

Battery Storage

A business case for battery storage?

2017 Report



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Appetite for disruption

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 May and July 2017.

Roughly half of those surveyed said they were investigating storage, and a minority had already invested. Their answers have been split off from the broader flexibility survey and form the research component of this report.

The majority (84%) of responses are from those that have not invested in storage, but are at various stages of consideration. Some 16% have already invested, though these are mostly utilities or companies involved in the energy sector.

Around 35% of battery storage responses came from National Grid's Power Responsive campaign mailing list (National Grid is a sponsor of the report).

According to the survey data, around half of respondents are considering behind the meter (BTM) projects, a market that report co-sponsors Endeco and Eon, among many others, are actively pursuing to unlock best-value flexibility. As such, the report is largely BTM-focused.

RISK AND REWARD

Two thirds (68%) of those surveyed believe their investments will payback within seven years, some significantly sooner. But almost half (47%) have revenue visibility concerns, with (32%) stating that policy and regulatory uncertainty undermine the business case. Almost a quarter (23%) said

investor appetite is a concern when it comes to financing battery projects.

All of those concerns are intrinsically linked. Policy and regulatory changes loom large on the landscape. Some appear positive, and others may yet end up providing clarity. But there is a degree of uncertainty over both the future revenues and cost-avoidance enabled by batteries, which has a bearing on both business cases and investor appetite.

Nevertheless, end-users, financiers, suppliers and aggregators interviewed for the report expressed interest in storage and the solutions it can bring both to businesses and the system as a whole.

Another significant benefit cited by industrial firms interviewed is resilience. For some companies avoiding lost production or load is the key consideration, given the impact of power quality issues on automated systems.

Meanwhile, those targeting I&C firms with batteries as a means to extract greater value from inherent flexibility believe the opportunity to increase industrial competitiveness while enabling greater renewables penetration could represent a step change.

TIMING ISSUES

The question then becomes one of timing. Battery costs are falling relatively quickly. Suppliers are gearing up for growth. Around half a gigawatt of new storage is already contracted via the Capacity Market.

So do companies wait for the 'de-risked' second mover advantage, potentially securing cheaper, more



proven technology at the risk of lower revenues in a commoditised market? Or do they capture relatively high revenues available via firm frequency response now?

Or should they look further ahead, beyond relatively short-term power technologies and at longer-term energy storage?

Companies packaging finance options believe that choice does not have to be binary and that the market fundamentals – greater volatility due to increasing penetration of renewables and reduced inertia due to loss of large thermal plant – mitigate revenue visibility issues.

How successfully they can convince end-users of the benefits storage will determine how quickly much of the BTM market grows.

But this survey suggests a substantial level of interest to build upon.

“...the...“



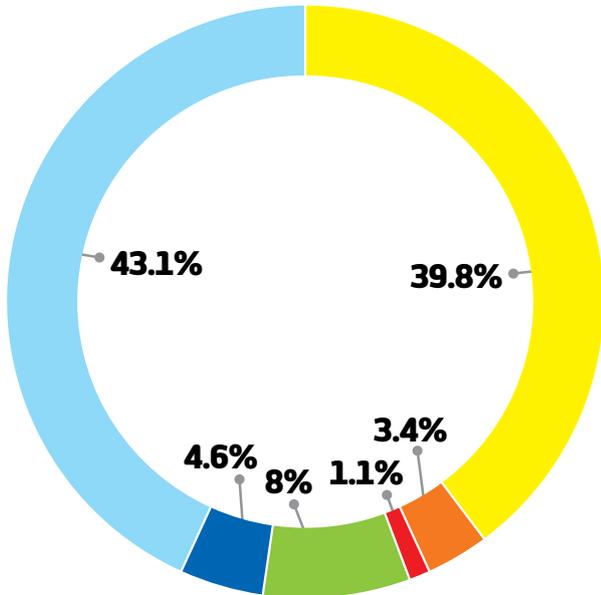
Author's note

Thanks to all that took part in the surveys and interviews for this report and to Victoria Box, from the Electricity Storage Network, for outlining current storage technologies. Any feedback welcome via theenergyst.com

Brendan Coyne, report author

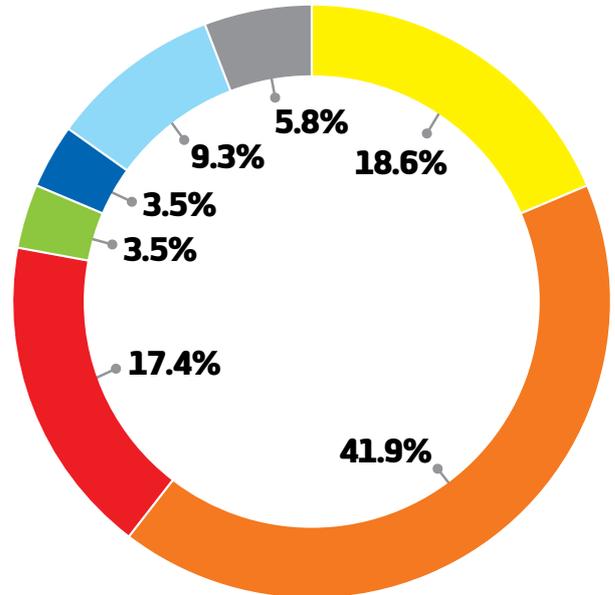
Survey respondents' demographic breakdown

Number of employees



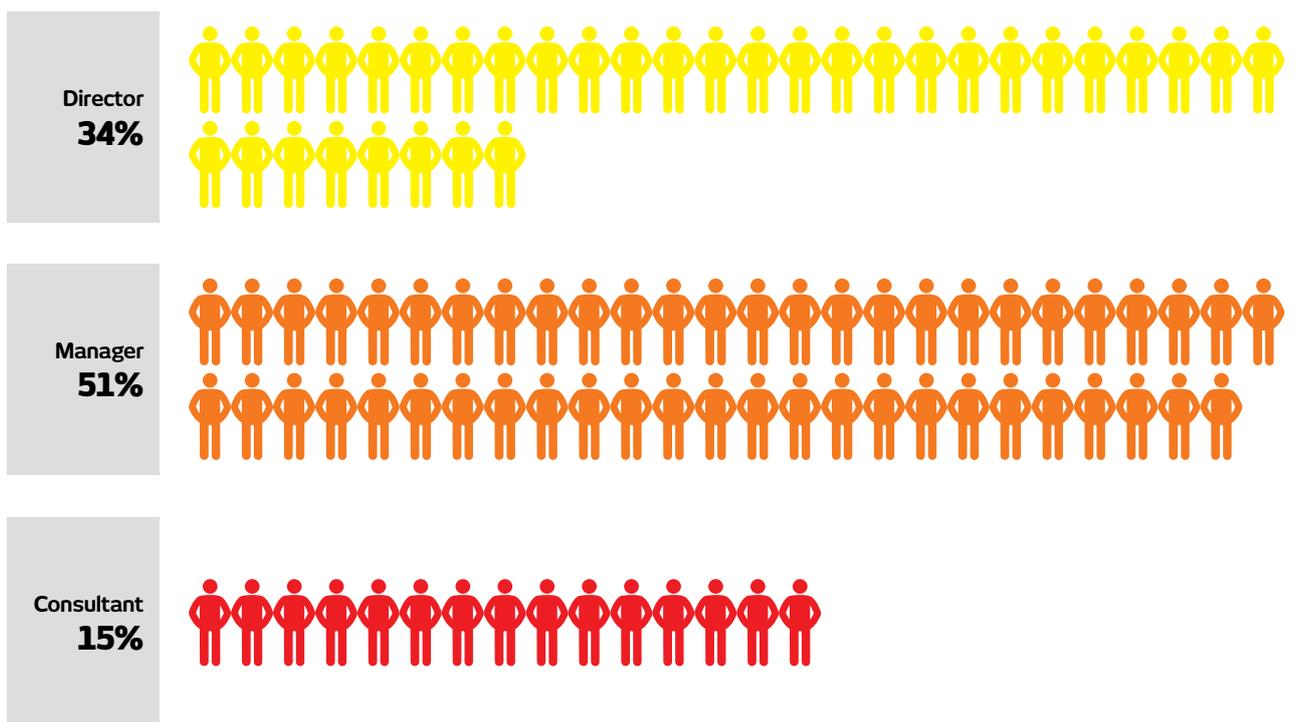
- 0 - 49
- 50 - 99
- 100 - 249
- 250 - 499
- 500 - 999
- 1000+

Industry sector



- Industrial
- Commercial
- Public Sector
- Finance
- Food / Drink
- Manufacturing
- Retail

Job title



What is your organisation's energy consumption?

Almost six in ten respondents consume more than £1m a year. That suggests many may be able to make six-figure savings on peak network charges, which could be enabled by batteries or other forms of flexibility.

A similar percentage (55%) are large companies (more than 250 employees) and across the sample roughly three quarters (78%) fall into the industrial and commercial bracket.

