by July 2021. Taking a combined approach to carbon and water management helps ensure we apply the same prioritisation principles to both programmes and make progress in both areas.

All our halls of residence are run under a joint venture with a third party provider on a long-term lease, so we do not have operational control of these buildings.

Our focus for water savings is therefore in our academic buildings, where savings principally revolve around 2 areas; science laboratories and washroom provision. We prioritise potential saving initiatives through a combination of their saving potential, implementation cost, ease of implementation and reputational benefits to give them an overall weighting that then form the basis of our annual delivery programmes.

How can water consumption in labs be reduced?

Tackling water consumption in our science labs has meant getting to grips with the basics of some of the complex science our researchers undertake. We have been fortunate to have good support from technical staff in the Schools, and a combination of initiatives have delivered estimated savings of 25,000 m^3 (£41,000) per year.

The biggest 'culprit' in terms of water consumption in labs has been the common practice of using water for cooling and to create vacuums, often leading to significant fresh water running to drain. Whilst this has long been recognised as wasteful practice, delivering alternative solutions has proved complex. School budgets are constrained and utilities bills are

paid centrally, so it has been important to work in collaboration with the Schools to deliver solutions for mutual benefit.

In 2017, as part of a wider refurbishment to a large Chemistry teaching lab, we invested £140,000 in the installation of a centralised vacuum system and chilled water system, which have delivered significant reductions in the lab's water consumption.

As these systems consume energy, a holistic approach was needed to assess the overall cost/benefits. The scheme is anticipated to pay back in around 7.5 years, and through an associated reduction in the energy required to treat and deliver water to the site, will also marginally reduce carbon emissions overall despite the increase in onsite energy use. We now plan to complete a similar upgrade in the second teaching lab in summer 2018, delivering further significant savings.

Water is also used for cooling in a range of applications in our research labs. After discussion with our School of Chemistry, Food and Pharmacy, we agreed to purchase 8 waterless condensers in a range of sizes as a trial. These devices have a very large surface area and are therefore able to provide the required cooling with only air, completely negating the need to use water. These quickly proved very popular, and with a payback of just over a year, we have happily bought the School 40 of these units, facilitating a change in behaviours previously embedded into the School's practices.

Increasingly, we are seeking opportunities to joint fund initiatives with our Schools, particularly where this can be used to encourage the purchase of more energy/water efficient products.

Highly purified water is needed for some experiments and we have made financial contributions to encourage Schools to buy more water efficient water purifiers, which use 50% less water than traditional models.

Whilst these contributions usually only account for around 20% of the overall costs, they have proved a sufficient incentive to 'choose well' and ensure whole life costs are being considered in purchasing decisions. Similar contributions for ultra-low temperature freezers and autoclaves have been provided to save energy.

> "AT A TIME OF GROWTH IN STUDENT NUMBERS, OUR STRETCH TARGET MAY PROVE CHALLENGING, BUT AS WITH OUR CARBON REDUCTION PROGRAMME, WE PLAN FOR ANTICIPATED CHANGES IN OUR ESTATE AND OPERATIONS TO TRY AND ENSURE OUR TARGETS ARE APPROPRIATE."

What about washrooms?

Sinks, toilets and urinals all offer opportunities for water savings. Our current focus is to try and ensure that existing urinal flush controls are properly set up, and this has delivered some surprisingly large savings.

In one of our large teaching buildings, re-commissioning the existing controls has saved 3,500 m^3 water (37%) in the first year, paying for itself in a year.

This opportunity is unlikely to be replicated on such a large scale in other buildings, but it does highlight the importance of checking our controls are working effectively; something which is evident throughout our Carbon and Water Management Programme.

Where do we go from here?

We have set a target to reduce our water consumption by 30% against our 2011/12 baseline, with a stretch target of 35% reduction. We have robust systems in place to continue to deliver on our sustainability commitments long term, certifying our energy and environmental management systems to ISO50001 and ISO14001 respectively.

At a time of growth in student numbers, our stretch target may prove challenging, but as with our carbon reduction programme, we plan for anticipated changes in our estate and operations to try and ensure our targets are appropriate.

To continue to make reductions, we will need to understand more about exactly where our water is consumed, and so our next focus will be on tackling some of the 'hard to do' metering to ensure we continue to make progress towards our long term targets.

Author's profile:

Dan joined the University of Reading as Energy Manager in 2011, subsequently also taking additional responsibility for the University's wider Sustainability agenda. He is also a Director for Reading Community Energy Society, and a Board member of Reading Climate Change Partnership. Dan achieved a 1st Class Environmental Studies Bsc from the Open University in 2014.

by ANDY WATSON
CEO at Sim Energy Ltd

Energy Management in Legacy Data Centres

The growth of the internet and our reliance on online transactions and communications has led to huge growth in the infrastructure in the form of hundreds of data centres in the UK. Furthermore, as we rely more and more on Cloud storage and thereby think less about IT storage conservation, the effect on growth of datacentres is considerable. Designing and constructing energy-efficient data centres is now becoming the norm for many companies where previously resilience to failure and service dropout was by far the most dominant factor. However, how we manage the considerable stock of older legacy data centres is also becoming a growing problem. Having surveyed some forty nine data centres across the UK, some enticing opportunities for reducing energy usage are available for minimal cost.

The equipment in data centres often requires precision cooling on a large scale. Novel approaches to cooling include:

- free cooling (using ambient external air to provide directly or indirectly remove heat from the IT equipment without going through a mechanical chiller process)
- direct cooling (pumping coolant into cooling fins located at the equipment cabinets)
- adiabatic cooling (using a form of evaporative cooling to reduce mechanical chiller loads).

These take place in the present design stages of data centres where servers are now less sensitive to overheating or air particulate contamination. However, older legacy data centres were frequently built with less focus on energy conservation and thereby relied on mechanical chilling, pumping of a cooling medium and tempering of air to be fan driven at the IT equipment.

What is in a data centre?

In typical data centres, the main assets for consideration include those normally found with air conditioned buildings including chillers, pumps, air handling units (or Computer Room Air Conditioning CRAC units), ducts and spaces for air flow, controls etc.

In essence, it is not so different to any air-conditioned building; however it is almost always the case that the following service criteria have to be achieved:

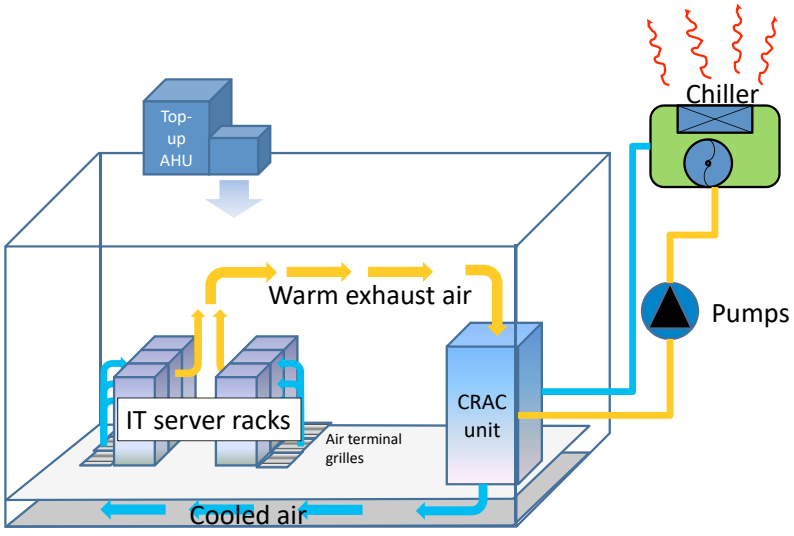
1. Supply air temperatures must be low enough so that fully loaded IT servers do not overheat and fail.
2. Supply air pressures must be high enough so that air delivered by the floor terminal grilles is "thrown" to reach the tops of the cabinets so that all servers are delivered adequate cooling.
3. Relative humidity must be controlled to eliminate the build-up of static electricity (with too low RH) and condensation (too high RH).

The above provisions must be normally available 24 hours a day and 365 days per year.

What can go wrong?

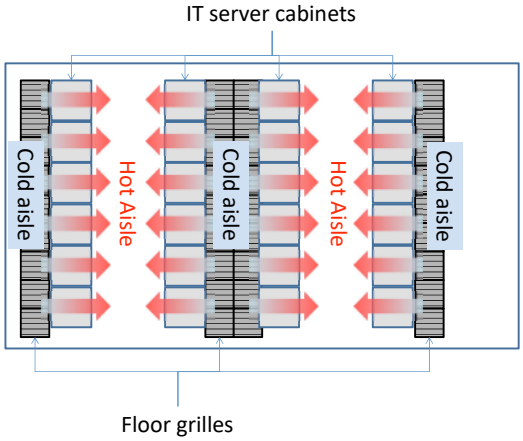
Over years of a data centre's life it is highly likely that changes to the assets and infrastructure will be made by owners, operators, clients and maintainers in order to achieve numerous, and often unclear, outcomes. Installing a new cabinet and placing an air-supply grille is commonplace. During this relatively straightforward procedure, all kinds of issues can be created by not communicating with the data centre owner or the maintainer of the infrastructure. Compounding this over many repetitions, along with a lack of clear operating policy and procedure, often leads to the rather sorry state that many legacy data centres find themselves in where even though the data centre isn't at maximum capacity:

- Overheating occurs
- Energy usage remains high even at sub-capacity



Typical equipment layout of a legacy data centre

- Air temperature setpoints have to be reduced in order to cool overheating IT assets
- Condensation and corrosion occur in the CRAC units



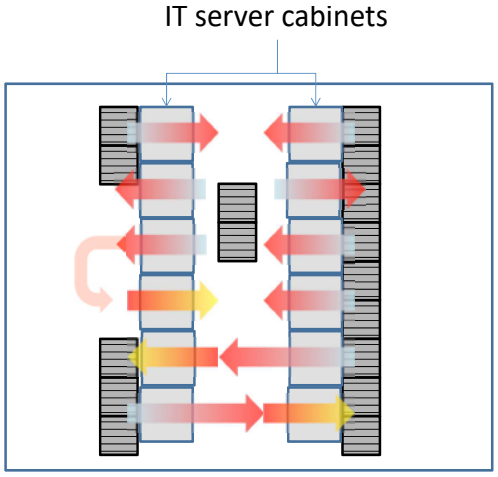
Arrangement of cabinets and floor grilles to make hot aisles and cold aisles

Oddly, a blinkered focus on resilience and reliability can lead to the exact opposite outcomes and in fact nearly exercises to improve energy efficiency are more than likely to result in better service availability and asset life.

Aisle and row configuration

The basic design configuration of a data centre should arrange IT servers and their cabinets so that halls are allocated into hot aisles and cold aisles.

In this configuration the amount of heated exhaust air being ingested back into a server is minimised. Without avoiding this hot and cold air mixing the amount of air required for effective cooling increases and cooling systems will need to be set to their maximum both in terms of air delivery and minimising temperature setpoints. In many data centres a random approach to configuration has evolved leading to inefficient and ineffective operation.



Common arrangement with lack of care regarding cold aisle and hot aisle configuration

Unfortunately, as shown in the diagram above, it is common for there to be a lack of care concerning the configuration of the servers to make dedicated hot and cold aisles. In this instance, hot exhaust can be ingested back into servers from either an adjacent cabinet or from cabinets located in adjacent rows.

