Battery Storage

Behind the meter: Positive outlook?

2018 Report



Survey respondents' demographic breakdown



Pushing through uncertainty

By Tim McManan-Smith, editor, the energyst

Companies surveyed for this report are all considering energy storage.

The Energyst surveyed readers about demand-side response and storage online and via its digital circulation between June and August 2018.

We cleaned up the data to remove those involved in energy – technology providers, energy companies and consultants/third parties etc. - that we considered would skew results. This left 76 sufficiently complete, largely end user responses to questions about DSR and storage (see breakdown opposite).

Of these, 48 (or 67%) are considering storage and two said they have implemented storage – though the latter were consultants. The published survey data subsequently focuses on the 48 companies considering storage investment/deployment. Their responses form the research component of this report, which is behind the meter focused given the vast majority of respondents are considering BTM storage at their sites.

Respondents include water companies, steel, cement, plastics, chemicals and pharmaceuticals companies as well as other manufacturers, plus hospitals, universities, colleges, local authorities and government agencies.

OPPORTUNITY

Almost eight in ten of the survey sample spend at least £1m a year on power, which provides some motivation for considering battery storage, given that at least half of the power bill is non-commodity cost. For now, at least some noncommodity elements are avoidable.

Just over a third (35%) of those considering battery storage already

participate in DSR, so have some knowledge about what is involved in providing flexibility. Of those that do not participate in DSR around 40% have some form of onsite generation, which could also be used in conjunction with storage to unlock greater benefits.

Around half are considering a third party fully-funded battery, which also suggests an opportunity for energy companies, aggregators and others with the expertise to properly design and package solutions that mutually benefit both parties.

CHALLENGE

However, revenue uncertainty (cited by eight in ten respondents) and regulatory uncertainty (cited by half) remain key challenges in converting consideration of batteries to megawatts on the ground. The situation appears to have worsened over the last year.

While a largely different sample to our 2017 Battery Storage survey, this year's data finds uncertainty about both these areas is much greater: the 2017 report found 47% had concerns about revenue visibility, 32% had concerns about policy/regulatory instability.

Some of the report's sponsors agree the outlook has become less certain. However, they point out that despite ongoing regulatory change, things like Triad avoidance still have four years to run. They also believe that in the medium term, the value of flexibility in managing a system increasingly penetrated by renewables will become clearer, and that emerging revenue streams – including local, wholesale and balancing markets – will repay those with sufficient flexibility to follow the money.

Convincing company boards to accept that risk profile – or to shoulder the risk on their behalf - is



therefore fundamental for those aiming to deploy storage. Market and policymakers could help by giving some clear signals that useful flexibility will be rewarded, regardless of ongoing structural change.

Despite those challenges, report sponsors E.ON, Flexitricity, GridBeyond and npower believe they can package solutions that go beyond storage to deliver business optimisation. Meanwhile co-sponsor National Grid ESO is working to increase opportunities for flexibility, with the Balancing Mechanism and a European market, Project Terre, appearing on the horizon and further rationalisation of its balancing services set for 2019.

If they can make good on those promises, this survey again suggests strong appetite for storage across the public and private sector.

T. Mc Manan-Suith

What is your organisation's electricity spend?

Almost eight in ten of the sample spend at least £1m a year on power, which provides some motivation for considering battery storage.

Given more than half of the average power bill is made up of non-commodity charges, some of which are currently avoidable, significant savings could be unlocked by well designed battery projects, particularly as most of the sample also have some form of onsite generation.

(49 respondents answered this question).

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FTW-FTOW

£10W-£100W

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Does your organisation participate in DSR?

A significant minority considering battery storage already provide demand-side response (17 of 48 answers).

Most (82%) that do provide DSR are in the industrial sector. All bar one provide load response. Eight in ten are large organisations (500+ employees) and 94% spend at least £1m a year on electricity.

Of those considering batteries that do not provide DSR, 58% are large organisations (500+) and 42% are SMEs. Eight in ten of those not providing DSR have some form of onsite generation, with solar the most common technology. Eight in ten would also be interested in providing DSR if it did not affect their operations.



Are you considering investment in battery storage?

Most of those surveyed are considering battery storage, though only 3%, or two respondents, have actually done so. Both of these were consultants, not actually end users.

Of those considering storage, 46% are industrial firms, 21% commercial and 33% public sector.

The majority (58%) were from large organisations (1,000+ employees).

The remaining survey answers are only from those considering storage (48 respondents in total).

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04% Yes, considering	3% Yes we have invested	33% No

What size battery are you considering?

Those considering small batteries tended to be small companies (61% of those considering <250kW batteries were SMEs), They were evenly split across sectors. Only two respondents (both water companies trialling small batteries) do DSR.

Three quarters of those considering large batteries (1MW+) have 500+ employees, most (53%) are industrial firms and almost half provide DSR.

85% of those considering midsized batteries have 1000+ employees and almost half provide DSR.

(45 responses)



Is the battery:

Only five respondents are considering in front of the meter projects, and two of these are investment companies. The other three are public sector.

The remainder are focusing behind the meter, often in conjunction with other assets, of which solar, CHP and back up generation were most common.

This answer is potentially misleading as when asked if they will combine the battery with other assets, 72% said yes (see p8). Perhaps using the term 'colocation' is confusing.