(87 respondents in total)

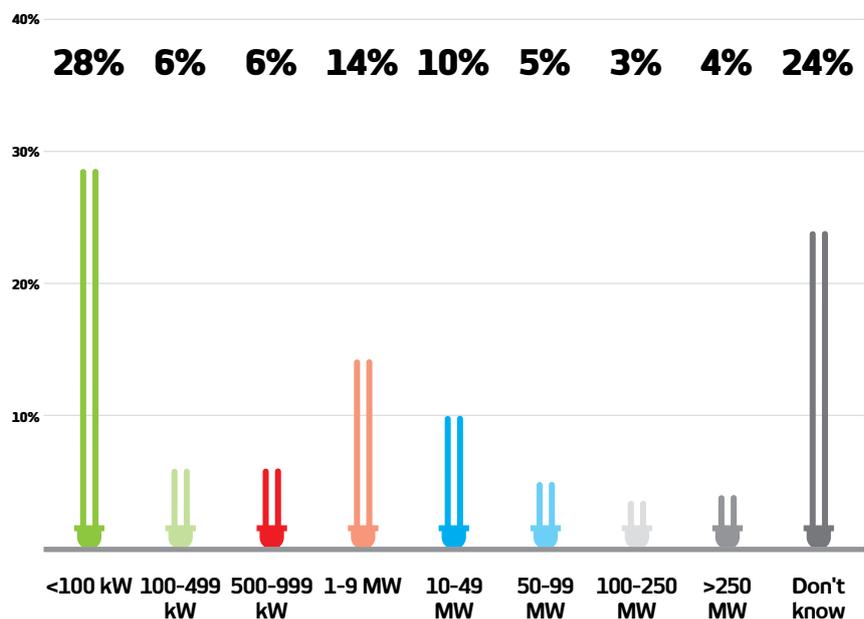


What is your approximate peak (maximum) demand ?

Avoiding peak charges is a significant part of the business case for behind the meter storage, and can provide an indicator of the size of battery that may be required to shift demand during peak times.

Roughly half of respondents have peak demand of at least 100kW. That figure could be higher given a quarter do not know their peak demand. Some 36% have peak demand of more than a megawatt, suggesting potentially significant savings could be made by peak charge avoidance and by harnessing load within flexibility markets.

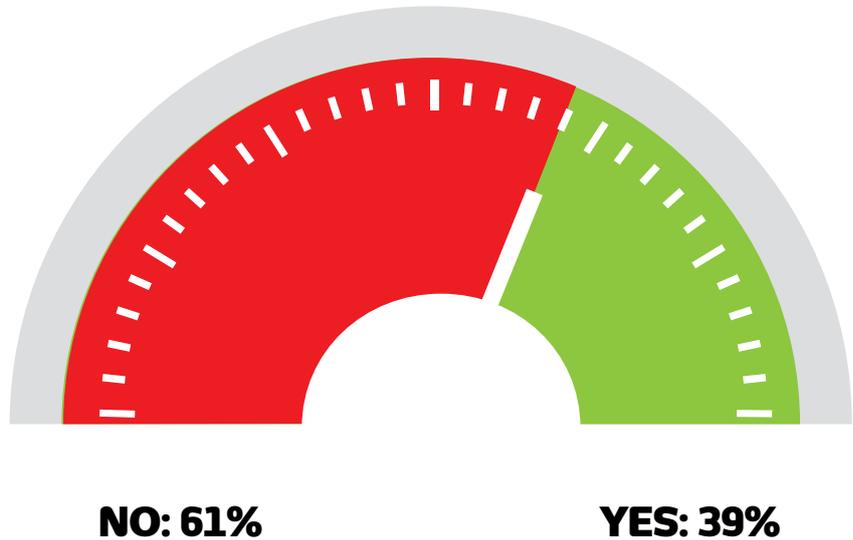
(70 respondents in total)



Does your organisation participate in DSR?

Most firms considering storage do not participate in demand-side response programmes. Of those that do not, most (56%) were small companies.

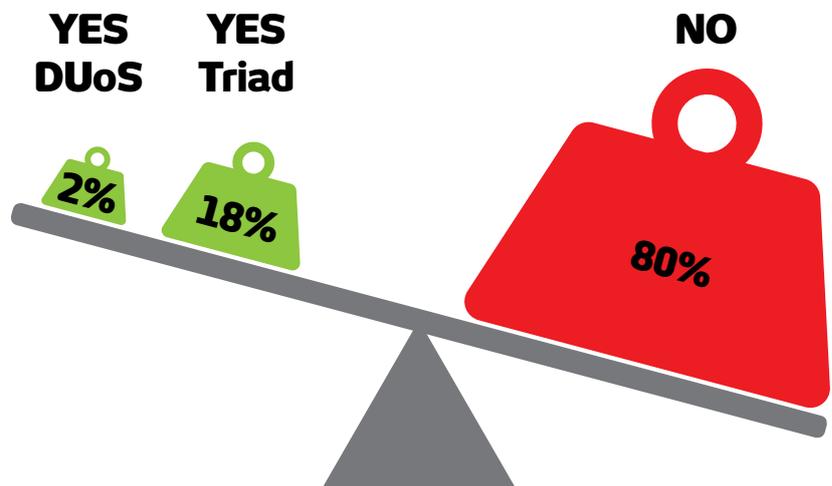
Of those that do, 77% were large companies, the majority were very large (1000+ employees) with relatively high consumption and peak demand. Their stated motivations are primarily to generate income from assets and avoid peak charges. Just over half of DSR participants (53%) currently use diesel assets to do so. Just under half (46%) are considering a 1MW+ battery. 63% of DSR participants are considering a BTM battery. (89 respondents in total)



Do you shift loads to avoid peak network charges (Triad/DUoS)?

The vast majority of those that answered this question do not avoid peak network charges. Interesting, given this is a significant part of the business case for behind the meter storage, which 58% cited as a way of monetising their asset (see p9).

Some firms, particularly manufacturers, are unable to shut down operations during peak periods, making batteries a potentially non-disruptive solution. Nevertheless, the data suggests scope for more effective energy management ahead of storage investment. However, this data is based on a lower sample size than most. (56 respondents in total)

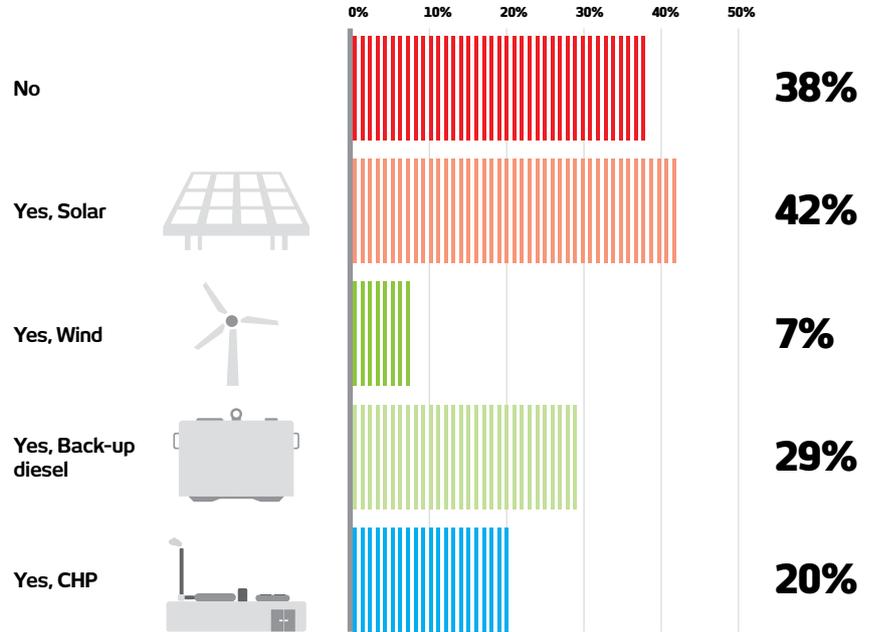


Do you have any form of onsite generation?

Most respondents have onsite generation. While there is risk of revenue cannibalisation from storage to some forms of generation, intermittent assets could benefit, although dependent on use, may require additional import/export capacity.

Adding batteries to dispatchable assets can also unlock revenue streams or resilience that would normally require response times beyond their capabilities. This can create efficiencies where smaller batteries are used in combination with generation assets. (Numbers are greater than 100 due to multiple choice answers.)

(56 respondents in total)

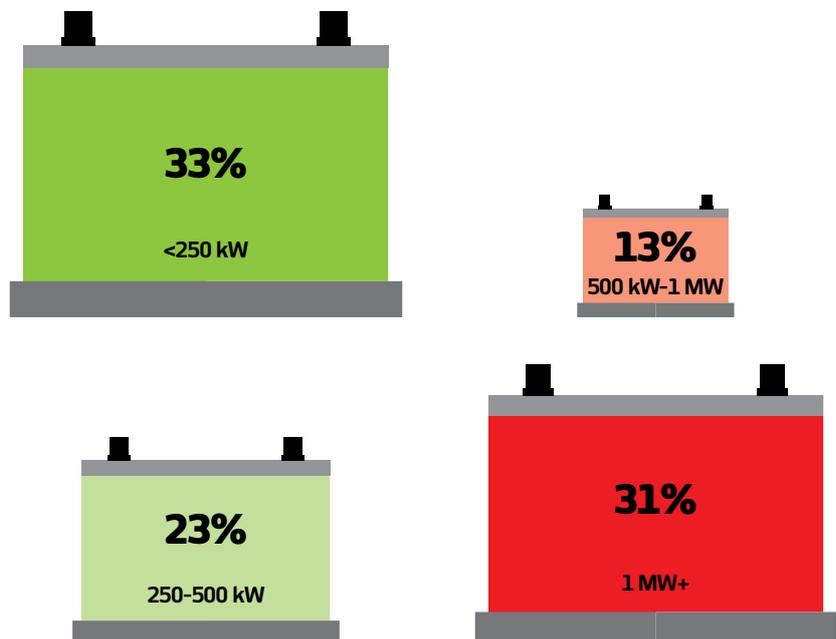


What size of battery have you invested in or are considering?