This causes equipment to overheat and subsequently data managers are compelled to further reduce the supply air temperature or put in even more supply air grilles.

Air terminal grille configuration

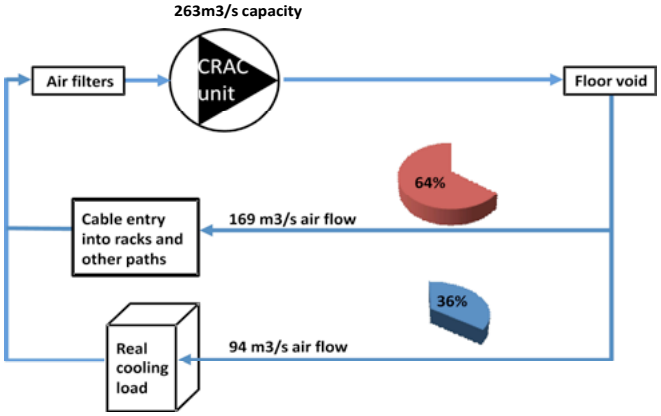
Unless grilles are positioned in front of cabinets so that the air "throw" can reach the top of the cabinet, effective and efficient cooling can never be reached. In many cases in legacy data centres, grille redundancy (the siting of grilles away from cabinets) can be as high as 90% causing supply and return air to mix. This creates an environment which has an almost homogenous air temperature which requires more air delivery and lower temperature setpoints in order to keep servers cool.

Redundant air terminal grilles contributing nicely to the electricity bill

The only reasonable time that grilles do not require positioning directly in front of a server is when cold or hot aisle containment exists. In these circumstances hot and cold air mixing is minimised through the use of a solid shell around the servers keeping supply and return air separate.

Leaks, holes and short circuiting

Without adequate sealing of cable-entry holes in the floor, whether they are beneath cabinets or around the walls, supply air will mix with return air and reduce effectiveness. In many cases, the vast majority of supply



The air flow path through most legacy data centres has been shown to go through ineffective short circuit paths often via cable entry penetrations in floors

air is wasted through these short circuit paths. By sealing these penetrations with brush grommets or similar devices, the underfloor pressure will naturally lift and more air will be presented at the air terminal grilles.

The routes to energy efficiency – cold air is money!

Essentially, effective air distribution should be the primary objective for increasing efficiency, effectiveness and resilience of a data centre cooling system.

Route 1 – optimising the underfloor air pressure can be simply and cheaply achieved by reconfiguring grilles, sealing penetrations and reducing obstructions. Once air pressure has reached a maximum achievable it may then be possible to reduce fan speeds on the air conditioning units. This will be largely dependent on the equipment installed (newer units have fan speed controls installed, older units may need this retrofitted) but if achievable the fan laws allow considerable energy savings for small reductions in fan speed.

$$P1/P2 = (N1/N2)^3$$

This means that, for example, a reduction to 90% of the fan speed will result in power being reduced by $(90\%)^3$ or 73%; a 10% reduction in fan speed for a 27% reduction in electrical power.

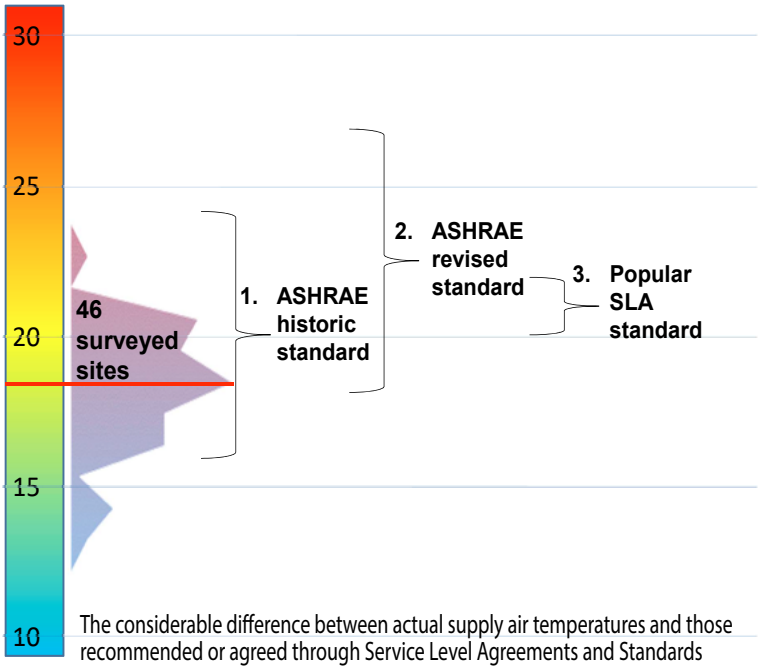
Case Study

In a recent exercise, a data centre with two halls A and B (600 and 800m^2, respectively) carried out a range of low-cost underfloor air pressure improvement tasks including reconfiguring grilles and patching up some of the floor penetrations. In Hall A, the pressure lifted from 7 to 23 Pa, in Hall B the pressure lifted from 9 to 17 Pa. The average rack temperatures dropped by 2 and 6°C respectively. In both cases the fan speeds were then manually reduced so that an average was met between the old air pressure and the new. This reduced the combined annual fan energy usage by 42 MWh while still reducing average rack temperature. The project (including parts and labour costs) paid for itself within 2 months.

Route 2 – for the next low-cost opportunity is to moderate the air temperature setpoints. Despite the trend for maximum temperature setpoint recommendations to have risen over time, the tendency is for overcooling to be inherent in legacy data centres. Over the 49 sites physically surveyed in the UK, the range of supply air temperatures was found to be between 13 and 23°C with the average around 18°C, far cooler than is necessary for the majority of IT servers. Even up to 5 years ago, many server manufactures were quoting preferable supply temperatures of 28°C, 10 degrees higher than the average legacy data centre.

Of those surveyed data centres where both supply and return air temperatures were accurately recorded (26 out of 49), it was found that the average difference between supply and return air temperatures was 4.1°C (or Kelvin as this should more accurately be described).

Of those 26 sites, only one exhibited the 10 degree difference in air temperatures that most air conditioning unit



The considerable difference between actual supply air temperatures and those recommended or agreed through Service Level Agreements and Standards

manufacturers design for. This clearly shows that on the whole, most legacy data centres are over-supplying air in either degree of coldness or volume, or both.

Route 3 – there is an approximate 3% reduction in chiller compressor energy usage for every 1°C lifted in supply air setpoint. This has been trialled and within reason shown to be effective in most cases (some chillers do not operate predictably through merely changing the setpoint). The reduction in compressor energy usage contributes to an overall saving in:

- Reduction in conduction losses in the pipework infrastructure
- Reduction of latent cooling of air (which may then require re-humidification – an expensive commodity)
- Reduction on chiller wear-and-tear

Data centres of the future

There has already been a marked change in the design and operation of modern data centres in comparison to those built in the 1980s and 1990s. A particular interesting direction is the manufacturing of extremely resilient IT servers that can easily use external ambient air as a cooling medium. This has led to the construction of open-air data farms which require no additional chiller plant or mechanical cooling.

At the other end of the spectrum are expensively-constructed, precision cooled data centres using direct cooling to the IT equipment and utilising the most efficient forms of mechanical chiller such as the magnetic-bearing compressor. The increase in number of smaller IT enterprises means an increased growth of co-location data centres and thus customer choice in future may drive the design of data centres. It is hoped that energy efficiency is as much a value as service resilience to the modern IT customer.

Conclusion

Every data centre needs to be assessed on a case-by-case basis to determine which opportunities are best and how they should be implemented. There are often large business cases available but the owner-operator should not forget about the quick wins through better management and care. These housekeeping opportunities will often have the shortest payback periods and will optimise the cost-effectiveness of any future large-scale energy conservation opportunities.

Author's profile:
Andy Watson has been involved in energy management since 1997, he was the Energy Manager for Heathrow Airport from 2001 to 2006, and since 2011 has worked extensively in data centre energy conservation carrying out a range of surveys, reports and energy projects. Andy is a Chartered Engineer with CIBSE and the EI. In 2005, he won the EI Energy Manager of the Year award and continues to sit on the evaluation panel.

by CAROLINE HOLMAN
Senior Manager, Energy Strategy & Provision at Jaguar Land Rover

Career Interview

The Energy Managers Association aims to encourage and enable more professionals to enter the world of energy management and environmental roles. We have taken on a challenge of changing the perception of energy management, by raising the sector's profile and sharing our members' – leading energy managers - insights into their career progress and achievements. In this issue, we have asked Caroline Holman, Senior Manager, Energy Strategy & Provision at Jaguar Land Rover a few questions about her career.

What made you choose energy management as a career?

To be honest I am not sure that there was a particular point at which I thought 'I want to be an Energy Manager' and the role is so much more than 'management' anyway. However, the main reasons would be a mixture of opportunity, circumstance and an increasing awareness within my previous roles that 'energy' is and will continue to be a resource that must be treated as seriously as other commodities including cash!

> "'ENERGY' IS AND WILL CONTINUE TO BE A RESOURCE THAT MUST BE TREATED AS SERIOUSLY AS OTHER COMMODITIES INCLUDING CASH!"

What does your role at Jaguar Land Rover entail?

My role at Jaguar Land Rover sits within the Estates Management (FM) function of Global Property. It entails energy strategy and provision up to and including all sites (Manufacturing and Non-Manufacturing) within our portfolio. The role is quite broad from guiding and influencing daily energy management to long term (2025+) policy and strategy.

What is the most exciting part of your job?

Historically as a project manager, I have always said delivery of projects. However, at the moment it is about developing clear policies and the standards which underpin them. Our industry is currently undergoing significant transformation and policies have to be future proofed yet agile, flexible, aligned and targeted. Probably the single biggest 'selling point' for me is that directly and indirectly my role involves every stakeholder function and it focuses on total resource efficiency. I have two pet hates – waste and mediocrity. This role allows me to influence and avoid in equal measure!

What is your biggest achievement to date?

I am very fortunate that I have been able to work within and alongside some incredibly successful and talented teams in my 28 year career and by definition no one individual can take credit. However, my most memorable and satisfying personal achievement was in 2015 when I was elected as a Fellow with the Institute of Engineering Technology (IET).

What was the most exciting project that you worked on and why?

There are two: delivering Jaguar Land Rover's first roof mounted PV Array at our Coventry HQ in less than 9 months from concept to delivery, and working with the Engine Manufacturing Centre (EMC), Purchasing and Group Sustainability teams to deliver on time and at budget the UK's largest (at the time) roof mounted PV array.

EMA ENERGY MANAGEMENT AWARDS 2018

ema energy managers association
Energy Management Awards

Giving prominence to those leading the energy management industry and inspiring others to follow in the same footsteps.

ENTRIES ARE NOW OPEN!

Entries for the following categories can be submitted on the EMA website until Friday 14 September 2018.

- Energy Manager of the Year
- Junior Energy Management Professional of the Year
- Energy Management Team of the Year
- The Most Inspiring Energy Reduction Project of the Year
- Energy Management Consultancy Service of the Year
- Energy Reduction Project through Organisational Behaviour Change of the Year
- Energy Reduction Product of the Year
- Water Reduction Product of the Year

Winners of the EMA Awards will be able to:

- Use the EMA Energy Management Awards 2018 logo.
- Have the category profiles included in The EMA Magazine and EMA website.
- Highlight their achievements with published case studies (The EMA Magazine and website).