(39 responses to this question)



How do you plan to monetise the asset?

Most business cases include avoiding peak charges and/or loadshifting. Yet regulatory uncertainty clouds those aspects in the medium term. While shifting loads could effectively enable arbitrage, it is perhaps surprising that only a quarter explicitly state arbitrage, given declines in frequency response prices.

Energy suppliers interviewed for this report (sponsors) believe wholesale market and Balancing Market opportunities are already significant opportunities, though only three people mentioned these aspects in 'other' responses.

(46 responses to this question)



What is the projected payback period (years)?

This question is potentially misleading given that around half of respondents are considering a fully funded route (see p10). Many of those contracts suggest little or no capital expenditure, though require a long-term contract.

Almost two thirds of respondents envisage a payback period of at least six years. Of these, 38% said the plan to finance the battery internally.

(40 responses to this question, totals exceed 100 due to rounding)



Will you combine the battery with other assets?

34 of 46 respondents plan to use the battery alongside other assets. 26 respondents specified the types of asset they plan to combine with a battery. Via those responses:

- solar/PV is mentioned 13 times
- back-up/onsite gen/diesel 9 times
- CHP 8 times
- wind 3 times

Of the 12 respondents that do not plan to combine the battery with another asset, 7 provide DSR - all of them using load to do so, which suggests they will use the battery to complement that.



Will you work with a third party to monetise the battery?

Only a minority plan to go it alone with their battery. These included large steel, cement and chemicals companies, a water company and a government-owned agency, plus a college and a local authority.

Most plan to use some form of third party, and the numbers suggest some will use more than one party.

Other third parties include consultants that can play a quasi auditor role between owners and operators.

(44 responses)



Do you have a connection agreement for your battery?

At face value, this answer suggests only a fifth of respondents are at an advanced stage with their plans.

However, given most are considering batteries behind the meter, a connection agreement is not necessarily needed.

A better question for next year's survey may be whether companies considering storage have sufficient import and export capacity, and if not, whether they have asked their DNO for a quote to increase it, or whether they are located in a constrained area.

(42 responses)



How are you going to finance the battery?

Half of respondents are hoping to find a suitable fully funded package.

That means finding a suitable contract with appropriate risk allocation.

Given 60% of respondents believe their projects will payback in under 7 years (see p8), it would be interesting to learn whether those providing fully funded solutions would consider contract lengths any shorter than 10 years. Anecdotally, that appears not to be the case.

(41 responses)



Have you faced any challenges in building the business case?

Battery proponents suggest market participants can take comfort from the fundamental need for system flexibility, but revenue uncertainty is the key business case challenge.

While there is some visibility of peak network charge avoidance for the next few years, there are major regulatory changes afoot. Meanwhile, frequency response contracts are relatively short and prices are susceptible to supply and demand economics.

Few respondents suggest their storage business case is straightforward.



(30 responses)

Bringing behind-the-meter to market: find a clear objective to maintain momentum

Georgina Penfold, director at Industrial and Commercial Operations Network (Icon) outlines the state of play and what end users considering battery storage should consider

Energy Storage has, for a few years now, enjoyed more column inches and conference airtime than any other technology. In 2018 alone, we have seen Pivot Power announce their national network of grid-scale batteries to support EV chargepoints at strategic locations, Highview Power launch the world's first grid-scale Liquid Air Energy Storage plant in **Greater Manchester and Swindon Council's Public Power Solutions** has shown that local authorities are working hard to deliver local low-carbon infrastructure as they

secured planning permission for a 50MW/MWh battery storage system.

But while the large, front-of-meter projects grab the headlines, the scoping and commissioning of sitelevel, behind the meter installations are steadily gaining in number.

As an energy manager, our core priority is to control budgets and, wherever appropriate, to decarbonise building services and operational activities, whether that be through reducing consumption or sourcing energy from alternative fuels.

Almost every one of our

subscribers at the Industrial and **Commercial Operations Network** is curious about energy storage, with the first few tentative, tangible projects starting to come through. This is reflective of wider activity amongst large energy consumers. Anglian Water has procured four vanadium flow machines to sit alongside a large solar installation; the Port of Tilbury will soon be enjoying the benefits of a 9MW behind-the-meter project, with a further 10MW of grid connected storage and almost all of the energy suppliers with strong presence in the industrial and commercial



sector are talking with their customers about 'virtual power plants', demand-response and other initiatives that include energy storage as part of a package of energy efficiency and management techniques.

Projects are happening, but many would say, not enough projects.

We all know that success in the shift to a flexible energy system is contingent upon the consumer becoming a market participant – I demur from using the phrase "active participant" because demand-led flexibility at its best should be, from the end-users' perspective, a relatively inert interaction. While we are far from passive, we do expect technology to deliver the physical management of load shifting with our engagement being more strategic than operational.

We also know that this shift will bring about challenges and change to the way we manage and pay for our network connections: as just one example, the proposed Significant Code Review on network access and forward-looking charges could fundamentally change our accounting and accountability with regards our energy supply agreements.

Behind-the-meter storage, appropriately sized and managed, offers an opportunity to support the systemic shifts, protect our need for site resilience and have more control over when and how we use electricity.

So why aren't more projects happening?

This is the point at which you expect me to trot out the story you've heard many times before: there's a lack of clarity on future policy, the finances are uncertain and the revenue contracts incomprehensible.