Across the sample extracted from our broader DSR survey, some 55% are considering or investing in storage. Of those, the vast majority (84%) are at consideration stage. Of the 16% that have invested, virtually all are some form of utility or company/consultancy involved in the energy sector, bar one local council running a small scale trial.

In total, there is a roughly even split between small, medium and large scale batteries, broadly reflective of the size of the companies that make up the survey sample.

(76 respondents in total)

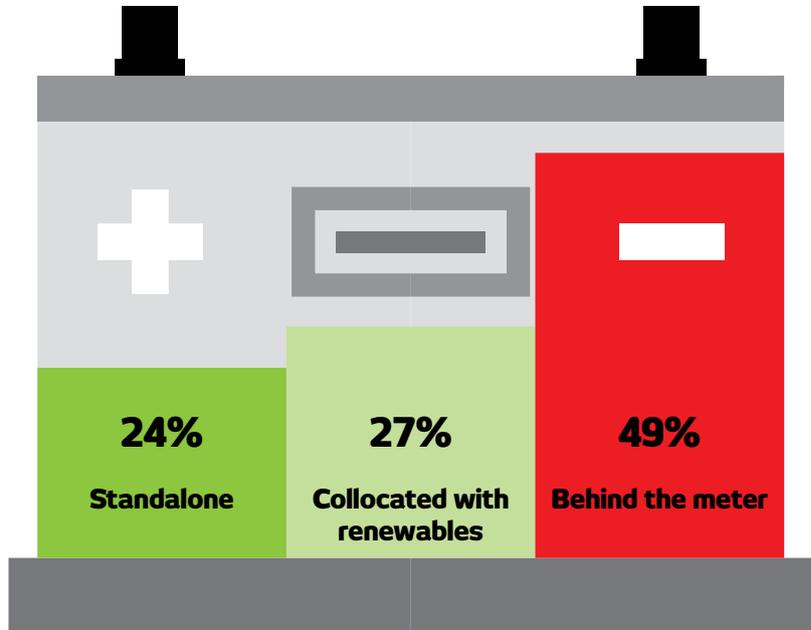


How would your battery be used/located?

Around half of respondents plan behind the meter (BTM) projects. Focusing on BTM, three quarters are considering batteries of <1MW and 74% believe they will payback in 3-7 years (see over).

Of those considering collocating batteries with renewables, some 55% are considering sub-250kW system. At that scale, it may be that these projects are also actually BTM.

Of respondents considering standalone batteries, half are considering 1MW+, a third 250kW-500kW, with the remainder sub-250kW. (76 respondents in total)

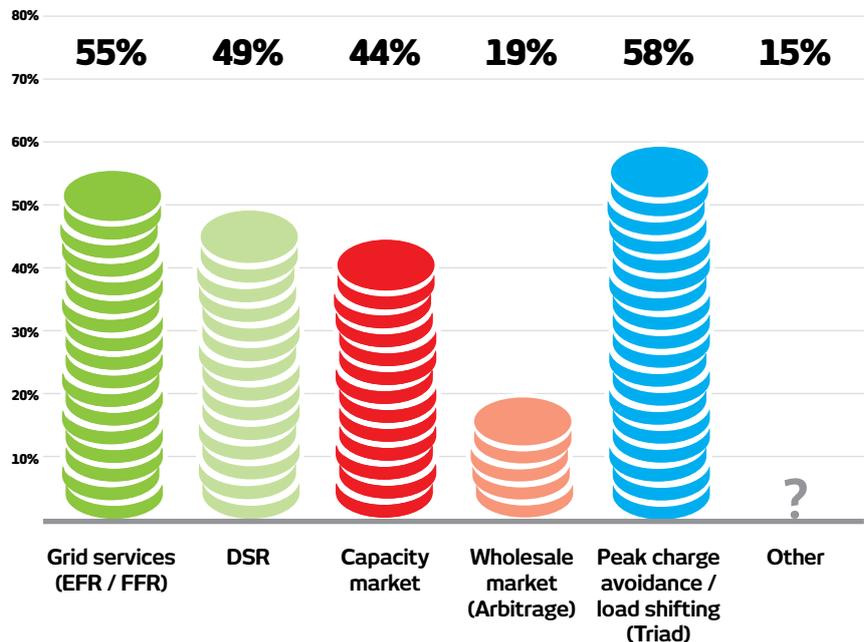


How do you plan to monetise the asset?

Grid services, demand-side response, peak charge avoidance and capacity market are all part of the potential revenue stack for those considering investment.

Fewer firms are considering arbitrage, which chimes with analyst predictions that the market for merchant-type services may be some years off (see p16-17).

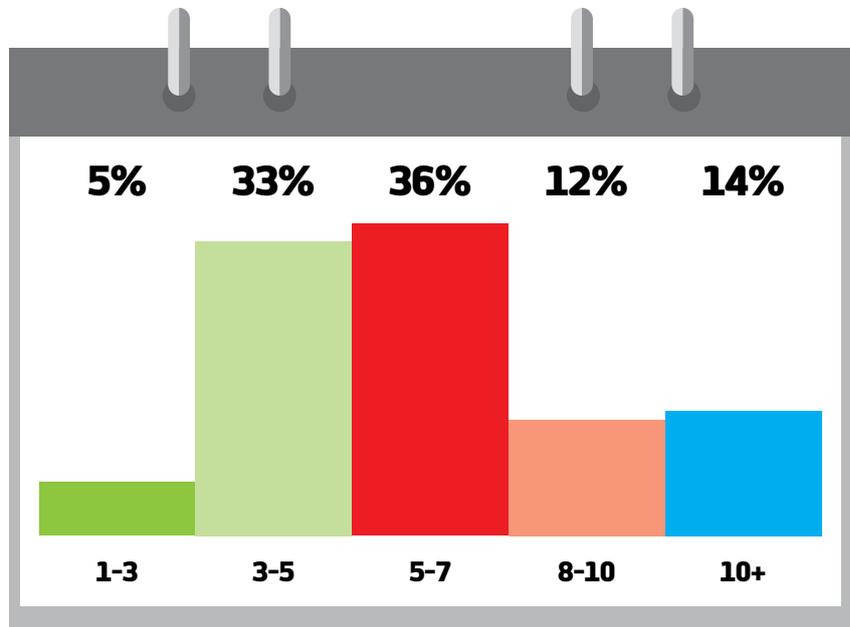
(74 respondents in total)



What is the projected payback period (years)?

Most respondents believe their batteries will pay back in under seven years. However, given many suppliers are promoting lease-type agreements and Esco models with no capital expenditure, perhaps the survey should have included an immediate payback option.

Paybacks can be modelled but are inherently uncertain as revenue streams will change over the next few years, as National Grid reviews its products, Ofgem reviews network charges and greater volumes dilute current value pools, while other markets open up new sources of revenue. (73 respondents in total)

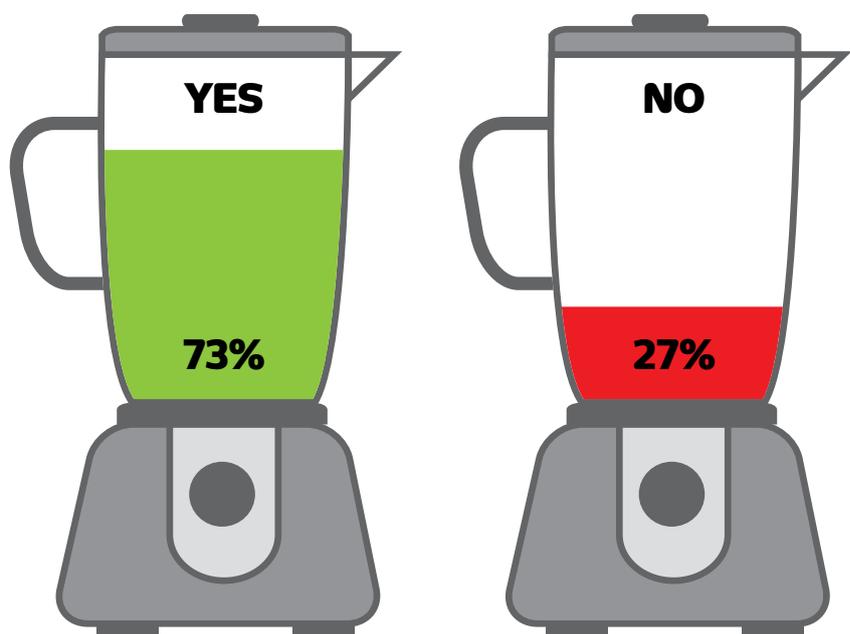


Will you combine the battery with other assets?