The winners and highly commended will be announced at a ceremony on Wednesday 21 November 2018 at EMEX, ExCel, London.

TO ENTER THE AWARDS VISIT:
www.theema.org.uk

What is the most frustrating part of your job?

It is less a frustration more a personal challenge I have in thrifting through multiple data and information sets to focus on the vital few and target high impact communication and engagement. I would welcome a more 'plain English' simplified and condensed approach when it comes to consultations, legislation and industry guidance!

If you had the opportunity to change one thing that would make your job easier, what would you change?

I am not sure I would change anything but I would like to see more of collaboration which has and continues to work so effectively in our industry.

A case in point is the use of EV batteries for energy storage including their potential role in grid stability. Recent articles appear to suggest a conflict between those who support this and those who feel this would undermine the practicality and uptake of EVs. In reality both arguments in the right (or wrong!) circumstances are correct.

However, we need stakeholders such as BEIS, Ofgem and local DNOs to draw a line in the sand and agree on a direction of travel, particularly from a national infrastructure and distribution viewpoint. Suppliers and innovators from generators through to energy consumers can and do work together to develop and bring to market practical, competitive and profitable solutions.

What is the best approach to attract women into energy management sector?

This is a difficult question but my personal view is that we should focus less on gender but more on providing good honest information about the many and varied opportunities within our industry to a much wider audience including women. This is a role which brings together a wide range of technical, personal and leadership skills and in my opinion is a significant 'growth' area for employment and long term career development.

What advice would you give to someone looking to become an energy manager?

Be yourself, do not discount the skills you have already acquired and their relevance to this role; I can guarantee that they will be transferable and influential in this area. Get to know the area in your business which currently leads Utility/Energy Management and talk to those whom currently do the job - test the waters (or in this case energy!). I have not met an energy manager yet who would turn down a willing volunteer no matter how temporary or inexperienced!

> "OUR INDUSTRY IS CURRENTLY UNDERGOING SIGNIFICANT TRANSFORMATION AND POLICIES HAVE TO BE FUTURE PROOFED YET AGILE, FLEXIBLE, ALIGNED AND TARGETED."

What is the most absurd statement that you have heard in your job?

'I have picked all the low hanging fruit so now my only option to reduce energy and costs is to invest…' Rubbish! You have to keep going back, checking, and looking for anomalies or outliers and review based on good performance measurement and assessment. It is also important to re-assess base assumptions, targets and performance as very little is static or permanent!

What are your long-term motivations in a company or a position?

After 28 years in the same industry and having had more opportunities than if I had changed companies/industries every 3 years I would say that my motivation has always been long term. I like the fact that I do not need to look beyond my current role for more challenges, new experiences or job satisfaction – it is embedded in what I do!

EMA Employment and Pay Gap Survey Results

The gender pay gap has always been a topic of interest, and in an attempt to increase awareness and improve pay equality, the UK government introduced compulsory reporting of the gender pay gap for organisations with 250 or more employees by April 2018. The results indicate that for the UK as a whole, the gap has reduced in the last 10 years but is still in favour of men.

The gender pay gap is defined as the difference in median gross hourly pay between men and women. However, even this measure does not take into account equal pay for equal work, which would be near impossible to achieve when it comes to energy managers.

The definition of an Energy Manager's role is a tricky task as its meaning varies across organisations, but we were interested to find out what you thought is happening in the industry and whether there are disparities between the gender pay in energy management. This is what you told us...

FINDINGS

Pay Gap:
33% believe there is no pay gap in their organisation
28% believe there is a pay gap in their organisation
34% have no one to compare with
5% do not know

Annual salary:
7% less than £25,000
18% £26,000 - £35,000
15% £36,000 - £40,000
17% £41,000 - £45,000
11% £46,000 - £50,000
7% £51,000 - £55,000
7% £56,000 - £60,000
18% above £60,000

Average salary in…
£39,700 Public sector
£45,400 Private sector

£44,762 Female respondents
£44,785 Male respondents

£42,400 In-house
£46,000 Consultants

£53,500 Retail
£46,300 Facilities Management
£45,000 Manufacturing
£44,750 Healthcare
£41,530 Education
£39,000 Local authorities

Pay rise frequency:
57% annual
25% other (external influencers, such as: inflation; in line with public sector rises; company performance)
10% never
8% every other year

44% of respondents requested a pay rise in the past (23% of women and 77% of men).

Pay rise influencers:
44% success rate of projects/achievements
46% other (external influencers, such as: inflation; union negotiations; company performance; cannot influence)
4% professional energy management training
2% CPD achieved
2% professional qualification (ESOS/ ISO Assessors)
2% chartered status

RESPONDENTS:

Gender:
28% female
72% male

Role in the industry:
69% in-house energy/facilities/sustainability/ environment managers
25% energy services providers
6% other

Years in the industry:
3% less than a year
27% 1-5 years
33% 6-10 years
15% 11-15 years
8% 16-20 years
14% 20+ years

Qualification achieved:
30% an Environmental degree
23% Training/Qualification with a professional body
17% an Engineering degree
14% other
11% self-trained
5% in-house training

How have you fared?

We would like to hear your thoughts on the subject, and we will continue with this topic in the next issue.

by MIKE PEDLEY
Head of Energy at Dwr Cymru Welsh Water

Five Fords Energy Park

Welsh Water is a not-for-profit water company serving around three million customers in Wales and Herefordshire. Operating over 4200 sites to deliver a 24/7 service uses a lot of energy, almost 500 GWh a year. Over the last 8 years, the amount of energy generated has increased from just 2% to 20%. By 2020, when current investments are fully online, that proportion will have reached 30%. Welsh Water's long term vision is to meet all its own energy needs by 2050.

Meeting such an ambitious goal needs innovative thinking, not just investment. At Five Fords Waste Water Treatment Works near Wrexham that's just what Welsh Water have done. Near to an industrial estate just outside the town, an unremarkable sewage works is being transformed into an innovative Energy Park that aims to maximise the energy generation and carbon reduction potential of the site. It already integrates a large (2.5MW) solar array (PV), anaerobic digestion (AD), a 1.2 MW combined heat and power plant (CHP) and an innovative bio-methane injection (gas-to-grid) project. Over the coming years the AD will see a further upgrade to triple its gas output and the existing technologies will be complemented by wind and hydro. The site is now well on the way to becoming a net exporter of both electricity and gas, and shows a significant reduction in carbon emissions as it moves towards true energy self-sufficiency.

> "THE SITE IS NOW WELL ON THE WAY TO BECOMING A NET EXPORTER OF BOTH ELECTRICITY AND GAS, AND SHOWS A SIGNIFICANT REDUCTION IN CARBON EMISSIONS AS IT MOVES TOWARDS TRUE ENERGY SELF-SUFFICIENCY."

Plans and objectives

The project originated from a desire to make best use of the available biogas but then widened out as the potential became clear for maximising benefits for the company and its customers by utilising multiple renewable energy technologies in tandem (AD, PV, CHP and gas-to-grid). We looked at the site and asked ourselves "How can we maximise the energy potential of this site?" All renewable energy technologies were considered and matched against the characteristics of the site (available space to develop, an open aspect and few immediate neighbours).

- Available brownfield or low quality agricultural land in and around the operational site suited solar PV,
- an open aspect and few neighbours suit wind,
- an existing intermediate pressure gas main combined with forecasted increasing gas production from sewage bio-solids is ideal for bio-methane injection,
- and the elevation of 35m above the river even makes small hydro a possibility.

The project set out to achieve a range of objectives.

- **Financial benefits** which, with its not-for-profit model, mean savings to keep bills down (Welsh Water has kept bill changes below inflation for the last 9 years) and to retain money to re-invest in the business. The not-for-profit model means that Welsh Water can invest its own money in projects without the need for external project finance. Thanks to this approach the total budget for investment into energy projects for 2015-20 has been almost doubled.
- By creating a **sustainable** and **energy neutral** (or energy-positive) operation at Five Fords, Welsh Water is taking another step towards its stated vision of being energy neutral by 2050.
- It also increases **flexibility** and raises **resilience** providing multiple ways to generate energy depending upon prevailing and operational conditions.
- Finally the investment in the AD enhancement also provides **improved treatment** quality for sewage bio-solids enabling it to meet the new standards set by Water UK's Bio-solids Assurance Scheme.

Development phases

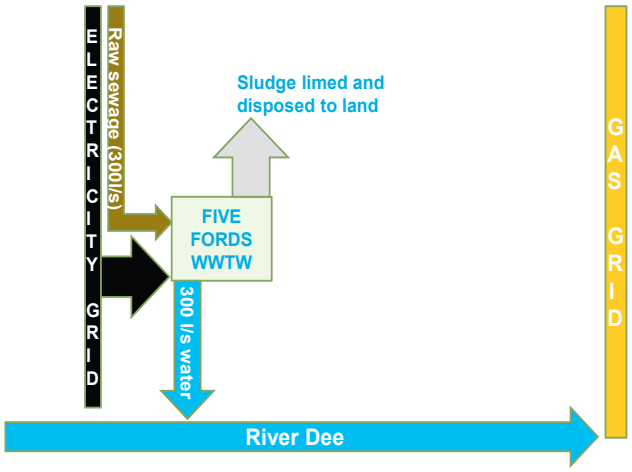
The key developments to date have come in three phases.

1. A conventional AD site with CHP was built in 2012. At that stage, it was intended as a standalone development as part of a wider programme to digest and generate energy from all the sewage sludge across the company.

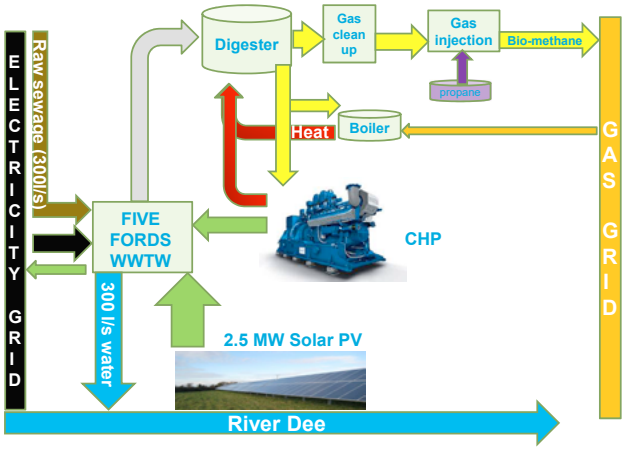
2. The energy park concept came in 2014 as we developed our next investment programme and looked to how our energy potential could be maximised. Feasibility and stakeholder engagement followed the same year, and the decision was taken to invest £7m, using internal financing, into an innovative membrane based gas-to-grid plant and a 10,000 panel solar array. Welsh Water's not-for-profit structure means it can reinvest money which would otherwise be paid in dividends into further projects to benefit customers through improved water quality or reduced costs (contributing to keeping bills low).

3. With the first two phases complete, the site can look forward to a third phase of development over this and the coming two years. The AD from 2012 is seeing the addition of thermal hydrolysis pre-processing as part of an expansion in bio-solids processing capacity. The additional plant will come online in 2019 and bring total investment in the energy park to £36m. It is also intended to complement these with a wind turbine by 2020 and a possible hydro. The latter would complete a project conceptualised in 1993, provisioned for in the pipeline design but never completed due to the challenging economics of delivering such small renewable energy schemes that were, and still are, ineligible for financial support.