All of those things are true. To a point.

But regulation has always lagged behind technological advancement; I expect anyone with a commercial view of the energy markets would agree with me when I say that a technology which enables control over when we consume has potential to offer a sound long-term investment.

The problem is: evaluating the benefits of energy storage

is notoriously difficult. Cost and returns on investments are highly dependent on application – which may not be fully worked through by the consumer when they start market engagement before issuing a procurement process – and effectiveness, which in an evolving market can be difficult to gather objective data to assess.

Benefits could be either operational, financial or – ideally – a combination of the two.

The financial benefits of battery storage depend on how often the system is used, but using a battery more frequently affects the cost of using it as maintenance cycles need to increase and degradation pushes the capacity down. Some electrochemical solutions are more impacted by this than others.

Equally, the outlay required will be connected to the type of battery chemistry specified, the installation costs and ongoing service and maintenance requirements – but these will be influenced by how the storage system is intended to be deployed.

Selecting and installing an energy storage system is a complex process that must consider capital outlay, operation and maintenance costs, useful service life, duration of charge and discharge cycles, response times and any additional costs that may arise associated with site preparation or remote monitoring. Not to mention the increasing impetus, particularly amongst publicsector organisations, to consider decommissioning and recycling cost and complexity at the point of purchase.

Distilling all these elements into a single, easily understood but meaningful metric of whole-life costings which accurately accounts for operational losses and future market scenarios is impossible.

When purchasing a photovoltaic system, the energy input, conversion efficiency, degradation rates, maintenance costs and cost of avoided import of electricity are all reasonably well modelled but storage is far more complex.

For an energy manager to understand and communicate the reasons to invest in batteries or any other storage system, we're going to need a bit help from the people who know this market best.

With that in mind, here's what the customer wants when they look to select a storage provider:

- 1. Financial Modelling what will a project cost and what can it help us save? This will be heavily dependent on other considerations in this list.
- 2. Strategic support how can this technology and your service offering support wider business and energy strategies? We need to understand why we are doing this. A battery is not a UPS but can be used to help site resilience. It is not a generation technology but can be used to reduce import demand at certain times of day. Are we designing this system to reduce running costs or generate income? How will we work together to optimise the charge and discharge cycles and what impact will that have on our wider energy procurement approach? Load shifting is going to change our demand profile so could have an impact on our trading strategy as well as our non-commodity charges. This needs to be considered from the beginning and clearly communicated with all relevant parties.
- 3. **Project support** we've never installed one of these before. We need practical advice. Is the installation going to be straightforward or is it likely to have a knock-on impact? Do we need to upgrade switchgear or install new control equipment? What kind of timelines are we looking at? What does the testing and commissioning phase involve and how are we going to monitor ongoing performance? Working with the maintenance and if appropriate, construction project managers as well as the energy or procurement manager is essential to make sure the technology is understood and accepted.
- 4. **Longevity** yes, the policy and finances are uncertain and no-one can claim otherwise, but for centuries, engineers and business people have created



opportunity from uncertainty. It's called innovation. If the technology is adaptable, it doesn't matter if the frequency response market becomes saturated or TRIADs are replaced with time-of-use calculation metrics; we can reconfigure the operation cycles and continue to benefit from the advantages that storage can bring. What we need to know is: how useful is your system going to be over the long-term? What is the duration of discharge - can this system be used only for very short duration 'peak lopping' or can we use this for more involved demand management. If time-based capacity charges are introduced, for example, can we reliably use the technology to take the entire site off-line for four hours a day, every day?

What is the installed capacity and how is that going to degrade over time? Is there anything that can be done to mitigate this degradation – for example replacing older cells in a modular system – and what would be the cost of taking that measure? Is this a 'fixed' cost or it is liable to change with changes in technology or material supply chain negotiations (and are there any forward models to assess that)? At icon, our advice to subscribers is to approach this with a clear objective. When commencing conversation with providers, know why storage rather than generation is of interest and be able to communicate how a successful project would be measured.

As with any major procurement decision, the buyer should carry out stringent due diligence but don't be either seduced or deterred by the first technology you consider. Lithium-ion may not work for a given site but one of other electrochemical or mechanical storage options might. The appointment of RedT with their vanadium-flow storage system to the NHSfocused Essentia framework, for example, shows how consumers are looking for operational preferences that a battery may not be able to offer.

The challenge, for storage providers, is how to maintain the momentum of commercial interest storage and scale the market to its full potential; the challenge for endusers is whether to trust the trend and moreover, whether to trust the technical sales teams that could be simply chasing a transaction.

As a buyer, we need to ensure we are managing the commitment risk as well as operational and financial risks when procuring energy storage. Any system installed should come with rigorous monitoring and comprehensive service and maintenance arrangements as standard, but to provide assurance that the storage option will continue to provide benefits on-site irrespective of any future changes to policy or network charging arrangements, the system needs to be selected because it meets greater need than chasing revenue.

The downward pressure on prices in all the response and reserve markets suggests that any business model based primarily on revenue from today's grid services options is not an effective long-term bet.

Instead, look at where storage can help support operational efficiency and other energy management initiatives; if you have an energy procurement team who are open to the challenge, maybe consider the opportunities from more risk-tolerant trading strategies including arbitrage or using a third party to access the balancing market.