Around three quarters of respondents plan to combine the battery with other assets.

Around six in ten have some form of onsite generation, which could benefit from storage. But it is likely that some respondents considering BTM projects also plan to combine load with the battery in order to better monetise flexibility.

Combining batteries with the flexibility within industrial processes can unlock inherent storage, potentially lowering overall investment, say some specialists (see p24). (75 respondents in total)

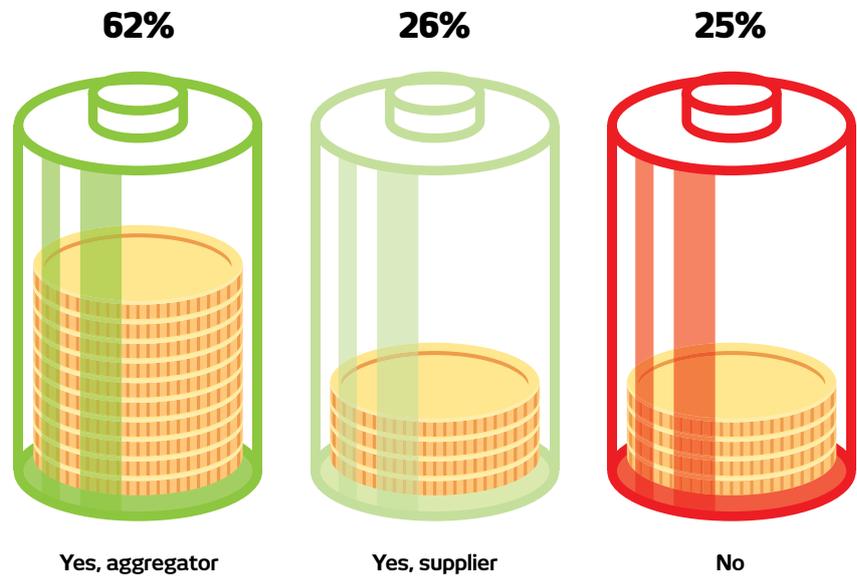


Will you work with an aggregator or power supplier to monetise the battery?

Most respondents plan to work with an aggregator, some plan to work with a supplier and some plan to work with both (hence percentages totalling more than 100).

Of the minority that do not plan to work with an aggregator or supplier, there is an even split between very small companies (which may be under the radars of aggregators/suppliers) and very large companies, which may have the energy management expertise to manage the battery themselves.

(73 respondents in total)



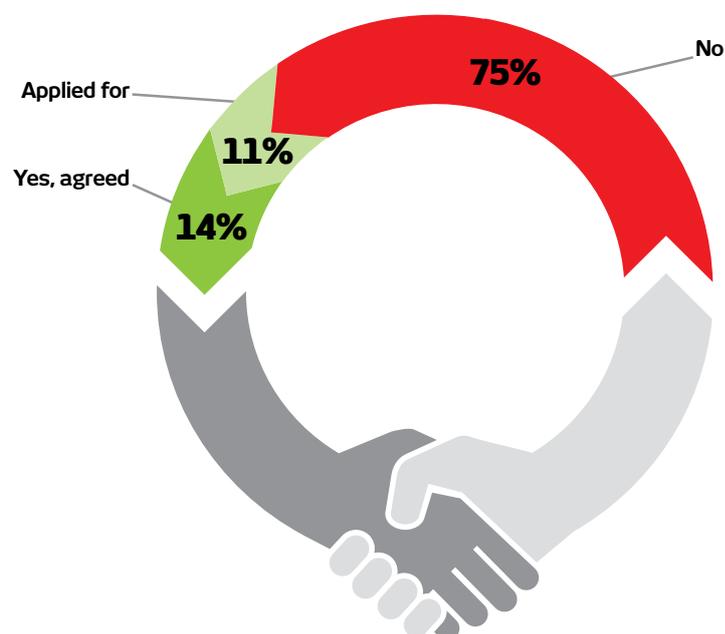
Do you have a connection agreement for your battery?

That most respondents do not have a connection agreement, or have not applied may underline that most plans are at a nascent stage.

Around a quarter have either secured a connection or applied for one, which accounts for the minority of survey participants that have already invested in batteries, and those that are advancing beyond investigation stage.

Grid consultants, however, suggest that securing import-export capacity should be the start point for any potential storage project (see p19).

(74 respondents in total)



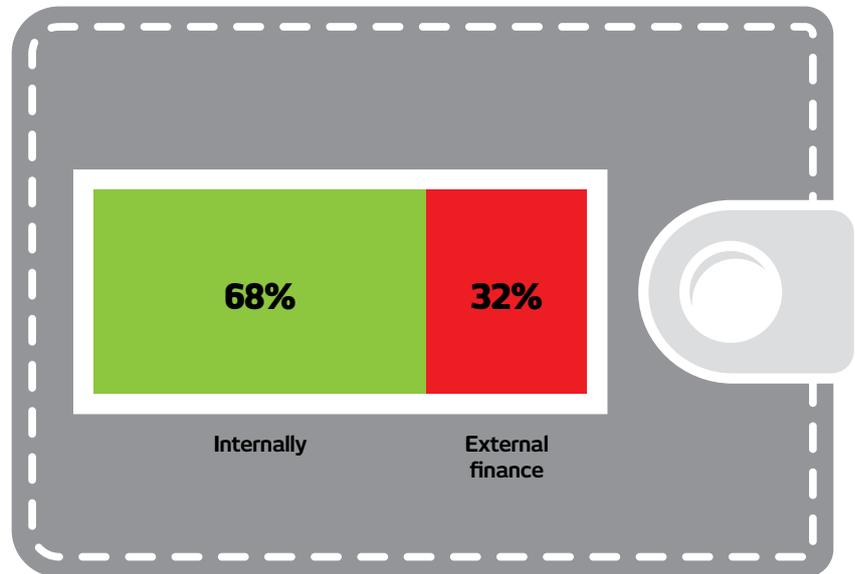
How are you going to finance this battery?

Almost seven in ten plan to finance the battery internally, suggesting some appetite for risk as well as reward.

But bringing a business case to board directors based on uncertain long-term revenue streams may prove challenging, as highlighted by some of the businesses interviewed for this report (see p26).

It remains to be seen whether appetite for external finance increases in tandem with understanding of the risk profile.

(75 respondents in total)

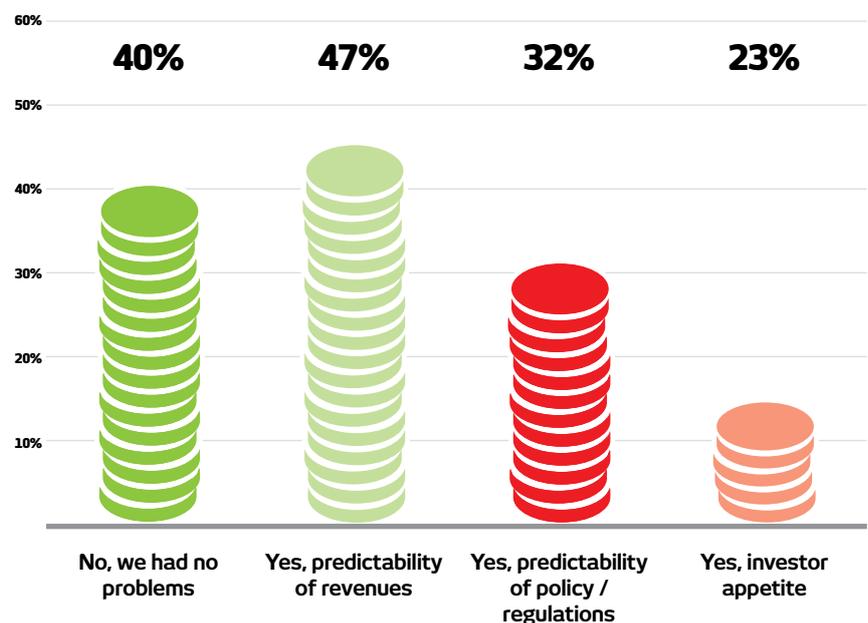


Have you faced any challenges in securing funding?

40% of respondents say securing funding has not been a challenge. However, many may not yet have tried, given the vast majority remain at a consideration stage. Those mulling zero capex funded options also do not face that challenge.

For the remainder, predictability of revenue is the single biggest challenge, followed by policy/regulatory uncertainty and investor appetite. However, all three of those factors are intrinsically linked. (Multiple choice, so percentages total more than 100.)

(60 respondents in total)



Electricity storage: what's the big deal?

Electricity storage is growing in popularity, viability and necessity – both for energy managers and consumers, and on the grid. It comes in many forms: some established; others newer to the scene. Victoria Box, external relations manager at the Electricity Storage Network introduces the key forms and discusses their advantages for an industrial or a commercial portfolio

The most well-known form of electricity storage is the battery. This electro-chemical technology has several different chemistries:

Lead-acid

A mature technology, and still the most employed of all battery types - primarily in vehicles - lead-acid batteries have a low production cost, reasonable safety characteristics, and are easy to recycle and decommission. However, their low energy densities are a drawback – although new innovations in lead-copper are beginning to change this – as is their toxicity. The Ultra-Battery, a new iteration, addresses some of the downsides to its chemistry and has seen considerable early uptake both in transport and in stationary applications, such as large-scale grid connected plant.