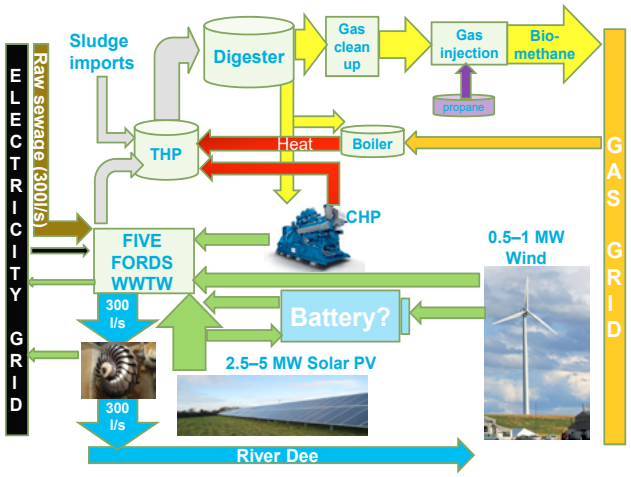
Energy Flow: Before



Energy Flow: Now



Energy Flow: Now



Operations and benefits

The gas to grid plant currently produces around 12 GWh gas per year. This is sufficient to provide heating to about 1000 homes which, in turn, has a carbon saving of over 2000 tonnes CO2e. These numbers are set to triple once the thermal hydrolysis pre-treatment stage has been added to the digestion plant. This allows greater sludge throughput and increased gas yields (which the gas-to-grid plant has already been sized to accommodate).

Two 600kW CHP engines are used to complement the gas to grid generating at peak times when our demand for electricity is high, when the price of imported electricity is high or when additional heat is required for the processes on site. The 2.5 MW solar PV array generates over 2GWh a year of electricity per year, power which is mainly used on site. These operational components of the Energy Park have saved significant energy costs and 3,800 tonnes CO2e/year through reducing the electricity required from Grid.

Savings will rise substantially when the remaining elements are completed. Each individual component has been a success but the real value is gained by operating them in an integrated way. Generating energy from the sun when it is shining (and eventually from the wind when blowing), heat and electricity from CHP when we need it for the treatment process, and exporting the gas to the local gas grid when we don't. There in the local community, people will be cooking their tea with gas created from what they flushed away a couple of weeks earlier. A real circular economy in action.

Complex and innovative projects are often filled with obstacles and lessons learnt the hard way. Whilst there was learning throughout, this project can be looked on as a real success story. Some of this success may be due to the extensive stakeholder engagement that was done before any consents were even applied for. Branding the combined elements as a waste water "Energy Park" also proved valuable. That combined everything into a sizable investment with 'green' credentials that local stakeholders could recognise and support.

> "IN DOING SO, WE ARE WELL ON THE WAY TO CREATING A MICROCOSM OF THE 'SMART NETWORK' THINKING THAT COULD TAKE PLACE ON THE MACRO LEVEL IN THE UK AND DELIVER LONG TERM SAVINGS AND SUSTAINABLE OPERATIONS."

Despite the gas-to-grid being the first membrane technology plant to be used for sewage gas clean up (other water companies use a water wash process), that element of the programme and the solar arrays were both delivered to tight timescales to hit tariff deadlines for Renewable Heat Incentive for bio-methane injection and Feed in Tariff for solar PV. Once operational, the gas-to-grid has run very reliably, being happiest when left to run in a steady state and have the CHP engines modulate around it depending on gas available and external conditions. We have also benefitted from having someone on site during working hours dedicated monitoring, maintaining and optimising the digestion, CHP and bio-methane injection processes. Having originally been designed to rely on external specialists, having some internal expertise has been a real benefit.

Innovation in action

The innovative nature of the project is underlined by the gas-to-grid project being both the first membrane technology gas-to-grid plant built by a UK water company and the first (and still the only) operational gas to grid plant in Wales.

By combining multiple renewable technologies at Five Fords we have created a showcase site which is attracting wide interest as well as support from local stakeholders. The Energy Park is an important part of our energy strategy at Welsh Water and the concept of combining multiple technologies is one that the company is pursuing on other sites albeit none offer quite such scope as Five Fords.

At Five Fords we are managing the electrical, gas and heat demand and meeting those needs from renewable sources. In doing so, we are well on the way to creating a microcosm of the 'Smart Network' thinking that could take place on the macro level in the UK and deliver long term savings and sustainable operations.

Author's profile:

Dr Mike Pedley leads Welsh Water's energy strategy including energy purchasing, optimisation, generation and carbon reporting whilst also bringing a commercial background, including acquisitions of renewable energy assets, as well as environmental and technical experience.

EMA Courses in 2018

Energy Management in Practice Training Programme

The EMA has produced a training programme for individuals interested to gain knowledge needed to operate effectively as an energy manager in a workplace.

The portfolio of practical courses features established, as well as new, EMA courses. Unless otherwise stated, the courses will take place in London.

- Fundamentals of Energy Management: 4-5 October
- Energy Assessments, Measurements and Verification: 8 October
- Energy Management Strategy: 9 October
- Understanding and Delivering Behavioural Change Programme: 27 September (Birmingham)
- Energy Procurement: 11 October
- New* Monitoring, Targeting and Validation: 21 September
- Water Management: 16 October
- New* Waste Management: 2 October
- Lighting – Basic Understanding: 25 September (Birmingham), 23 October
- Battery Storage for Business: 29 November (Leeds)
- Essential HVAC Control and Optimisation: 13 November
- New* On-site Electricity Generation: 18 October (Birmingham)
- Regulatory and Legal Compliance and Carbon Management: Half-day course starting in 2018
- Turning Data into Energy Savings: 6 November
- EMA Energy Assessor: 7-9 November
- Become an ESOS Lead Assessor: 2 November

These courses are intended for candidates who are:

-Up-skilling their existing energy management knowledge and skills
-Re-skilling from other professions such as sustainability, environment, facilities and engineering
-Newly appointed energy managers
-Interested in becoming energy managers

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Theory combined with real-world applications

by REBECCA CARTER
Senior Engineer at Sweco UK Limited

Storage Wars – How Batteries Can Give Businesses a Commercial Edge

As the government looks to make power generation in the UK more efficient, re-engineering the way we consume energy as a nation is going to play a key role. Known as demand-side response, essentially the idea is to use dynamic pricing to encourage large energy consumers to use less power at peak times, smoothing out consumption and reducing the maximum generation capacity needed across the grid.

This will make better use of electricity-generation resources by reducing the need for power stations that currently sit unused for most of the year, only to be 'switched on' during peaks in demand. It will also lessen the UK's dependence on polluting fossil-fuel generators and reduce the overall cost of powering the country.

For businesses, Behind the Meter (BtM) energy storage will play an important role in negotiating this changing landscape and keeping energy costs under control. BtM energy storage means just that – installing batteries that can store and discharge energy on a business' own site, so that energy doesn't need to be used as and when it is purchased from the grid. This allows large consumers to buy power from the grid at the most affordable rate and store it for use during peak times. It also allows them to store any energy generated on site so that it can be exported at peak times when the best rates are on offer.

This is a strategy that has become economical only in the past two years or so. Already the UK has seen strong growth in both utility-scale storage and, to a lesser extent, distributed micro-storage of the sort that could help businesses save or even make money. The energy market moves rapidly, as do the benefits available to companies, so agility and up-to-date awareness of any forthcoming changes are both essential to any energy storage strategy.

Here, we'll look at the positive impacts battery storage strategies can have, and which are likely to be available and attractive to energy managers of large commercial buildings or industrial sites.

The potential benefits of battery storage

Running your operations from stored power rather than directly from the grid during high-demand periods can allow you to avoid the higher tariffs payable for energy during those timeframes.

There are three mechanisms network operators can use to charge large power-consumers more for using power at peak times – peak-rates, triads and the Capacity Market Levy.

1) Peak-rates
Peak rates vary between different agreements between customers and networks but typically cover daily periods totalling between two and four hours. Using stored power during these times will allow you to avoid the higher charge.

2) Triads
Triads are more complex. They comprise the three half hours of highest demand, separated by at least ten days, each winter. The network calculates additional charges for each large energy user based on their consumption during those periods. To be sure to evade the charges, you would need to avoid consumption during all potential peak times throughout the winter, which would add up to four hours per day. Of course, these periods are likely to overlap with the peak rates mentioned previously. The benefits of avoiding triads are only available for a limited time, however, as Ofgem recently announced that the charges will be gradually phased out between now and 2020.

3) Capacity Market Levy
The Capacity Market Levy was added in 2017. The charge is typically based on consumption during the biggest winter peak, so avoiding it requires a similar approach to triad avoidance.
Side-stepping energy prices is a major benefit of a battery storage, but there is potential for business to go further than that – batteries can also be an earner in their own right.

Storage as a revenue generator

Few businesses will have the capacity to work directly with the network, as most grid services require a minimum power output of 1-3 MW, which few BtM schemes will have. However, these revenue schemes can

be accessible through aggregators – companies that use smart grid technologies to combine medium-size assets into a package for selling services to the grid.

There are five main mechanisms available for sharing your storage capacity. Some of these are being used more actively than others at present, and a good energy management consultant will be able to advise on the feasibility of participating for any business with specific requirements.

1. Firm Frequency Response (FFR)
Historically lucrative, the minimum power output for this scheme was reduced from 10MW to just 1MW in 2017, greatly increasing the number of tenders received.

2. Short Term Operating Reserve (STOR)
This is a power storage reserve operated by National Grid to manage short-term supply losses or localised constraints. It operates over six 'seasons' per year, for which storage suppliers can bid for contracts. This has been growing in popularity, with the number of successful contract applications rising from around a third in 2015 to around 80 per cent in 2017. Participants will need to be able to respond to demand requests within five minutes, and provide power for a minimum duration of half an hour.

3. Capacity market
Since 2017, this has offered long-term contracts of up to 15 years, with auctions for capacity held four years ahead of the requirement coming online, with a subsequent auction held one year ahead. The next of these auctions is expected to be held in March 2019, and this will be confirmed later in the summer. Participating in this scheme is most cost effective for batteries which can provide their peak output for four hours continuously, due to rules limiting the capacity usage of batteries over shorter durations.

4. Wholesale markets
These require a membership fee for participation and work on the basis of day-to-day trading of capacity. Both this and the balancing mechanism below work best for a site which can support a large battery of a few hundred kilowatts, and 24-hour operation, such as a waste-water treatment works.

5. Balancing mechanism
This is an ad-hoc market, with no forward commitments and highly dynamic prices. The need for short-term bidding means frequent communications and a 24-hour control room are required.

Looking further ahead

Two new frameworks that could draw big headlines in the years ahead but which are currently in the early pilot stages are Demand Turn-Up and Virtual Power Plants.

The **Demand Turn Up** service encourages large energy users and generators to either increase demand or reduce generation at times of high renewable output and low national demand. This typically occurs overnight and during weekend afternoons in the summer. Having only launched in 2017, there are currently no energy storage participants, although this could well change in the years ahead.