Storage is not a 'fit and forget' technology. Nor is it a route to making a fast buck; but it is a technology that can be used to support an effective energy management strategy and provide the energy manager with unparalleled options for operational efficiency, demand management and long-term budget control.

4MW of food for thought

Philip Dennis Foodservice, based in Devon, has invested in storage. The company has a 3.75MW in front of



the meter battery as well as a 256kW behind the meter Tesla Powerpack. The firm's Barnstaple headquarters also has a 250kW rooftop solar array and two 500kW wind turbines.

While the batteries are currently used for generating revenue, director Peter Dennis says the firm may ultimately use the smaller battery to offset energy costs. But for now, the company has a twoyear FFR contract and a 15-year capacity market agreement, with the batteries linked via the latter agreement. The firm also plans to "do some Triad chasing this winter while the revenue is still good".

FLEXIBLE DEMEANOUR

Dennis admits some concern over falling FFR prices, "they are only

going one way", but its aggregator is already bidding batteries into the Balancing Mechanism and Dennis says the firm's assets may ultimately head in that direction.

However, he believes its contracted revenues will pay off 35% of its investment over the next 20 months, enabling it "to compete with new, cheaper entrants" bidding for frequency contracts.

Meanwhile despite FFR prices "crashing" between building the business case (at £17/MW/hr) and securing a contract (at £12.5/MW/ hr), Dennis says the company faced lower barriers than most due to a generous existing grid connection. With distribution network operators now tightening up on capacity, it made sense to use that capacity rather than lose it, says Dennis.

"WPD gave us [a] 1.4MW connection some years ago, so we had very good capacity, which meant that aspect was a very low cost. We already had the land and we had cash, so finance costs are zero," says Dennis. "So of all the people that invest in this market,

Less risky than DSR?

The company considered doing traditional demandside response, given its compressors could provide "quite a decent load". But Dennis says it was insufficiently attractive given the potential risk.

"Our compressors are quite old, they are not VSDs and the refrigerators, which use hot gas or liquid, don't like being suddenly switched off or ramped down," he says. "The revenue was small compared to the additional maintenance requirements and [risk of] possible outages, so we decided against it."

we will be the last ones to lose money – and so far the returns are good."

Dennis is now turning his attention to flow storage as well as considering how to decarbonise the company's fleet of 65 HGVs.

Too little certainty to invest

Numatic, maker of the Henry vacuum, is the UK's largest commercial cleaning equipment manufacturer.



As such, it has a significant electricity bill. Property & energy manager, Andrew Smith, spent "about 18 months" looking into storage to see whether it would help cut costs and boost resilience. It was not a straightforward exercise and the firm eventually decided to put it on hold. Smith summarises how Numatic arrived at that decision:

"At the outset we had the following objectives:

- To have a back-up system that could replace our main HHM supply (2,500kVA) in the event of a power failure. This was driven by concerns about national power security, not from local experience.
- To use the system for Triad avoidance.
- To avoid peak DUoS red bands.
- To participate in DSR.

"We had detailed discussions with seven different companies and they all had different versions of what size and type of installation we would need to achieve these objectives. Some said that the objectives were not all achievable, others said there were," says Smith.

"Finally, with DUoS red band charges due to go down, DSR rules changing almost daily and predictions of vast reductions in battery storage cost in the pipeline, we decided that the time was not right. The whole project would have cost around £1.5million and, depending on who and what you believed, would have had about a 4.5 year payback," says Smith.

"We will no doubt re-visit the subject at some future point."

BTM storage: What do 'end users' need to consider?

Looking beyond the sales pitch, Cornwall Insight's Tom Palmer outlines real life opportunities and challenges presented by behind the meter storage

Behind the meter (BTM) storage, a pyramid scheme it is not, but after the sales pitch, end users need to be aware of the ability to secure potential savings/revenue and the inherent risk in the energy sector.

Behind the meter storage is seen as an area of opportunity for end users to reduce charges and even make additional revenues. Firstly there is the promise of avoiding network charges, both transmission (those Triad periods) and distribution (red rates) network charges. At the same time the Capacity Market Supplier Charge, which depending on the capacity market clearing price in that year can be substantial avoided cost. These avoided costs are based on the using power from the battery to supply power to the end user, rather than drawing off the grid in specific periods.

Win-win right? Well not quite as the network charges will need to be recovered and this will mean changes to charging for residual elements of these costs that may risk some of these revenue streams disappearing in most part. Likewise at some point it is likely that Ofgem will consider investigating the ability for BTM assets to avoid paying for Government levies. While not directly being covered at the moment, it is no doubt a matter of time before another Significant Code Review by Ofgem looks at this too.

There are other opportunities for BTM storage that do not rely on network or Government levy avoidance. It is possible to participate in the wholesale market and Project TERRE (Trans European Replacement Reserve Exchange) even though asset are located behind the meter. BTM storage is also able to import cheaper electricity over night or other time to be utilised during the peak periods and higher wholesale prices. The ability to access these revenues may depend on the end user's existing supply agreement. The supply agreement may be limited to a peak/off peak tariff rather than a flexible pass through contract, making access to these revenue streams infeasible, with restrictions on participating in flexibility markets. This is before you even start to consider the internal risk, finance and treasury limitations that could be placed on trading activities and limit the end user's ability to be flexible.