Copper-Zinc

The copper/zinc battery chemistry is based on the invention of Italian physicist and chemist, Alessandro Volta, approximately two hundred years ago. Recent innovations, such as that by Sheffield-based company Cumulus Energy have enabled this single use battery technology to become a rechargeable one. This is still an emerging technology but promises an efficient, low maintenance and scalable solution that offers some of the lowest-cost of energy commercially available from an electricity storage solution.

Lithium-ion

Widely commercially available since the early 1990s, lithium-ion technology has grown in popularity over the past decade (overtaking sales of sodium-sulphur batteries) due to its high energy density and ever-decreasing manufacturing cost - although they are still more expensive than the older lead-based

chemistries. Their target market was originally electric vehicles and small mobile devices, where weight is a significant factor. There various types of lithium-ion batteries with differing performance characteristics such as fire-resistance, energy density and high-power performance: a complex choice, dependent upon the intended application. Many electric vehicle (EV) manufacturers, most notably in the UK, Nissan, are looking to profit from their expertise in lithium-ion technology: 'vehicle to grid' applications use the electricity from an EV battery to support the demand in the electricity consumer's premises. In addition, EV battery manufacturers are selling their lithium-ion batteries directly to customers for use in stationary applications.

Other battery chemistries include: lithium-metal hydride, which has now largely been replaced by lithium-ion; nickel-cadmium, which is no longer in use because of environmental constraints on cadmium use, and several new chemistries currently under development such as the Zinc-air battery and other metal-air batteries.

Battery storage presents good opportunities for energy consumers, but other forms of electricity storage may have more to offer.

FLOW TECHNOLOGY

The flow machine, or redox flow battery, has a high cycle lifetime and a near-unlimited calendar life. It boasts numerous commercial and technical advantages including economies of scale, simplicity of operation and low manufacturing costs. When compared to more common battery chemistries, flow technology has a slightly lower efficiency and lower overall power density, but these disadvantages should be traded off against the lower whole-life cost of the storage

system. Flow technology operates with two liquid electrolytes, which can be chosen for reaction on the basis of cost, availability and performance – enhancing its versatility for a variety of applications, particularly in conjunction with renewables. The British company RedT is installing several vanadium-based redox flow systems worldwide for grid-connected and off-grid applications.

LIQUID AIR

This is a type of thermo-mechanical storage that uses electricity or industrial waste cold to liquify air, which is stored until the electricity needs to be recovered. The liquid air is returned to a gaseous state through a turbine, generating electricity. Suitable for grid applications, the evidence from current demonstrations in the UK is that Liquid Air has the potential to be a viable and versatile industrial- and grid-scale longer-duration electricity storage technology. Highview Power Storage is building a 5MW Liquid Air Energy Storage demonstration plant near Manchester.

COMPRESSED AIR

Compressed Air electricity storage is a mechanical storage system that uses compressors to pressurise air, store it and then generate electricity by expanding the air, usually in a combustion turbine with the addition of a hydrocarbon fuel. The compressed air can be stored in tanks or in naturally-occurring underground formations such as salt caverns. Because the system usually requires natural gas to facilitate expansion process by heating, it is less than ideal as a longer-term development. Although there have been a number of demonstration projects, only two remain in operation worldwide and future development of this technology is limited.



PUMPED HYDROELECTRIC STORAGE

Reversible hydroelectric turbines were first developed over eighty years ago, filling reservoirs during low-demand and generating electricity at peak-demand. Pumped hydro now accounts for the majority of grid-connected electricity storage worldwide. However, further development is limited by the availability of suitable sites. Although the projects have a high capex, their long lifetime means that they have a low through-life cost. The British and Irish power systems have relied on pumped storage as an efficient provider of reserve power and frequency response over many years. Europe's largest pumped hydro scheme to date was commissioned in 1984 in the disused Dinorwig slate quarry, Wales.

HYDROGEN ELECTROLYSIS

Simply, this process uses an electric current to split the molecules in water into hydrogen and oxygen gases. The hydrogen gas is then able to replace natural gas (methane) in the gas grid. British company ITC Power are developing these 'Power to Gas' systems, which use excess renewable energy to electrolyze water to supply zero-carbon hydrogen. Northern Gas Networks launched its H21 project this year, aimed at supporting UK gas grid conversion from methane to clean hydrogen. This innovative form of storage is rapid-response for renewable sources, whilst decarbonising our use of natural gas.

BUT IS IT EFFICIENT?

Yes. It is often pointed out that electricity storage systems are net consumers of electricity: frequently, more electricity is used in the storage process than is recovered. However, the efficiency of many of these technologies lies in their long life-cycles and their integration with renewable energy sources and 'clean' electricity supplies. Over the whole lifetime of the system, the value of the recovered energy is higher than the cost of the input energy: value takes into account both its sustainability and its cost. For example, it is viable to use renewable electricity generation to charge a storage device off-peak: the stored electricity is recovered at peak times, displacing the use of more expensive and polluting fuel.

A BIG DEAL

Just as it is impossible to imagine a mobile phone without a battery system, we in the Electricity Storage Network think a future power system will be unimaginable without electricity storage. Opportunities are now emerging for energy managers to play a part in the power system, ensuring that demand and generation continue to match up. An energy manager can use electricity storage, whether that's a battery, a liquid air system or a flow machine to reduce energy costs and even earn additional income. The purchase of electricity can be shifted from high cost peak times to lower cost periods, showing savings both in energy and in connection charges.

By incorporating electricity

storage into their portfolio, energy managers, familiar with the concept of Demand Side Response – shutting off demand in response to price signals – can have a new way to control and reduce net demand and thereby benefit from DSR. This can be achieved without the loss of production incurred by shutting down a manufacturing or service process.

The government and Ofgem recently published their Smart Energy Strategy, describing the importance of consumers participating in a flexible electricity market. Energy managers with their own on-site generation may now wish to maximise their self-consumption of electricity. We expect that the ability to reduce demand by responding to price signals will become ever more vital: this flexibility will be rewarded with demand reduction payments. We have already seen some energy consumers being paid to turn up demand, especially on hot summer evenings when energy is at a surplus, and those with storage would benefit hugely from this. For some customers, on-site electricity storage can be used to provide local power in the event of a network failure; an evidently valuable asset.

As we move towards an energy system dominated by renewable generation, our present infrastructure needs urgent change. Putting the right infrastructure alongside our industrial and commercial energy consumers will go a long way to reduce energy costs. We believe that incorporating electricity storage is the path to take.

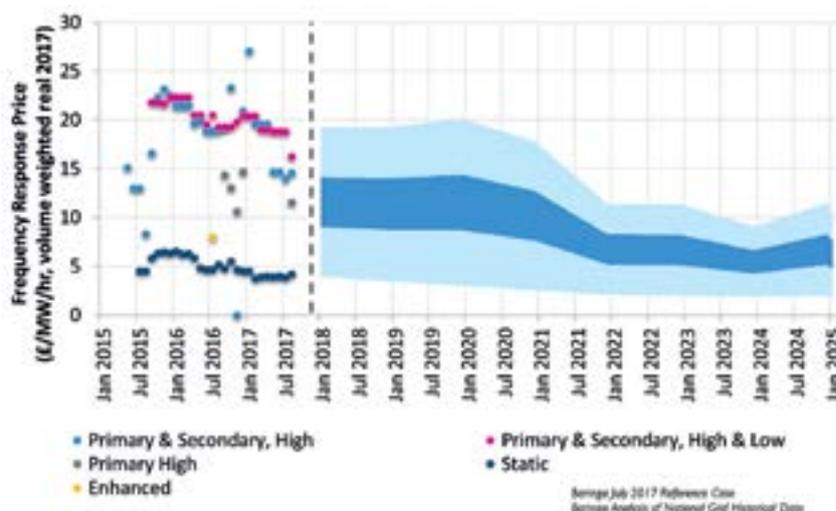
Batteries: applications, risks and revenue streams

Opportunities exist for battery storage, both today and in the future. But the business case is fluid, leaving firms with many variables to ponder

The 2016 tender for enhanced frequency response (EFR) kick-started the market for larger batteries. But National Grid is overhauling its suite of flexibility products and has no plans for another EFR tender round.

However, the System Operator currently procures firm frequency response products on a monthly basis. Richard Howard, head of research at Aurora Energy Research, says "it's certainly possible for businesses to pursue a battery model with firm frequency response as their main source of revenue". In the near-term, he says, "that is the main business model that we see [batteries] pursuing".

Aurora's grid-scale modelling suggests other revenue opportunities as penetration of renewables increases while battery costs and UK baseload capacity diminishes.



"In the longer-term there will be an opportunity for batteries to pursue load shifting applications. Load shifting; or arbitrage. People describe it in different ways. But that means you can make money from different

merchant sources, including the wholesale market and the balancing market. You can top that up with Capacity Market payments," says Howard.

"That is a varied income stream, whereas the FFR model is more about contracted services."

Viable merchant options, however, could be some way off. Aurora's modeling suggests mainstream arbitrage may take the best part of a decade to emerge.