Virtual power plants meanwhile involve direct trading between batteries and consumers in a virtual utility scheme. We have already seen examples of this, including Tesla's recently launched scheme in Australia, and this is set to be an important space to watch for the future

Where to start

For any business considering whether it could benefit from energy storage, there are two fundamental questions to ask at the outset.
Understanding what electricity supply contract and metering arrangement is in place is key, as it will determine whether energy is purchased at a flat variable rate.

Only businesses that buy according to a variable rate will be able to avoid peak time pricing by storing energy purchased off peak for use during periods of high demand. It may be possible to negotiate a new agreement with the network, however this may incur costs of its own, for example if new metering needs to be installed.

The second is whether the business is generating any power on site, and whether it has an export connection. If so, storage may allow you to maximise the revenue you can make from using on-site generated power or selling it to the grid.

Next steps

For those looking to make savings or bring in revenue from energy storage, the first step is to carry out a grid review. This means investigating existing grid agreements for contracted import and export of any capacity. The next is to carry out a feasibility study based on the following factors. Firstly, your critical vs non-critical load. Examples of critical load might include freezers in supermarkets, servers or airconditioning, which need to be always on. Non-critical loads are processes that can be scheduled for any time of day in order to benefit from favourable pricing.

Once that is established, you need to determine the optimum size of batteries to make a business case. This is a complex calculation that will yield a different result based on your consumption and generation patterns, and the agreement you have with the network. The final step is to look at the prices available from storage technology providers. These are currently around £300-£700/kWh for a commercial BtM system depending on battery size and chemistry, but prices have been falling rapidly. The challenge, then, is to work out potential return on investment based on the options available, factoring in the risks associated with future price changes.

Ultimately, energy prices are set to rise rapidly in the years ahead as the government looks to re-engineer the way the UK generates and consumes power. Those businesses that can take advantage of the new opportunities the emerging system is making available will gain a significant commercial advantage over those that are hit by the price increases.

Author's profile:

Dr Rebecca Carter is a Senior Engineer in the Heat and Power team at Sweco UK, where she has worked since 2012. She is responsible for developing and delivering Sweco's digital services in the water and energy sectors, including data analysis and management, modelling and simulation, and whole-life costing.

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by LORD RUPERT REDESDALE
CEO at Energy Managers Association

Climate change "we're d

Private Frazer's catchphrase in Dad's Army reflects the mood at many Climate Change discussions. The decarbonising targets of an 80% reduction by 2050 are challenging, to put it mildly. However, it may be possible to reach our targets on emissions, although there is a mountain to climb.

First the good news, since 1990 the UK has cut emissions by 42% while over the same period our economy has grown by two-thirds. The reduction has been achieved through the phase out of coal power stations, energy efficiency that accounts for 17% and the growth in renewables. These to an extent are the easy wins; the next steps are going to be harder and will have a significant cost.

The Government, through signing up to the Paris Accord, has agreed to an 80% reduction in emissions by 2050, although many scientists believe the 2050 target needs to be brought forward. This sounds great but, and there is always a but, delivering the reductions will need not only a move to decarbonising generation but also removing fossil fuels from heat generation and transportation. This may be the most difficult part. Is it feasible to replace gas boilers and fossil fuelled cars with electric? And where will the electricity come from?

Renewable heat is going to be one of the challenges that will need to be rapidly addressed and is one of the most problematic. The assumption that gas will be phased out for industrial and domestic boilers by electricity would, if achieved tomorrow, increase carbon emissions. Gas boilers in the home can be 95% efficient; if replaced by electricity then the losses from primary fuel to use need to be factored in.

Over 50% of our present electricity requirements are met by burning gas, large gas plants are around 70% efficient, that means thirty per cent of the energy is wasted through generation. Electricity transmission losses on the electricity grid are higher than the transmission losses suffered by the gas grid. According to the latest figures, a half per cent of gas is lost through transmission a year, and unused gas sits in the pipes whereas unused electricity is dissipated if not used. Finally, using gas efficiently at point of use has a far lower emission profile if gas is used in generation, but the government targets are all based on electrification which makes no sense till we achieve 100% low carbon generation.

The UK will be reliant on gas in generation for at least the next decade, but if we are to move to replacing our heat requirements with electricity, we will need to quadruple the generation we presently have. Renewable heat is an issue the government has been grappling with and was the basis for the introduction of the Renewable Heat Incentive (RHI) scheme. Renewable heat is based on burning biomass with the idea that the carbon is recycled by the next crop grown for fuel. There is a timescale problem in terms of our targets and that is wood takes longer to produce than our targets allow.

Biomass also has higher carbon content for KWh produced than gas, so we may actually through moving to biomass be increasing our CO_2

doomed!" or perhaps not

emissions in the short to medium term. The future of the RHI is also in doubt as there is no commitment by the Government to renew past the scheme's present fixed term.

The next problem area in the progress towards a low carbon economy is that one third of our emissions come from the transport sector. To electrify the circa 27 million vehicles on the road would mean quadrupling the entire electricity generation of the UK to meet charging requirements.

Charging an EV at home can more than double the electricity usage of that home. The cost of the electricity makes EV ownership attractive on the cost per mile, at present around 4p, but will cause real headaches for the grid when mass roll out starts to happen.

Software that charges only at off peak is a short term solution but the sheer volume of power needed will mean that we will need to build a lot of new nuclear, wind and solar. Governments have since privatisation achieved low energy prices by basically avoiding the cost of building new power plants and distribution infrastructure.

> "FIRST THE GOOD NEWS, SINCE 1990 THE UK HAS CUT EMISSIONS BY 42% WHILE OVER THE SAME PERIOD OUR ECONOMY HAS GROWN BY TWO-THIRDS."

Following the dash to gas in the eighties almost no new gas and no new coal plants have been built and the last coal plant opened was in 1987. There is no specified fund for this cost and any spare finance has been tied up in Hinkley Point C.

The present subsidies and cost of renewable roll out is met through a number of levies such as CRC, CCL to name two. The government will in all probability increase taxes on fuel to meet investment needs. This could hurt as, following the implementation of the new business energy efficiency taxation regime next year, 70% of your fuel bill will be taxation.

The new tax element will include past elements such as general taxation but will include the cost of ROCs, FiT, RHI, CCAs, CCL, CFD and up till April CRC. From April, these will all be wrapped into one tax - the business energy efficiency taxation regime collected through CCL, the climate change levy. This is the element that will add up to the 70%.

The move to a low carbon economy will cause the problems set out above but also should create major new opportunities for the energy management community. The business as usual approach will need to be challenged, but there is still the hope we will hit our carbon targets.

by STUART REID
Head of Industrial Renewables at AMP

Biomass CHP and its Economic and Environmental Benefits

Clean growth is at the heart of the future vision for the UK economy. The UK has committed to sourcing 15% of our energy from renewables by 2020, a target which breaks down to 30% of electricity, 12% of heat and 10% of transport. Whilst we look likely to surpass the electricity target we are only half way towards achieving the heat target. The Renewable Heat Incentive (RHI), which was launched in 2011, is the main government policy aimed at increasing our share of renewable heat. Whilst the Government is now developing ideas for what may replace the RHI in the 2020s there is still a significant window of opportunity available for organisations to use an incentive to benefit from both shifting to low carbon energy and becoming Medium Plant Combustion Directive Compliant (MPCD).

Large industrial organisations present the greatest potential for decarbonisation with on-site Biomass CHP being a potential technology for the typical energy profile associated with industrial and process heat or steam users. Biomass has dominated the RHI with more than 90% of installations under the scheme being commercial biomass boilers of less than 1MW. Recent RHI reforms help make biomass more attractive for larger energy users up to 50MW/ 50 tonne per hour. These large energy users have until March 2021 to install equipment that will be eligible for the RHI and drive a shift to on-site generated very low carbon heat and power.

For energy or production managers requiring process steam the most noteworthy development in CHP technology is the Steam and Power ORC system. This fills a significant gap in the market by providing a solution for generating 1MW to 5MW electricity, and still meeting process steam requirements with 100% of the CHP output being in the form of usable steam. I will return to this system later, however let's begin by looking at the environmental and economic benefits of Biomass CHP first.

Environmental benefits of biomass

The environmental benefits of biomass are well documented and are summarised below:

- It is considered carbon neutral if it is sourced, grown, harvested and replanted in a sustainable way.
- When combined with the efficiency of CHP, Biomass CHP provides substantial CO2 savings.
- Using biomass as a fuel to produce heat, hot water or steam, significantly reduces carbon emissions in comparison with fossil fuel solutions.
- Biomass currently benefits from CCL and deploying it can protect end-users from future government policies that will drive the decarbonisation of heat and power.

Economic benefits of biomass

As fuel blending has become more sophisticated – with sawmill co-products and forest residues now being used – biomass has now become a more cost-effective fuel.

- Unlike conventional grid power and a gas boiler, where two-thirds of the heat goes up the chimney, biomass CHP enables the user to capture the heat and deploy usefully on site.
- CHP provides a 30% energy saving in direct comparison with grid power and a gas boiler.

- Biomass CHP provides a baseload energy which is very important for high intensity heat and power consumers.
- Using biomass CHP over the long term substantially de-risks organisations from volatile fossil fuel and gas prices.
- Deploying biomass provides protection from future government legislation. For example, Climate Change Levy (CCL) rates on gas are set to increase substantially in 2019 by around 67%.
- Biomass benefits from the RHI which provides a 20-year government backed source of cash flow for suitable biomass projects.
- Biomass CHP provides high quality heat, reliable and high system efficiency which avoids grid charges and results in significant carbon savings.

The fundamentals of Biomass CHP are no different from CHP generated from fossil sources. CHP generates electricity whilst also capturing usable heat that is produced in the electricity generating process.

CHP is decentralised and local and compared to traditional thermal generating electricity stations heat is captured and utilised effectively. As the diagram below outlines the benefit of CHP is that it can deliver around 30% overall energy savings compared with thermally produced grid electricity and on-site heat only boilers.

Types of CHP

In common with fossil fuelled CHP systems, biomass can be deployed using a range of different CHP technology types.

The 5 main solutions are:
1) Gasification
2) Steam expanders
3) Organic Rankine Cycle (ORC)
4) Steam and Power Organic Rankine Cycles
5) Steam turbines

There are a range of different manufacturers of these types of solution. For ORC, the unique market offering that has been recently developed is one that allows process steam users with 1MW to 5MW of electricity demand to generate electricity and have consistent, high quality steam at up to 25 tonnes per hour.

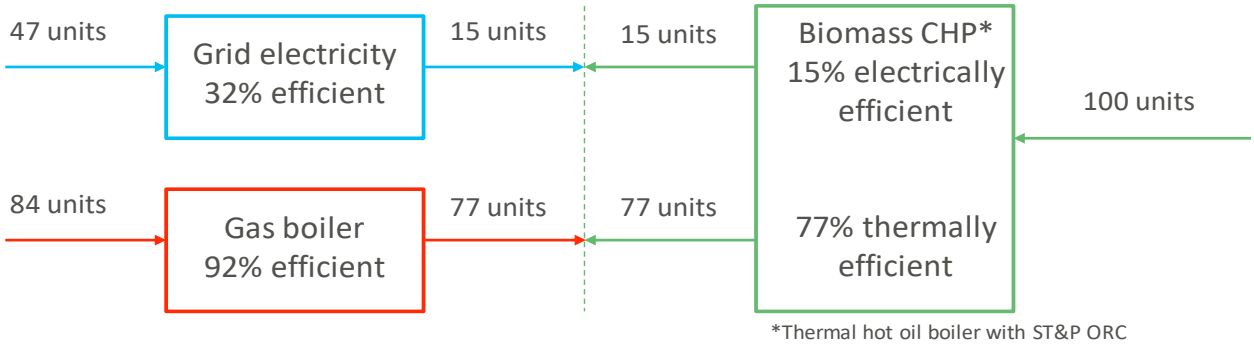
This provides a valuable solution to a section of the market where steam-based CHP was previously challenging.