The provision of Firm Frequency Response (FFR) remains a valid option for BTM storage assets, primarily targeting overnight FFR when the battery is chasing other revenue streams. However, prices remain challenging and when the energy throughput charges and export charges are included there is the potential to lose money from offering the service at the moment given the low prices in the market. There will be opportunities for Distribution System Operator revenues if the end user is in the right place at the right time, but this source of revenue is still in an early stage of development.

The most interesting aspects often undersold tend be resilience, oversizing of renewable generation and the integration of electric vehicles.

The value of resilience is often not known, but there are already many Uninterruptible Power Systems (UPS) which themselves can already do some of these activities, although not previously designed for that purpose. The ability to also over build solar capacity to be greater than the demand profile of the end user and shift additional solar output could be justified with longer duration storage. The integration of electric vehicles can also be supported with storage to avoid costly network upgrades in demand dominated dense locations. So considering other revenues that are not immediate may help to get through the real life challenges for BTM storage.





Source: Cornwall Insight GB Frequency Response Report

Network charges (LV HH user in London)

Closer to real-time procurement will open frequency response to fast-acting assets



Over the past year, we have been working with the industry to identify improvements and enhancements to our existing balancing services and markets that will make them fit for the future. This process started with the publication of the System Needs & Product Strategy document and consultation in June 2017, where we sought feedback from the industry both on specific issues and on the direction of travel for future reform. This was followed in December 2017 by the first Product Roadmap covering frequency response and reserve service, which set out our work plan based on the feedback received through the consultation.

AUCTION TRIAL FOR FREQUENCY RESPONSE

One of the more significant pieces of work outlined in the Product Roadmap is the trial of a different method of procurement for a small volume of frequency response closer to real-time.

Moving procurement closer to real-time will create a new opportunity for distributed energy resources (DER) to access the frequency response market, lowering barriers and thereby increasing competition. This is because participants with variable generation and demand will have a more accurate picture of what they are able to offer closer to real-time. Alignment of procurement activities closer to real-time would also allow all parties to assess which revenue streams offer them greatest value.

Since the publication of the Product Roadmap, we have identified a preferred supplier to deliver the trial, completed the initial design work, and are now finalising contractual discussions to deliver and operate the platform. The trial will run next year and will last for 24 months from the end of the development phase to ensure that we can test different parameters and approaches prior to full implementation.

For anyone who would like to learn more about the auction design, we have shared the outputs of a webinar which explains how the auction platform will operate.

FASTER ACTING RESPONSE

As our system becomes more decentralised, the amount of inertia from large thermal generators is continuing to decrease. This results in system frequency becoming more volatile closer to real-time.

We introduced Enhanced Frequency Response (EFR) in 2016, which was designed to control frequency under normal operational conditions, as well as contain frequency changes that may arise from a sudden loss of generation. In future, a more efficient use of fast-acting assets may be to utilise them to address frequency containment alone.

The Product Roadmap for frequency response and reserve presented a broad concept of how a faster acting frequency response product could work. To build on this, in April and May this year we engaged with a range of stakeholders – including a large number of battery providers – through a series of technical workshops to seek views on the design of this new product.

We are continuing to model the new proposed products, and will be publishing a plan for the reform of frequency response products in December this year.

For further information, including our monthly newsletter, please visit **www.nationalgrideso.com/** insights/future-balancingservices where you can also register for latest updates.

The bigger picture (batteries included)

E.ON is confident it can unlock mutual business benefits despite fluctuating energy markets and regulation. But battery storage is just one piece of the puzzle, says Bid Management Lead John Anderson

Pressure on key components of the battery storage business case – such as falling firm frequency response (FFR) prices, unpredictable Capacity Market (CM) outturns and changes to the value of peak network charge avoidance – are well known. But that doesn't mean people should throw out the baby with the bath water, says E.ON's John Anderson.

"We all know these revenues are diminishing, but they remain important revenue streams in terms of paying for capital investments like battery storage," says Anderson.

The extent of regulatory changes will remain unknown until Ofgem finalises its ongoing charging reviews. To minimise uncertainty in the meantime, E.ON factors a "degree of reduction for things like Triad and DUoS" into its forecast modeling for storage projects, with "significant reductions for those elements from 2022/23 onwards," says Anderson.

EMERGING OPPORTUNITIES

Prices are also hard to predict beyond the medium term for FFR and CM revenue streams, which help to underpin current storage business cases. But Anderson believes energy markets represent a significant opportunity, and the company is "actively talking to customers about spot optimisation".

He says the Balancing Mechanism represents another revenue stream for assets in the right place at the right time, while National Grid's plans to open up services such as Black Start to storage are welcome.

Meanwhile, E.ON sees "services we could potentially get involved with" starting to materialise via

Short bursts or island mode: Picking the right batteries

Many businesses with onsite renewables want to maximise storage to minimise grid use. That creates a tradeoff between long-term energy storage and the ability to respond quickly to both outages (resilience) and grid services/energy market opportunities.

Anderson says that is where a combination of technologies can deliver maximum benefit – and points to the company's involvement in the Pellworm Island smart grid project in Germany as an example, (pictured right).