"Energy arbitrage would be quite difficult to make work today, but it will improve over time for two reasons," says Howard. "One, battery costs are reducing. Two, prices become spikier if you have more renewables on the system, presenting an opportunity [to exploit price spreads]."

Howard admits arbitrage is "quite

Regulatory risk/change?

Simultaneous changes occurring across the energy landscape create challenges for those building battery storage business models.

National Grid is redesigning its flexibility products. Under the System Needs and Product Strategy (SNAPS), its intent is to simplify the market and make it more accessible and liquid. That creates opportunity in future, but limits visibility in the short term, although National Grid has said it will honour all contracts agreed before changes are cemented.

Ofgem is conducting a broad review of charging arrangements and how that might affect existing revenue opportunities is not yet clear. But it creates scope for fundamental change, given Ofgem is concerned that growing peak charge avoidance loads sunk cost recovery onto fewer and fewer parties. Peak charge avoidance is an important aspect of BTM storage business models.

As National Grid stated in its 2017 Future Energy Scenarios document: 'regulatory factors will be significant in determining the future commercial profitability of various decentralised technologies, and hence their anticipated growth rate'.

Conversely, the regulator's moves to classify storage as generation should remove market barriers for storage operators, such as double charging of environmental levies.

Meanwhile, government is changing the rules in the Capacity Market so that batteries are categorised based upon duration of full power output.

While Beis has promised transitional arrangements for upcoming auctions, some developers have expressed frustration at "going in blind" for December 2017 contracts.



Richard Howard

Frequency response

Frequency response is presently the most valuable revenue stream for batteries. Procured monthly by National Grid, various firm frequency response (FFR) products require fast responding assets to keep the power system stable at around 50Hz. Batteries are well suited to delivery.

FFR prices vary for different capabilities and the market is competitive. An influx of providers could impact prices paid, although National Grid is redesigning its frequency products, which may create further opportunities.

Capacity market

Some 500MW of new battery storage projects secured contracts within the December 2016 Capacity Market auction at £22.50/kW. They must be online by 2020. Upcoming auctions may provide a barometer of storage coming forward, but the picture could be clouded by proposals to de-rate batteries according to the duration of their power output.

Although a junior partner in the battery revenue stack, new build batteries can secure 15-year Capacity Market contracts, which are 'bankable' income for investors.

Enhanced frequency response

National Grid kick-started the large-scale battery market with its 2016 Enhanced Frequency Response tender. Four-year contracts for 201MW of EFR were awarded to eight projects, giving developers revenue visibility. However, National Grid says it has no current plans to run another EFR procurement round ahead of redevelopment of its product portfolio. Meanwhile EFR prices paid, compared to FFR market rates, have factored in forecasts of "revenue compression" for other frequency services.

Embedded benefits/peak charge avoidance

For behind the meter storage (e.g. on site at UK firms), avoiding peak charges is a large part of the business case. Triad charges can represent seven figure sums for big companies. Batteries can help avoid those charges, but many organisations will already have avoidance strategies/onsite generation in place. Meanwhile Ofgem's charging review could alter economics altogether.

Demand turn-up (DTU)

Batteries have the capabilities to help absorb excess power from the grid over spring and summer, as increasing

solar generation causes constraints locally and nationally. One of National Grid's newer products, DTU revenues could potentially be added to the battery stack. In its recent SNAPS consultation, National Grid illustrated that its requirement for upward reserve (assets that can increase consumption or stop exporting to the grid) may double over the next five years.

Arbitrage

Arbitrage is essentially drawing power cheaply at night (or other non-peak periods) and selling it on the wholesale or balancing markets when prices spike. Price spreads today might not make arbitrage economics stack up, but it could be a compelling, if ultimately self-balancing, revenue stream in the future.

Cashout opportunities

In simple terms, making money through helping energy companies balance their portfolios. Changes to cashout arrangements makes it more expensive if they get portfolio positions wrong, so some are paying firms for flexibility.

Voltage control and constraint management

Distribution network operators (DNOs) are trialling procurement of flexibility and may in future seek voltage control and constraint management services from battery operators. DNOs may ultimately procure regional services which are also used by National Grid to manage the UK system, although significant DNO revenue streams for batteries are not expected until the 2020s. National Grid is also considering new voltage control products as demand falls on the transmission system.

Black start

Black start contracts were traditionally awarded to generators to kick-start the grid in the event of a blackout. As part of its product overhaul, National Grid says batteries may be able to provide those services.

Resilience

Not a revenue stream but a quantifiable cost, resilience and back-up is potentially the cornerstone of industrial behind the meter storage business cases. Two I&C firms interviewed for this report cited the cost of lost production from power quality issues as a major factor in their consideration of batteries and/or generation investment.

an uncertain thing" to model.

"Another complexity depends on the type and size of battery. People need to consider whether to buy a half-hour, one-hour, two, three, or four-hour battery. Some of those different sizes become viable at different times. But we see energy arbitrage becoming viable by the mid-2020s."

REVENUE RISK

Eamonn Boland, senior manager at Baringa Partners, broadly agrees with

those considerations.

Speaking at The Energyst's DSR Event in September, Boland outlined current and emerging opportunities and risks for battery storage.

"The beauty of batteries is their flexibility," said Boland. "They are incredibly versatile assets that very clever people will find clever ways of using. I expect to see a whole ream of applications."

For now, however, FFR is the main game – and Boland highlighted risk of



“revenue compression”.

“Batteries are very valuable to the system but they are still an expensive asset. Frequency response is a high value product. It is one of the few things that would [currently] meet the return expectations for batteries,” said Boland.

However, frequency response is a “relatively small market”, he said, with fast acting asset owners “looking to rush into this space”.

“Frequency response is up to 2GW in depth. Total installed GB capacity is around 80GW, peak demand somewhere around 50GW. So 2GW is a small number relative to the size of the system, and more importantly, relative to the size of the interest in frequency response,” he said.

Revenues may therefore drop quite quickly.

“We see acute risk for [price] compression in that high value frequency response market. That may be a short, sharp cycle,” said Boland.

Endeco CEO Michael Phelan thinks FFR price declines could mirror that of short term operating reserve (STOR). Some investors in diesel assets, he says, “lost their shirts” after prices collapsed.

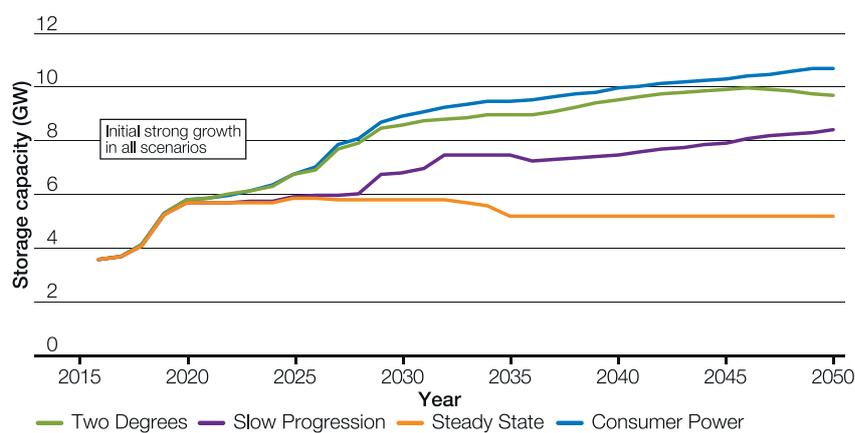
Baringa’s Boland believes FFR revenues may follow a similar path.

“A public reference point is last summer’s EFR prices clearing at an average of £8/MWh for a response within one second. That compares to the similar provision in the commercial market of £18-£22/MWh,” he said.

Boland pointed out that STOR prices have settled at around a quarter of their peak, seven years ago.

“We forecast in our modeling a similar downward pressure on frequency response pricing,” said

Figure 4.7
Storage capacity to 2050



Boland. “Our projections show acute fall off in that value in the next few years.”

Aurora’s forecasts of price decline are slightly less steep. But they “show the FFR price roughly halving between now and the early 2020s in real terms,” according to Richard Howard.

POWER VERSUS ENERGY

Boland agrees with Aurora’s Howard that technology and duration choices may be key in unlocking future revenue streams such as load shifting or arbitrage.

“Markets today are being built for power batteries providing half an hour of discharge. The challenge is whether those batteries can serve the needs of the future,” he said, “if future, deeper markets [require] load shifting for three to four hours in duration.”

Assets that can provide that kind of duration are “energy storage assets, which are not necessarily what is being built today,” said Boland. “So that is a challenge.”

Scott McGregor, CEO of flow storage manufacturer RedT, backs

longer duration energy storage, potentially in tandem with power batteries, to come to the fore.

“Lithium is a good technology for power applications, such as frequency response or short-term services. Lead acid is a predecessor and they are both very good power intensive technologies,” he said.

“But if you are moving to a more flexible system, you need to do lots of things and those things are going to change year on year. If you are working in a merchant market [such as arbitrage], you will need a very flexible asset that can do short and long-term services.”

McGregor says that necessitates energy storage or hybrid machines as opposed to pure power assets.

“The energy technology, such as a flow machine, is your workhorse. It will handle 60-80% of the work all day long: shifting solar, providing long duration services. Your lithium will provide short spikes of power. Combine the two and the lithium will last ten years, potentially even 15,” says McGregor.