Gasification CHP

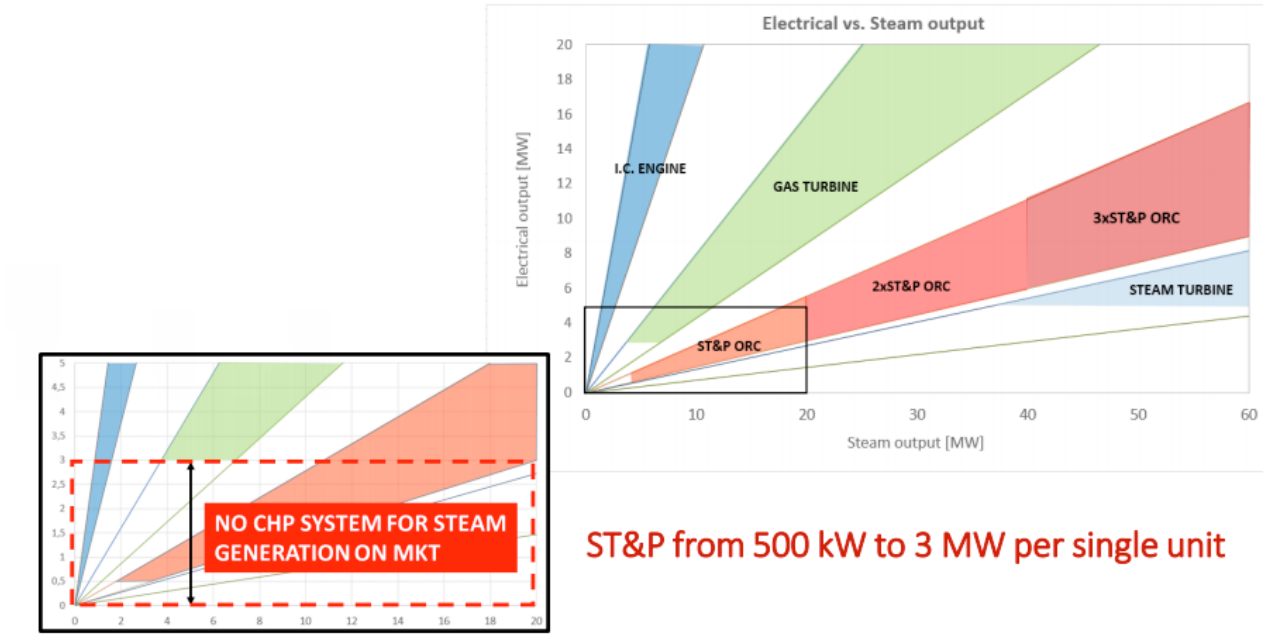
Biomass gasification technology can theoretically be deployed at any scale and the process effectively melts ("gasifies") biomass fuel - normally wood chip or wood pellet - to create a gas which is then burned in a combustion engine to create heat and power. The ratios of Heat to Power produced are generally around 2:1.

In the UK, there has been some reasonable traction gained by these systems over the past 3 years and there was a period – which has now passed - where they were able to utilise both RHI and ROC funding streams. Typically, these systems require high quality, extremely consistent fuel and relatively high levels of maintenance and are normally in the sub 150kW electric and sub 300kW thermal range. The heat output is in the form of LTHW and these will be most suitable for commercial organisations with a steady 24/7 heat load. The market for these solutions is more challenging than it was 3 years

CHP delivers 30% energy saving versus conventional grid power and a state of the art gas boiler



ST&P covers a frame of electrical output that is unmet by competing CHP technologies, suitable for medium pressure steam generation (i.e. steam turbines and gas turbines)



ST&P from 500 kW to 3 MW per single unit

ago although it is still possible to deploy them in the right project.

The other types of CHP solution are best deployed at a larger scale and are more appropriate for larger users of heat and power.

Steam Expander

There has also been some uptake of electricity generated through steam expander technology. This uses the differential pressure between steam generated at higher pressure and used at lower pressure to generate electricity. Electrical efficiency is typically between 5% and 10% of thermal output. Changes in CHP efficiency standards associated with the RHI (from 10% to 20%) have impacted on the uptake of this type of solution and for process steam users requiring higher pressure steam the normal lower pressure output of this type of CHP system can make it challenging to meet core processing requirements.

Traditional ORC

Organic Rankine Cycles have been relatively widely deployed over the past 50 years and common areas of deployment include in waste heat applications, geothermal heat sources and of course in biomass plants. Working on the same principle as the Rankine cycle the use of the organic fluids allow Rankine cycle heat recovery from lower temperature heat sources which can be used to generate both heat and electricity.

The overall electrical efficiency of the process will vary significantly depending on the input temperatures and the desired use and temperature requirements of any heat from the ORC. Traditionally, for industrial users, it has not been possible to use an ORC to generate both electricity and usable steam but the development of the Steam and Power ORC outlined below has changed that approach. I do also believe that there is a significant market in the UK for industrial users utilising traditional Organic Rankine Cycle technologies in the waste heat space.

Steam and power ORC

This development is the most noteworthy recent addition to the CHP solution and will be relevant to many industrial organisations in the UK, particularly those wanting to deploy on-site applications. The very high temperature thermal oil used to generate the steam for the ORC can be produced from either a biomass or a gas boiler.

This solution will generate between 15% and 17% electrical output and can provide intensive process heat users with the lowest carbon, lowest cost energy, without compromising on manufacturing or process integrity.

This highly effective technology combines steam and power with an Organic Rankine Cycle (ORC) turbine and thermal oil boiler. The thermal hot oil boiler – which has temperatures of up to 400 degrees - sends thermal oil into the ORC as a fluid which spins the turbine less quickly. This allows for heat recovery with the low-temperature heat then converted into useful applications, which can itself be converted into electricity.

This provides high pressure, high temperatures, steam, high availability (around 95%) and relatively low maintenance costs. The steam output is 6 to 25 tonnes of steam/p hour and the pressure between 6 to 30 bar. Biomass Process Steam or Heat CHP provides the same benefits to manufacturers who use heat or steam in a process but is more suited to process heat users who operate 12 hours a day over a five day cycle, using more than 8,000,000 Kwh per year.

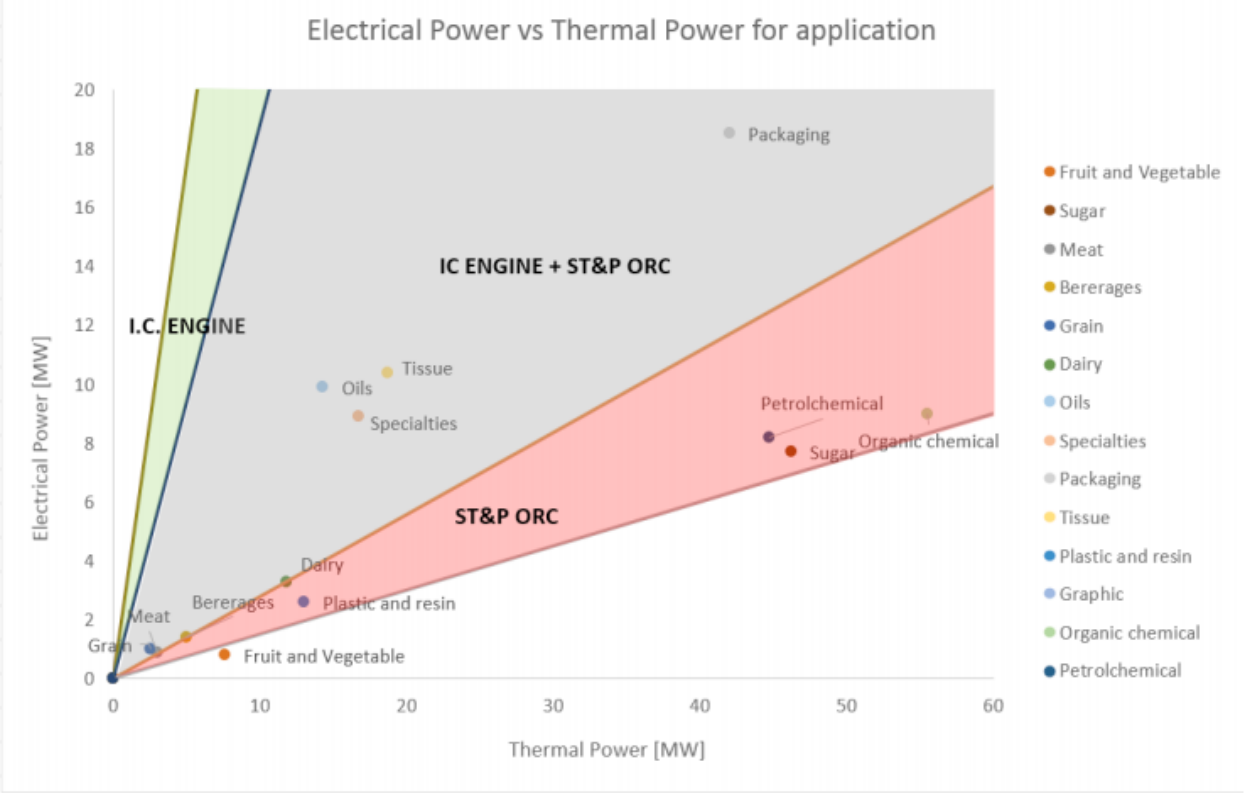
For organisations which do not have such a high heat requirement a hot air boiler with an ORC may be more suitable, generating 250KWe, or a steam boiler with screw expander which generates up to 500 KWe.

The sectors and processes most suited to the different types of solution are outlined in the chart below:

How can I fund a Biomass CHP energy centre?

The incentive of the RHI, along with the other economic and environmental benefits outlined, means that biomass CHP has become an attractive proposition to investors. Indeed, the end of Renewable Obligation Certificates (ROCs) and challenges of Contracts for Difference (CFD), makes RHI attractive to infrastructure investors looking for inflation linked to government backed cash flows, offering lower cost of capital and the opportunity to deploy assets.

There are a number of organisations who offer fully funded biomass energy centres, making them off balance sheet with zero capital outlay for clients. This is done through an ESCO arrangement whereby the ESCO owns the asset and contracts with the end user of heat and power on an agreed price over a long term.



Biomass versus gas

Biomass clearly needs to compete with the price of gas if it is going to be adopted. As outlined, Biomass CHP does enable the user to avoid grid charges and provide the benefit of heat which can be used usefully.

Price forecasts suggest that wholesale gas prices will continue to rise above inflation. It is also the fluctuations in gas prices which can create an organisational headache and make long term financial planner harder.

ESCO arrangements allow for contracts over the long term linked on an inflation basis, providing energy security on energy costs.