Pellworm, off Germany's north coast, is home to around 1,200 people. It produces about 22GWh of electricity a year via wind, solar PV and CHP which is stored in centralised lithium-ion batteries and a Vanadium Redox Flow battery. Decentralised storage – night storage heaters and heat pumps – is also used in islanders' homes. E.ON devised the hybrid scheme and the energy management system that predicts consumption and the required generation to power the island.

While Pellworm still uses the mainland grid via two 20kW subsea cables, it exports as well as imports and is now much more selfsufficient. By harnessing different technologies it is also able to store its own generation resources for many hours on end via the flow battery, while responding to quickly to short-term opportunities using lithium-ion.

E.ON believes its experience from the Pellworm project is highly relevant to optimising commercial microgrids and decentralised prosumer energy systems that are beginning to emerge locally and internationally.

distribution network operators (DNOs) as they start to procure flexibility and transition to distribution system operators (DSOs).

The opportunity is therefore "broad", says Anderson. But the number of moving parts mean solutions providers must ensure they are correctly valuing each aspect. While some of these remain an unknown quantity, Anderson says E.ON has significant expertise in fundamental elements such as energy trading.

"There is potentially a lot of volatility [returning to energy markets] and flexibility can take advantage of that, not just in winter, but also in summer," he says. "The commodity market is a big focus."

BEHIND THE METER

For industrial and commercial businesses, cutting cost and carbon while maximising onsite generation and boosting resilience are important pillars of the storage business case particularly the latter aspect, given power quality issues can cause significant production losses for manufacturers with highly automated systems.

Anderson says while "not everybody has a resilience requirement", there are many firms, particularly manufacturing, where the cost of production losses can



be crippling.

For those businesses, Anderson says offsetting loss of production cost against the capital cost of a battery can make a more compelling business case, but emphasizes that safeguarding against outages is "not as straightforward as simply citing a battery behind the meter", with additional protective measures often required.

MUTUAL GAINS

As non-commodity costs now make up the majority of electricity bills, E.ON is working with customers to maximise their use of onsite generation and reduce draw from the grid. Anderson says it is critical to look at the bigger picture on a site-by-site basis both to specify the right battery and to extract maximum value from customers' existing assets and operations. He thinks that is where suppliers have competitive advantage over other solutions providers.

"We have cross-domain teams operating across flexibility, storage, onsite generation, EVs and energy efficiency as well as commodity," says Anderson. "That means we always look for the most efficient way of optimising a customer's operation and maximise their returns, however that might be achieved."

Anderson says utility companies' willingness to fund solutions is another aspect that should give customers some comfort that projects will deliver returns.

"E.ON will provide funding for these projects, which mitigates risk for the customer in terms of capital expenditure, and they will still receive revenue and cost avoidance benefits," says Anderson. "E.ON is putting its own money into these projects and is willing to take risk on behalf of the customer. We want to put assets into customer premises to provide them with benefit – and we can also benefit by harnessing those assets within out virtual power plant," says Anderson.

"As part of an overall energy performance contract, that approach provides mutual value on a long-term basis."

Right place, right time, right contract

Flexitricity founder and chief marketing officer, Alastair Martin, believes there is a strong business case for batteries that are unconstrained in their ability to deliver flexibility when and where it is required

The market for flexibility is not about to stop changing, therefore "breadth of capability is the best way to success", says Alastair Martin.

"That doesn't just mean having a battery with a particular set of parameters," he explains, "but making sure you access all the potential revenue sources and move between them as the needs of the system ebb and flow".

He points to the widely predicted decline in frequency response prices by way of example.

"Batteries [bidding for FFR contracts] are suffering from cannibalisation – and that's not a surprise. But the flip side is that the Balancing Mechanism is opening up. National Grid has described that as 'the ultimate flexibility market', so being able to access that is very important," he says.



While National Grid is working to open access to the BM, companies currently need a supply licence to participate. Flexitricity acquired one earlier this year for that reason - and to provide customers with direct access to the wholesale market, so that they can manage risk in a manner that suits their operations. While Martin says BM access and wholesale market trading "go hand in hand", he thinks battery developers will be less concerned with forward electricity trading.

"With all the capability that batteries provide, they will be looking for real-time opportunities," he suggests. "That said, there will be periods when it is lucrative to generate or consume based on where you are and what the system is doing at the time," says Martin.

In simple terms, he explains it would be "smart" for a battery to start a sunny afternoon on a lower charge than on a cold Monday morning. "So there is value in regular consideration of where the asset sits in the market at any given time. Prudent operation of the battery takes advantage of all available opportunities."



EMERGING OPPORTUNITIES

Outside of the Balancing Mechanism, Martin thinks the ability of batteries and demand-side response to better manage rate of change of frequency (RoCoF) represents another emerging opportunity.

The firm is involved in a trial with National Grid to work out how to respond directly to the speed of movement of frequency on the system rather than waiting for it to reach a set trigger point, when National Grid has traditionally called assets to deliver frequency response. It is also examining how regional variances in system inertia affect other locations.

By "catching the slope [of rate of frequency change] and not just the absolute level", Martin believes strategically located batteries and other types of asset will deliver considerable value to National Grid. Particularly as thermal plant – a traditional source of inertia – continues to come off the system, summer demand decreases and renewables penetration increases.

National Grid's need to replace traditional forms of inertia also gives Martin confidence that flexible assets will be adequately valued by the electricity system operator. "It's a large challenge for National Grid to solve," he says.