“If you build a flexible energy storage platform, you hedge against all uncertainty, rather than building a particular technology that just does one thing.”

Solar and storage

Renewable energy developer Anesco recently opened a collocated solar and battery storage plant in Bedfordshire. Solar capacity is 10MW at the Clayhill site, battery capacity 6MW.

The firm plans to bid power into the T-4 capacity market plus solar timeshifting/arbitrage alongside frequency response. Clayhill is part of some 185MW of storage that Anesco plans to complete by the end of 2018.

The scheme was announced as the UK’s first subsidy-free solar project and its economics benefitted hugely from a pre-existing grid connection at an adjacent solar site with sufficient import-export capacity, according to Roadnight Taylor. “Until prices come down further, collocated solar and battery storage will only work where there are circumstances such as these,” the consultancy states.



Scott McGregor

Gigawatts when?

National Grid predicts around 6GW of storage on the system by 2020 across all of its 'Future Energy Scenarios'. However, that volume includes all forms of existing storage, including large pumped hydro, plus other operational storage assets.

Some 500MW of storage secured Capacity Market contracts in December 2016, with around 200MW of EFR contracts awarded a few months earlier. Meanwhile, Western Power Distribution said in May it had agreed 1GW of connections, and had offered connections to a further 1GW queued. UK Power Networks said in January it had received more than 12GW of "highly speculative" connections applications, mostly for storage, in the preceding 15 months.

Aurora predicts around 1.2GW of batteries will be on the system by 2020.

Roberto Castiglioni, Senior Investment Director – Infrastructure at Ingenious Group and head of battery storage, believes there is "probably" 1GW in the next two to three years from BTM storage alone.

Roadnight Taylor CEO, Hugh Taylor, who secures grid rights for developers and operators, "would put money" on more batteries coming on stream.

"Ofgem, Beis and National Grid together have probably slightly underestimated where the market is and just how much will be deployed in the coming years," he suggests.

National Grid sees cannibalisation

As greater volumes of batteries are deployed, so market extremities are dampened. Realisation of that fact led National Grid to almost halve its long term, top range estimates for storage in its 2017 Future Energy Scenarios, versus a year earlier.

In 2016, the SO forecast a top-end of 18.3GW of storage on the system by 2040. In 2017, however, that was slashed to 10.7GW by 2050.

Explaining the revision at the Future Energy Scenarios launch, National Grid head of energy insights, Marcus Stewart, said "more sophisticated" modelling took into account cannibalisation, "so we have brought down that [estimate] to a level where we see storage being economic as a business case."

All of National Grid's short-term scenarios suggest a steep growth curve out to 2020, with deployment rates subsequently slowing, in line with analyst predictions of price compression for some revenue streams.

STANDALONE AND COLLOCATION

There is "huge interest" in collocating storage and generation from developers, according to Hugh Taylor, CEO at grid connection rights consultancy Roadnight Taylor. But in virtually all cases, regardless of generation type, "grid is king".

Collocation is "very much a recent phenomenon" says Taylor, pointing to the column inches devoted to Anesco's Clayhill Farm development (see box).

"Four months ago, nobody was asking about that. But now, it is all about being able to collocate."

For such schemes to stack up they need sufficient import and export capacity, which Taylor says are not readily available.

"I think the assumption, across the country, is that the batteries will charge from solar energy and then discharge when the solar isn't generating," says Taylor.

"But for those schemes to work, they need to be discharging at the same time as generating. Or at least have the ability to do so, in order to stack enough revenue streams," he continues.

"So essentially grid is king. If

you can secure enough import and export capacity, you can make money. As long as you can import and export across thermal, voltage, fault level - all the other characteristics that mean you can collocate storage and gensets, or storage and solar - that is where the opportunities are."

For those that "have to pick and chose export capacity for one technology or the other," the opportunity is much smaller, says Taylor,

He believes "serious operators" accept that reality. But Taylor is unsure "whether the solar industry and the storage industry as a whole quite understand they will need that amount of export capacity. And



export capacity is at a huge premium across the country".

BEHIND THE METER

Export capacity is also an essential consideration for behind the meter storage, says Taylor.

"At the moment, simple timeshifting really doesn't work [for BTM storage economics]. You have to provide flexibility to National Grid. So the first thing we look at is how much export and import is available and can be made available," says Taylor. "That is absolutely key to a scheme."

Beyond that, firms have to consider the level of capacity headroom outside of onsite generation and peak demand periods, and what can be shifted.

"Very large I&C firms typically have enough load and baseload to engage in demand-side response with or without a battery. If they provide demand-side response, the battery can amplify that opportunity," says Taylor.

"But I think that there is an assumption at the moment, because storage is 'sexy', that you can put in a battery anywhere and it will make money.

"That simply isn't the case."

Positive outlook? Investor views on storage

Investors want to support storage, but there are significant challenges to negotiate

As an enabler of greater renewables penetration, "storage is a key area that the bank is looking to support," says Philip Bazin, Environment Team Manager, Triodos Bank.

Triodos is therefore "keen to support the right type of projects for customers with medium to long-term outlooks in this space", says Bazin. But the bank has "a relatively cautious appetite, because there are questions around risk, reward and bankability" of battery assets.

"Energy storage as an asset class is difficult to bank as low risk due to significant uncertainties that sit around the space," he says.

Given the risk profile, "we have been trying to overcome the shortfall in level of debt we could offer compared to the debt to equity ratios in some traditional asset classes," adds Bazin.

The bank is looking at 'bundling' funding streams. Bazin uses a mortgage analogy to explain it.

"[With a mortgage] you might typically take a loan-to-value (LTV) range of 70-90%, depending on assets and locations. Similarly, that is what we would typically expect to lend to a project with a [traditional] renewables risk profile. They are well understood with long

economic life, which is why banks feel comfortable with those LTVs," he says.

"With energy storage, there is a much greater level of uncertainty around them, market and regulatory. So we have to take a pair of scissors to the assumptions, cut them down and you end up with very prudent projections of loans-to-value of senior debt that are relatively low, 40-60% at the very best," Bazin continues.

Going through the "rigmarole" of engaging with the bank to get a LTV of 40-50% "may not particularly attractive to an asset developer," says Bazin. "So there is a challenge as to whether we can create a compelling enough service.

"Other forms of capital are prepared to take greater risk at a greater cost and we are trying to compete against different types of funding sources. So we have to bundle together different types of capital to provide an overall service that is more compelling compared to other funding sources available out there," he says.

"That is the challenge for banks."

BEHIND THE METER

Bazin believes behind the meter storage "makes a lot of sense".



Philip Bazin, Triodos Bank

"Ultimately the key question [for us] is who is the customer, who is going to be using this asset? Behind the meter, a large I&C firm represents a much clearer answer to that key question ... [and that] should be a natural home for energy storage solutions," he says.

Others looking to deploy capital also view BTM storage as an opportunity. Ingenious Infrastructure expects substantial growth in the sector.

"We are focusing on behind the meter and collocation behind the meter. So private wire PPAs, together with batteries behind the meter, or just battery storage behind the meter for commercial and industrial customers" says Roberto Castiglioni, Senior Investment Director – Infrastructure at Ingenious Group and head of battery storage.

"We believe there is a big market out there, probably around 1GW within the next two to three years



Roberto Castiglioni, Ingenious Group

Regulatory risk?

Ofgem has not yet made clear its intentions for behind the meter storage as part of a broader review of charging regimes.

That is "a bit of a concern", says Ingenious Infrastructure's Castiglioni.

"The issue is not having visibility. We are working on something today that will change tomorrow. Any time you don't have visibility over your cash flow there is a concern. And we know that they may reduce our revenue stream," he says. "That would be ok if they increased the visibility of the cash flow."

Triodos Bank's Philip Bazin agrees, caveating his belief in BTM at industrial sites as "making sense" for storage by admitting "these are based on current charging regimes and it is difficult to know what they look like going forward."

However, Bazin believes "all of the right questions are being asked now, so hopefully in the next 2-3 years we will get to a more stable regulatory framework to enable better investment decisions to be made".

Mass market?

Jason Hunter, associate director of Capitas Finance's Energy Efficiency Division, believes there is "a very solid business case" for behind the meter storage at industrial and commercial sites. "I think that is where the growth area is," he says, driven by increasing non-commodity costs "of which there is clear visibility".

That helps to mitigate risk, says Hunter, and is a persuasive argument for industrial and commercial companies.

While both network charging structures and frequency products may change, Hunter believes increasing volume of renewables, loss of thermal plant and inertia creates an ongoing requirement for batteries.

"We are comfortable in this sector, because we know there are so many applications for storage systems. Regulation and markets may change but taking out gigawatts of coal and gas and adding gigawatts of wind and solar will only increase demand for voltage and frequency response services."

just on the BTM side."

Castiglioni says the market "has moved quite a lot" from in front to behind the meter since the firm started looking at batteries some 12 months ago.

"We always believed behind the meter was good, because we come from energy efficiency. So we understand how to manage relationships with customers behind the meter," he says. "And we believe that adding a contracted, long-term revenue to the battery stacking system creates better visibility for an investor over the long-term."

Castiglioni believes an Esco type approach makes storage projects more viable.