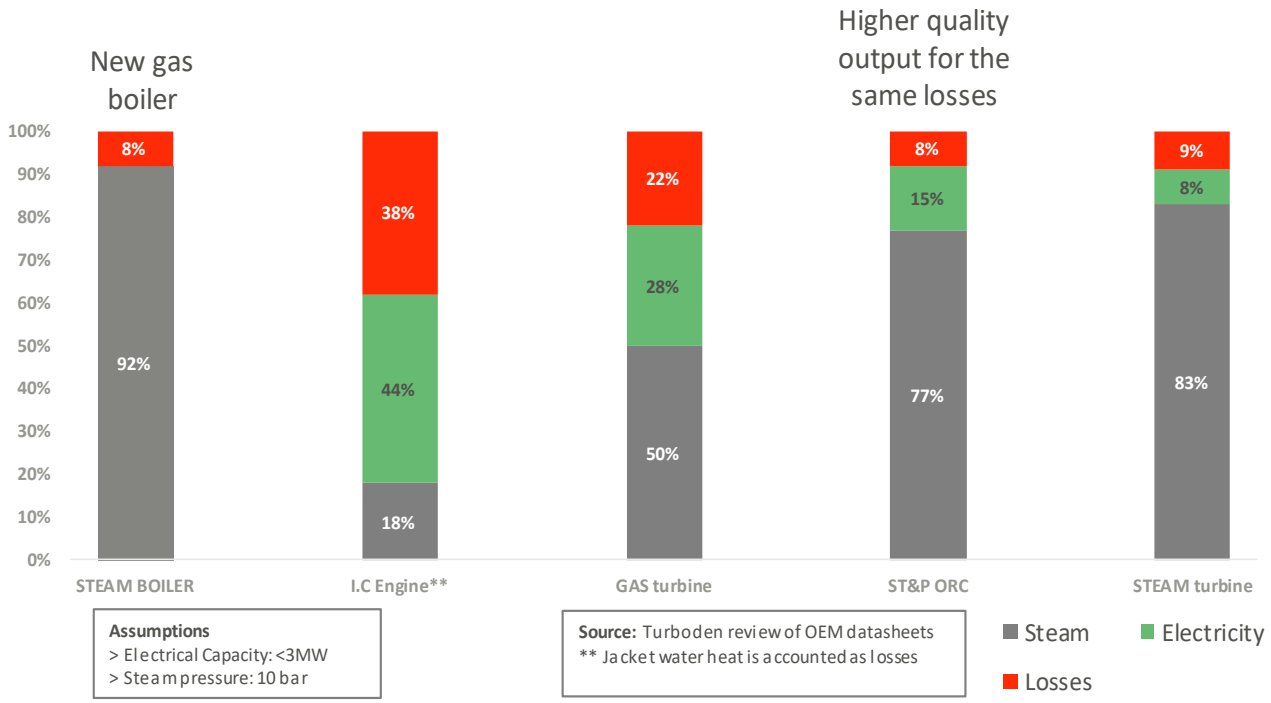
This makes the energy centre viable for organisations who have challenging payback systems, and further enables them to focus on their core business.

The ESCO is also responsible for the operation and maintenance of the asset, removing all efficiency risks from the on-site user.

Decommissioning

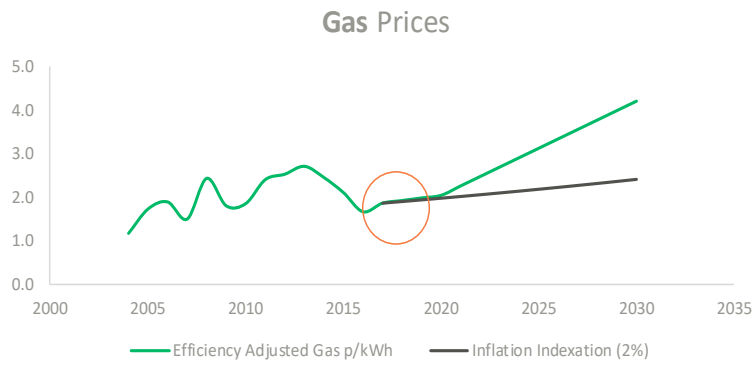
Typically it would be anticipated that the business case for a biomass CHP or biomass Steam system would be justified on a 20 year basis, partly as this is the duration aligns with the RHI cycle. The lifespan of the system may be longer than that.

Techology comparisons

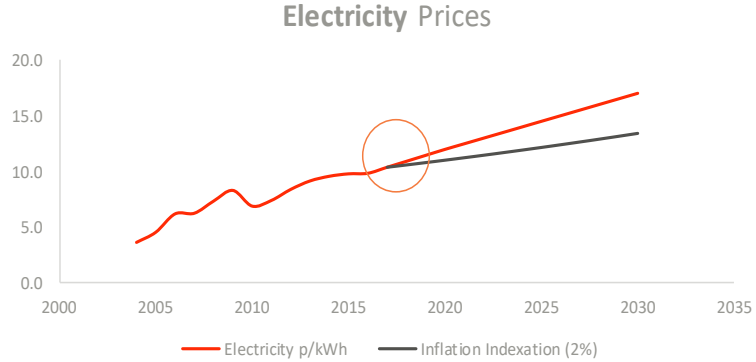


A major element of the investment in the energy centre building, ancillary M&E equipment and fuel handling infrastructure would be anticipated to retain significant value at the end of the 20 year period and would continue to be appropriate for use as energy centre for the most relevant low carbon technology at that point. It is considered that full decommissioning and breakdown of the energy centre would be unlikely to be required.

Prices forecast* to increase above inflation**



BEIS Survey Very Large Customer Gas Pricing (2017) = 1.58p/kWh = 1.86p/kWh on the meter (at 85% boiler efficiency)



BEIS Survey Large Customer Electricity Pricing (2017) = 10.37p

*Forecast provided by Committee on Climate Change
**Inflation set at 2% in line with BoE target

Conclusion

Most organisations understand that there is a compelling need to decarbonise their energy mix. Pressure from the Government, supply chains, trade associations and consumers is also increasing the focus on this area. The future of UK manufacturing and food and drink production is to be at the vanguard of the global clean growth transition and with both big Government departments of DEFRA and BEIS pushing hard on the clean growth agenda these are issues that will not disappear.

The requirements of the MPCD also act as a driver for those with aged and inefficient plant to replace their equipment – almost every boiler larger than 1MW in the UK will need to be replaced or radically overhauled by 2029. Currently we see the "push" factors in the market associated with the MPCD and future increased tax or legislation on high carbon fossil fuels, as well as the "pull" of consumer and supply chain pressures, looking for low carbon products.

Alongside this, the time limited incentives associated with the RHI could increase the demand for new energy centres. With the relatively long ROI and paybacks associated with these replacement energy centre projects we could see a significant growth in the demand for fully financed solutions.

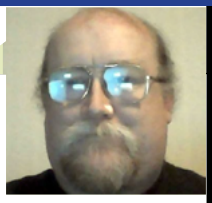
Using biomass CHP over the long term substantially de-risks organisations from volatile fossil fuel and gas prices, as well providing protection from future government legislation. For example, Climate Change Levy (CCL) rates on gas are set to increase substantially in 2019 by around 67%. Decarbonisation will remain a key issue and driver of Corporate Social Responsibility, and high carbon applications will be increasingly penalised through carbon pricing and legislation.

And of course, the era of incentives to support decarbonisation won't last forever, although the RHI does provide a 20-year government backed source of cash flow for suitable biomass projects.

Author's profile:

Stuart Reid is Head of Industrial Renewables at AMP. Stuart is a member of the Renewable Industry Advisory Group with expertise in scoping feasibility of biomass projects and has considerable experience of supporting the development of government and industry policy that will ensure a sustainable future for the biomass heating sector.

by ROGER LOW
EMA Board Member and Chartered Energy Manager at Speedwell Energy Services



OFGEM – Fit for Purpose?

To start with, what is OFGEM's purpose?

It's actually a fairly obvious question, that nobody seems to have asked, since it's inception as an organisation. It's had multiple parents, DTI, Department of Energy, DECC and now BEIS; and it covers multiple energy related laws and Government policies, some of which are contradictory.
It supposedly is meant to protect energy consumers, but it has manifestly failed in that regard. Energy prices keep going up, even when the fuel prices are going down, a badly thought out and poorly set up smart meter programme that is slowly turning into a car crash of epic proportions and the fact that as a country we are now a net importer of energy.

So what is needed?

The argument that OFGEM needs reforming and ultimately changing both in its structure and purpose seems obvious to me, but the issues are how it should be set up, what its actual powers are and what it is meant to achieve.

The body is controlled by Government via appointed directors and cabinet office policy, making it a politically influenced organisation. Due to past and present Government's policy of regulation reduction in some parts and poorly thought out laws in others, and intermittent meddling, it is guided by political expediency rather than technical need.

The most obvious thing would be to put the organisation on the same level and arrangement as the Bank of England, with an independent governing body answerable to a parliamentary select committee, removing political affiliations and influence; this would also make things simpler for Government by reducing their need to maintain the body as it could be funded by a levy on the energy suppliers and transmission bodies, and reducing their need to officiate over regulations.

The new OFGEM would be established by legislation, similar to the Health and Safety Act, which permits one law to run multiple regulations, so that all of the varied energy related laws could be amalgamated into this single act as regulations. Simplification of the laws and regulations, less red tape and a single body to administer them in the most efficient manner - which seems to meet the present Government's publicly stated policy.

That the country's strategic need for energy, environmental targets and consumer protection can be better served by a statutory body as above is becoming more evident every day. The new OFGEM could work to mandates established under the act and deliver them in the way they feel is the most efficient, cost effective and technically desirable. I also include under this the nuclear energy programme, as this has been politically driven from the start with costly and unnecessary consequences.

Appointments

The Directors and governing body could be recruited via open competition similar to the civil service, rather than appointment by cabinet office, reviewed and confirmed by the select committee and with the members given a guaranteed contract term to prevent political interference by affecting career paths.
The new body and staff to have mandated tasks and targets set by parliament via legislation, and the directors and governing body answerable to a parliamentary select committee.

The need to ensure that the directors are technically competent could be embedded in the legislation, via requiring them to belong to a recognised energy institute or association, to enable them to work with the energy companies from a position of industry knowledge. This would allow them to deal with the energy companies, without issues on jargon or practice; and to prevent industry influencing them, exclude anyone from applying for the posts if they have worked for the big six, and preclude them from ever working for them in the future, so that they have nothing to gain by colluding with the companies.

Legislation

Going further into this, the amalgamation of all the various energy related laws into regulations of a single overarching act, similar to the HASAW act, seems obvious and desirable. The contradictions in legislation could be eliminated, the regulations simplified, and a more defined and targeted system put in place to meet mandated targets. This would also meet the Government's policy of simplifying and reducing red tape.

Mandates

These should be established by parliamentary act, and reviewed by the select committee as needed. Example mandates would include:

- ensuring the lowest possible energy pricing for consumers whilst meeting the financial need to maintain and upgrade energy supplies;
- meeting emission reduction targets agreed under treaty;
- developing a sustainable and as much as feasibly possible self-supplied resource to reduce the impact of international prices and conflicts on national needs.

At the end of the day, the new OFGEM and enabling act and regulations would be geared to deliver a sound and sustainable energy supply to the country, which is technically, environmentally and financially sustainable with an emphasis on future need.