LOCATION, LOCATION, LOCATION

As well as batteries' technical characteristics, asset location will become increasingly important, Martin suggests. In the immediate term, he says location is becoming critical in unlocking value from the Balancing Mechanism.

"If you have a large battery in a useful location, but don't present that to National Grid's control room in a way that enables them to recognise its usefulness, you will miss out on value," Martin suggests.

He says while some batteries have started to play in the Balancing Mechanism, batteries that make the most money from the BM in future will be those that are ascribed at Grid Supply Point (GSP) level.

"It is all about how assets are ascribed to different Balancing Mechanism Units (BMUs). Right now there are a couple of batteries active in the BM, but they are participating through a BMU whose location is spread across a whole distribution network," says Martin.

"That means National Grid has a limited knowledge of where [those batteries] sit in the transmission network – so it cannot be sure that using those batteries will not exacerbate another problem.

"If a battery is ascribed to a BMU described down to GSP level, it is

visible to National Grid, and National Grid can make more intelligent decisions as a result," says Martin. "If National Grid does not know that location, it has to take a prudent approach - and not use that battery."

KEY BTM CONSIDERATIONS For businesses contemplating storage behind the meter, Martin says it is important to consider how the battery will work with on-site processes – and not to limit opportunity with unsuitable supply contracts.

"It is important not to kill the asset's value with provisions in the contract that take away risk management from the site," says Martin.

"Some people like to protect themselves from imbalance risk by inserting an imbalance threshold into the contract. That is a fairly common form of risk protection, but it acts like a ball and chain when it comes to Balancing Mechanism participation," he adds. "So you need to think in different terms if you want to take an asset or site into full BM participation."

Martin advises industrial and commercial firms deploying batteries to "think about who does your risk management. "Is it yourself – based on your own assets and knowledge of what you are doing – or a supplier?"



Hybrid approach counters market uncertainty

GridBeyond CEO Michael Phelan believes the market has become more challenging for pure-play storage and instead favours those that can combine existing assets with batteries to unlock lower cost flexibility

The long-term requirement for flexibility provided by batteries is becoming clearer, says GridBeyond CEO, Michael Phelan. But the short-term picture is perhaps more opaque than it was 12 months ago.

"If you get through the next 6-12 months, the longer-term outlook is better, it is on the right track," he says.

"But market makers need to give the right signals. Policymakers and regulators must realise flexibility is more reliable than conventional generation that can't help with curtailment of wind generation or store energy."

Phelan says de-rating of storage within the Capacity Market suggests that realisation is perhaps not yet fully grasped.

As a result, along with falling firm frequency response (FFR) prices and lack of concrete detail on the new products expected from National Grid's review of services, he thinks some pure-play battery companies will start to struggle financially.



"National Grid's SNAPS review outputs are all good ideas. But it takes time to put them in place," he says. "For battery providers that increases uncertainty in the short term – and over last summer National Grid did not procure as much frequency response as it normally does."

That has created a knock-on effect on FFR prices, exacerbating downward pressure on bids.

"Uncertainty changes people's behaviour, they might bid less because they are under pressure," says Phelan. "Those sitting on batteries with big repayments to make have to do something." As a result, some of the dynamic FFR bid behaviour witnessed this year, dipping into mid-single digits per megawatt per hour, "appears somewhat desperate" says Phelan.

HYBRID FLEX

As such, Phelan believes it is critical to create 'hybrid' flexibility, where batteries form a relatively small part of the overall solution. He says there are "gigawatts" of existing – and untapped – flexibility in the UK that can be blended with a battery to provide valuable services across multiple areas.

"If I had invested in a batteryonly operation, I would be tearing my hair out," says Phelan. "But our hybrid model remains viable. It is basically 20% battery and 80% existing assets [generation or load], so it still makes sense. And we can see there are multiple revenue streams, not just FFR. By next summer there will be the traded market – so if you have a hybrid solution you have an advantage."

I&C sector: Lower cost, elegant wins

Phelan says certain types of companies can cost effectively unlock flexibility within their processes – and these companies represent the "gigawatts" of existing, low-cost flexibility that he believes lies untapped in the UK.

effectively look and behave like flow batteries, likewise cold stores in the UK and Ireland," he says.

The food industry is another example. "They already have flexibility in their refrigeration and compressed air plants, which also has storage capability. They can benefit as that plant will be doing a certain amount of the work, and then a battery will work on top of that," says Phelan.

"The cost of using demand assets that exist on a site already is zero. The battery of course has to be paid for, but they can make quite a lot of money on the smart grid capabilities of the inherent storage that is actually in their systems," he adds.

"There are a lot of assets that behave in that manner, and so they have a very low cost of providing balancing services. It is an elegant way of unlocking flexibility because businesses can unlock flexibility without the high capital cost of a larger battery."

Phelan thinks these are the kind of "optimum solutions that the market should be trying to encourage" and where GridBeyond is focusing its activities in both the UK and Ireland.



Cast iron opportunity?

Phelan says cast-iron bar manufacturer, United Cast Bar, is a good example of how its hybrid approach – joining up existing load flexibility with a battery – can deliver strong commercial outcomes at lower cost.

United Cast Bar has worked with GridBeyond to cut network charges, optimise energy and provide demandside response since 2014. Last year the company added a 500kW battery in order to unlock further flexibility and boost resilience at its Chesterfield site.

The fully funded installation meant UCB could participate in dynamic frequency response and enable greater peak avoidance without upfront cost.

The aggregator's platform takes the flexibility from UCB's existing processes and equipment - exhaust fans, induction furnaces, sand mixers, dust extractors, compressors etc - and combines it with the battery to extract greater value

James Brand, managing director (Foundries) at United Cast Bar, said the result is that the firm "has been able to earn large sums, generate significant savings, and meet our commitment to the environment without any impact on operations."



"So there is a strong business case to be made," says Phelan, "but it is not simple".

MARKET FORCES WILL PREVAIL

However, Phelan believes higher value assets, such as flexible storage, will ultimately command higher prices. The question is when.

"Storage and flexibility have a high value – but both of them together – not just individually," he says. "Gas engines can provide flex, but they do not provide storage. Storage is more valuable, and storage technologies tend also to provide flexibility. So eventually market forces will take over, and ultimately the higher value asset will command a higher price," suggests Phelan.

"It's just not happening yet – but the direction of travel is positive."



Risk mitigation through revenue diversification

Dan Connor, DSR development and delivery manager, Energy HQ, npower Business Solutions, says risks to battery storage revenue streams can be overcome with a flexible approach

Properly looked after, batteries can last 10-15 years. Yet energy policy, regulation and markets are changing fast. "So there is no way that the storage business case for year one will hold in year ten," says npower's Dan Connor.

Businesses considering batteries must therefore take a leap of faith that flexibility will continue to be valued. But, in a power system that will become dominated by renewables, Connor thinks the value of flexibility "is not going to go away". He also believes behind the meter (BTM) benefits can underpin viable storage business cases for at least the next few years.

REGULATORY CHANGE

Regulator Ofgem is planning significant changes to network charging and access rules. But Connor points out that these will not kick in for some time, likely 2021/22 at the earliest. That provides "semi mediumterm" visibility on cost avoidance aspects of BTM battery business cases, says Connor. "However, you are unlikely to have paid back the initial investment on a new battery over that period". He says it is therefore "crucial to



What should businesses consider when choosing a battery?

"How long do you need the battery to deliver and what's your site load over the winter peak are the two questions businesses should ask themselves," says Connor. "Also, what will that load look like in five years' time – are you scaling up or are you increasing efficiency? If you use 1MW now but in five years' time it will be closer to 750kW, the battery business case needs to account for that."

Connor says npower will also ask broader questions to determine how a business can use existing assets – load or generation - to maximise flexible response and reduce overall risk

"That is more palatable to a board [decision maker], because you have more levers to pull to unlock greater value."

have right partner to identify and act upon opportunities as they arise".

Longer-term, if the only guarantee is that the rules and revenue streams will change, "the more areas you can access, the greater certainty you bake into the overall business case," says Connor. "Our motto is risk mitigation through revenue diversification - that is key."

CURRENT AND EMERGING OPPORTUNITIES

Batteries are already earning money for providing multiple services across different areas: frequency response, Capacity Market agreements and wholesale market arbitrage are existing opportunities. National Grid is looking to enable batteries to deliver services such as Black Start, where it pays suppliers to be available to help reboot the grid if it crashes. These contracts are worth tens of millions of pounds a year.

Meanwhile, batteries have recently started to bid into the Balancing Mechanism and distribution networks have begun to buy flexibility instead of spending money on traditional network reinforcement.

Connor says npower sees value in all of those services, but the firm believes the wholesale market may represent the main prize.

"The Balancing Mechanism might be worth £350m. The day ahead and intraday markets are worth about £6bn, so we see that as a bigger opportunity," says Connor.

DNO/DSO OPPORTUNITIES

As regulatory changes start to take effect around 2021/22, distribution network operators (DNOs) have indicated they will be buying much more flexibility at that point. While some DNOs have plenty of spare capacity, others do not and all will have parts of their networks that are running close to their limits. Connor therefore expects the value of flexibility to DNOs – or distribution system operators (DSOs) – to increase, but in some places more than others.

"There is a lot more network at distribution level [versus



transmission level]. Many more miles of copper with constraints and issues that need to be overcome," he explains. "In a few years' time, when people ask how much their flexibility is worth, the first thing I will ask them for is their postcode. It will be very location specific."

WHY BTM WINS

Connor believes behind the meter businesses cases can be stronger than standalone batteries because the battery can help with core business requirements, such as resilience, and work in conjunction with onsite load, renewables, or any form of generation, to deliver cheaper power.

As long as the site has adequate import and export connection capacity, he says, "you can then do whatever else [in terms of grid balancing or merchant operations] that is commercially viable with that battery and achieve a shorter payback period, a better business case and reduced risk".

PPAS?

Connor says npower "gets asked a lot" about power purchase agreements (PPAs), but is not convinced they are the right structure for batteries.

"We understand the value and certainty PPAs provide from an investor point of view, but think it limits overall value that the battery can deliver, because the whole point of a battery is its flexibility and ability to do multiple things," he explains.

"By taking the PPA route you are restricting what the battery can do. We don't think the battery should be beholden to one activity at one particular time. That is what we mean by risk mitigation through revenue diversification."

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