And to answer the question that might be raised of what is wrong with the present system, I will list a few things:

- Smart meter roll out, £11 billion, and has delivered less than half of its target to date, with serious issues over the technology, which even the SMETS2 roll out cannot rectify.
- The new nuclear programme, long overdue, massively overpriced, economically unviable, environmentally unsupportable; and with the rapid development of renewables, storage and more energy efficient systems, rapidly becoming redundant before a single kilowatt has been generated. Would the Hinckley C project have got past a politically independent and technically knowledgeable body such as proposed?

  And now EDF are playing the same act of repeatedly threatening to pull out without more and more subsidies and price guarantees, over the Sizewell C project!
- Overly complex laws and regulations that choke off development, just look at the issues of hydro-electric projects, the sheer complexity and red tape has killed off perfectly feasible and desirable projects. Sudden kneejerk changes in legislation that is ill thought out, and damaging to industry, such as the accelerated drop off of the FiT programme. How many PV companies bit the dust after that? And surprisingly (Not) the carbon emissions UK wide are going up again.

Conclusions

My proposed idea would meet the Government's stated aim of reducing red tape, it would take the political element out of energy supply and leave the government to deal with other issues. The new body would be answerable to parliament, who would set up the mandated tasks, and leave the body to deliver these in the most cost-efficient manner deemed best by them, based on industry knowledge and with the express aim of ensuring that the consumer, both commercial and domestic, is provided with a secure, value for money and sustainable energy supply.

It would allow the body to alter regulations as needed, without recourse to new legislation, making it quicker and ultimately cheaper. Moreover, it would allow them to use best industry practice and experience to achieve these goals, without interference from vested interests that would benefit financially from affecting governance.

Is this politically shocking? Would it shake up the industry? Would it be a game changer? Would it deny the jobs for the boys culture that is prevalent in these quangos?

I say yes to all of these questions, but we need these changes and soon. We would like to hear from you, hence do not hesitate to get in touch with the EMA, and we can then voice these opinions to government and OFGEM.

Authors' profile:

Roger trained originally as a maritime engineer, but diverted into estates management via vehicle fleet management, working with the Ministry of Defence from 1996. Following promotion and retraining, Roger became one of the MoD's small number of directly employed energy managers; eventually transferred to DIO; Roger now runs his own energy management consultancy business.

Readers' Letters

Paul Eggleton, Commercial Director at Mitie Sustainability wrote:

I was really interested to read Lord Redesdale's views in the difference between a Facility Manager and an Energy Manager in the March/April edition of The EMA Magazine.

Having spent almost 15 years in Corporate Energy and Sustainability and now working for an Energy Services business within the UK's largest FM company there was much that resonated for me. However, there were also some areas which didn't necessarily tally with my experience. What is clear is that Energy and FM worlds continue to converge as digital technology takes on a deeper role in managing buildings and their energy use.

As the article pointed out, in a very competitive market place, FM services run at lower margins and there are many contracts that do not work for either the FM provider or the customer when it comes to energy management. Woolly contract clauses such as 'the provider will support the customer in meeting their energy and environment goals' do nothing to provide specific scope, opportunity, or incentivisation to deliver real value to the customer nor help providers manage risk.

There are other issues too; the separation of energy procurement from energy management, energy management vs. misplaced comfort control and maintenance services, multiple service providers with differing commercial interests, and even protectionist practices where external help is perceived as a threat. These are just some of the issues that muddy what logically should be a happy partnership between FM and Energy Management. Because, when it's done well and in collaboration, the results can be spectacular.

For me, the sharing of knowledge and expertise between the two specialisms is what really adds value and creates impact for clients. For example, within the team at Mitie, we have over 340 dedicated Energy & Sustainability professionals who work alongside our FM colleagues to provide a fully integrated service. I wouldn't expect Facilities Managers to analyse energy data or adjust BMS schedules. Similarly, it would be presumptuous of me to advise on facilities management as there are far more qualified experts than me for that.

What is important for any company, large or small, is to offer energy specialists who work hand in hand with the Facilities Managers and Engineering Services. From understanding client needs and how their buildings operate, to identifying opportunities and then finding solutions to deliver the best outcomes for customers.

Both Energy and Facilities Management are defined professions in their own right. Trying to blur the roles and responsibilities ultimately dilutes expertise and therefore effectiveness in both roles. I would argue that trying to merge them, usually to save money, results in devaluing the overall service and all parties being disappointed.

There is a task to continue to educate across both areas of expertise in order to build a shared knowledge and understanding of how we can work better together. Also, to raise awareness with customers that greater value can be achieved by designing an integrated approach where FM and EM work closely together, with shared objectives. If this can be understood and appreciated, then it makes the scoping, contracting and delivery far more straight forward – a win win situation for everyone.

Both Energy and FM sectors are facing digital revolution and this is bringing the two professions even closer together. IoT is enabling greater connectivity to equipment. Combine this with energy and building management system data and a rich picture of how a building operates can be created. Add the growing interest in Well Being and there is a real opportunity in terms of finding synergies and driving value.

Future looking FM companies are able to bring all these elements together. Technology is enabling the shift from output to outcome type contracts where KPI's measuring maintenance visits are replaced with 'a clean and productive environment' or a 'sustainable office'. This shift can only take place when FMs and EMs work together and take customers on this journey with them.

Creating high performance buildings is a task which includes both FMs and EMs. Again, delivering greater comfort, reducing energy and enabling a greater employee and customer experience is the responsibility of both parties working together. Facilities Managers and Energy Managers are not the same thing, and in my view, neither should they be.

The expertise both parties bring to the table should be celebrated. By working in harmony together, we can and are achieving smart, sustainable and productive buildings, which ultimately, can only be of benefit to building occupants.

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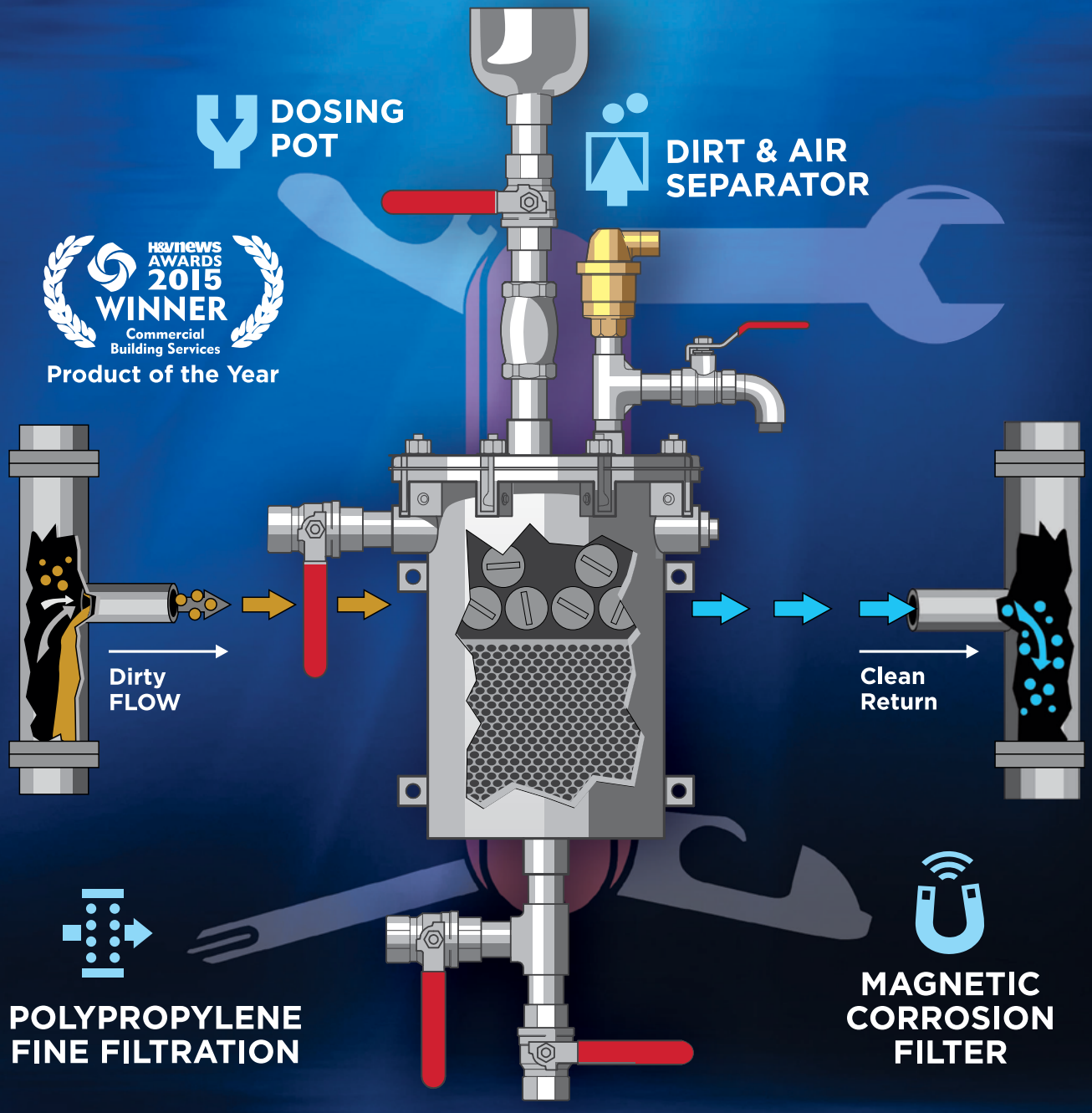

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Millennium Point Case Study

Millennium Point is an iconic building, which enables its visitors to explore ideas, science, education, technology and the arts. Millennium Point is owned by the charity Millennium Point Trust and acts as a landlord to a number of prestigious organisations.

Consuming around 7GWh of electricity per annum, Millennium Point wanted to start looking at ways of reducing their energy costs. Since the buildings opening in 2001, minimal action had been taken to analyse its energy usage, including no validation of their utility bills.

Bill Validation

Inspired Energy validated the electricity invoices dating back to the start of the contract. We immediately noticed that CCL charges had been added to the account from March 2015 and were still being billed accordingly.

In July 2015, the UK government budget statement stipulated that CCL exemptions for renewable energy were to be removed from 1st August 2015 onwards. We raised a query with the supplier, resulting in a credit of £46k.

Energy Procurement

Millennium Point's electricity contract was due to end in September 2016. We secured a new fixed price electricity contract in May 2016 when the cost per MWh was £36.80. This contract compared to their current one represented an annual saving of £95k and £285k over the three years of the contract.

Capacity Reduction

The current available supply capacity of 3,000 kVA was underutilised. We analysed two years of profile data and established that the highest maximum demand was 1,414 kWh. We recommended and arranged a reduction in the available supply capacity to 2,000 kVA from the start of the new contract which provided a further saving of £14,100 per annum.

Meter Installation and Tenant Billing

Millennium Point has over 50 sub meters to monitor electricity consumption for its tenants and communal areas. The meters were over 15 years old and needed to be manually read. We arranged and managed the installation of new digital AMR meters that automatically send readings and 30 minute profile data. This ensured that all tenants are charged accurately and only pay for what they use.

Having this data available online enables Millennium Point's tenants to view their consumption and engage in energy efficiency monitoring and behavioural changes, making the building a more sustainable property.

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