"We started from the issue of making the project bankable or investible. That is difficult when you are only relying on a short-term revenue stream," he says.

"So if you add energy savings to the mix, you create long-term contracted revenue on the battery. On top of that you can do Capacity Market, which is 15-years. That leaves FFR, which is short-term, but at least you have created a bulk of long-term revenue that can amortise the full cost of the battery under the contract."

Taking that approach, the firm is targeting a 150MW storage portfolio within the next two years. Castiglioni admits that is ambitious and that engaging customers will be key within this emerging sector.

"Doing business with customers is not straightforward. We have experience with energy efficiency so we understand how complex it is. It is not like building a solar park, which, once you have planning and connection, is easy to do," he says.

"But people are getting up to speed and they know batteries can benefit their business and give them an edge – because if you have lower opex, it is money you can put somewhere else in your operation."

MANAGING RISK

Ambitious targets suggest Ingenious has faith that its business model will attract customers and that it can overcome issues around certainty and visibility of revenue. Castiglioni accepts that FFR revenues may fall markedly, as some predict, but suggests that risk is counterbalanced by market fundamentals.

"We are comfortable that the need for battery will still be there," he says.

"The more intermittent renewable generation that is put onto the grid, the more batteries we need. The more that older generation comes off the system the more batteries are needed on the grid.

"So, we take comfort from the fact that there will be a need for battery storage. But also from the high flexibility of the asset itself; it can chase different revenues and do different things. Unlike a solar plant, where if you kill the subsidies you kill the project, the battery can actually chase different revenues," says Castiglioni.

"So we know things will change, but we are confident that the battery will be flexible enough to chase different revenues."

TECHNICAL RISK

Castiglioni takes a similarly pragmatic view on technical risk

around potential asset degradation as a result of performing multiple services.

"Warranties are important [and] more importantly who's providing them. We will operate with suppliers that are going to be there for us in the long run. Experience says that things can go wrong, so we are focusing on top tier suppliers."

As in any market, Castiglioni says credible suppliers will tackle problems should they emerge.

"The worst-case scenario is that in year ten, you start putting in some new cells, maybe second life, maybe new technology," he says.

"The technology is moving so quickly. The revenue stream is changing. There are so many different variables that it is impossible to model all of the potential scenarios that may arise.

"Ultimately we need to take comfort from the underlying asset."

NICHE MARKET?

While Ingenious perceives a growth opportunity for its business, Triodos Bank's Philip Bazin believes the market may end up being relatively small, compared to the renewables sector.

"We can see a longer-term demand, the question is how much demand, how much supply and what are the barriers to entry. At the moment, there are simply a lot of unknowns," he says.

"Banks don't like uncertainty. So they won't lend against too much uncertainty. We do underwrite risk but not at the quantum of where the market is currently sitting."

While emerging opportunities enabled by batteries such as arbitrage are "interesting", Bazin describes that revenue stream as "cream, rather than anything else". Similarly, he says voltage control is "very interesting... but still rather technical, complex and uncertain.

"So it's a very interesting market, but it is going to be quite a niche market for a little while. There seems to be too many people looking at what is going to be quite niche in gigawatt terms relative to the many gigawatts of installed renewables," says Bazin.

"Look at the volume of [connections] applications, how much has gone into planning. Yet in the near term we are perhaps only talking about one, two or three gigawatts of additional storage capacity."

Eon: Storage 'an undeniable opportunity'

Storage provides an opportunity for businesses to transform energy spend, according to Eon

Eon has "definitely bought into energy storage as part of the energy system's future," according to Simon Mitchell, senior solutions development manager at the energy company. "It is undeniable."

Mitchell suggests Eon's newly completed 10MW battery facility at Blackburn Meadows, built after securing an enhanced frequency response (EFR) contract last summer from National Grid, is evidence of the firm's conviction.

INDUSTRIAL AND COMMERCIAL OPPORTUNITIES

Eon also believes businesses can benefit and the firm is building a project pipeline on the back of "huge" interest, particularly from the industrial and commercial (I&C) sector.

"It enables them to avoid peak costs, generate revenue from helping to balance the grid and also, improve power quality resilience – which can be quite a significant part of the business case," he explains. "Also, for those with onsite generation, batteries can enable them to optimise those assets."

But conversations with clients highlight concerns around revenue and regulatory stability.

"In terms of revenue streams, risks and visibility are key concerns for customers," says Mitchell. "But there has been a massive focus on batteries over the last 12 months as



Simon Mitchell

people try to understand both the opportunities and the risks."

He says the question then comes down to certainty of the business case, "and that is where a lot of our conversations with customers are taking place".

MANAGING FLUX

Due to the nature and pace of change, those conversations and associated business plans often require revisits, says Mitchell.

"Over the course of this year, the number of consultations from Beis, Ofgem and National Grid, which have some impact on energy storage, large or small, is significant. For I&Cs, keeping track of all the changes and the impact on the business is a challenge," he says.

"The sheer volume of consultations mean we have drawn up a business cases and had to tweak it within two or three weeks,

then communicate that to the customer. Many conversations with customers have gone down that route."

Recent consultations and proposed changes include derating of batteries within the Capacity Market, changes to Triad, Ofgem's broader review of charging and related uncertainty around the treatment of behind the meter storage, plus National Grid's plans to change products and procurement via its System Needs and Product Strategy (SNAPS) process.

"It is challenging to understand how these changes may impact potential revenue streams going forward. It doesn't necessarily destroy business cases, but it does create uncertainty and customers are having to try and get comfortable with quite a lot of ongoing change," says Mitchell.

"In b2b/I&C arena, that is not core business. Most people are not experts in storage and indeed the intricacies of the energy market. So they need some help and guidance from an expert partner – and that is key to building the confidence to get comfortable with storage and flexibility."

WORKING TOWARDS CERTAINTY

Despite simultaneous change, Mitchell reiterates Eon's belief that decentralisation of generation and increasing volumes of renewables will require a more flexible grid and fast acting technologies. Some change is necessary to create new rules of engagement for a next generation energy system, he suggests.

"While there is uncertainty around policy and regulation, piece by piece it is starting to become clearer. And every piece helps people to become more comfortable and make investment decisions," he says.

"The question then becomes when to get involved, at what point do you jump in? So you understand that there will be some risk, but also a lot

Arbitrage and voltage control

Distribution network operators (DNOs) are starting to procure flexibility to manage their networks. That may create opportunities for I&C firms that invest in storage to provide flexibility services such as voltage control to DNOs, says Mitchell. Meanwhile arbitrage, where businesses can exploit power price differentials by loadshifting, is another potential revenue stream for battery owners. But those opportunities will not emerge overnight, according to Mitchell.

"We see those as more of a long-term opportunity, into the 2020s for [mainstream] DNO procurement of flexibility, and similar timetable for arbitrage applications," he says.



Blackburn Meadows online for EFR delivery

Eon completed its 10MW battery storage facility at Blackburn Meadows, Sheffield, in October. The facility was built after Eon successfully bid for one of eight, four-year contracts awarded via National Grid's enhanced frequency response tender for 201MW of sub-second response assets. The System Operator will call on the assets to help maintain frequency close to 50Hz, with the speed of response helping it to better maintain grid stability.

Sited next to Eon's 30MW biomass CHP plant, the company managed to complete the storage facility three months ahead of schedule, making it the UK's first operational EFR scheme.

of opportunities as well if you have your battery up and running."

GIGAWATTS WHEN?

Trying to model the speed and scale of change is notoriously difficult. But Mitchell believes the results of the next capacity market auction later this year, will provide a "good indicator of how much storage is likely to come forward and when."

Either way, he says, from the conversations Eon is currently having with customers, "we can see a considerable amount of storage built over the next few years".

FINANCE AND RATE OF RETURN

Finance is a key question for customers, says Mitchell.

"From Eon's perspective, we don't just paint a rosy picture. We help them build the business case and ensure they understand all the opportunities and risks," he says.

"But there are plenty of options;

leasing, revenue and risk sharing, for example," adds Mitchell. "So customers have to ensure they are talking to the right people to access all of the options available to them."

Rates of return vary by project and are very much dependent upon customer assets and processes, says Mitchell.

"There are quite a range [of payback rates] across the piste. It depends on how many revenues you can stack up – plus resilience, avoiding the cost of lost production can be significant," says Mitchell. "Stack that up with peak charge avoidance, Triad etc. and you can really get the payback down."

HYBRID APPROACH

Mitchell agrees with those that suggest a hybrid approach, aligning batteries with existing assets and the flexibility inherent in equipment and processes, can be an optimal approach for BTM storage at I&C sites. In some cases, he

acknowledges, storage will not be the best solution.

"Understanding what is happening on site is key. All of those stacking options run the risk cannibalising what you are already doing, such as Triad avoidance using back-up generation. A battery might not necessarily do that any better," says Mitchell.

"So you have to look at operations, assets and energy in totality, make sure the proposition stacks up and adds material benefit rather than cannibalisation. Eon has a far broader remit than battery storage. We are purely interested in finding the best solution, regardless of technology, for that customer."

That said, Mitchell believes businesses should definitely consider the advantages that storage technologies can bring to their bottom lines.

"The opportunity is undeniably there," he says. "Go out and explore it."

Endeco: Go hybrid to minimise cost and risk

Endeco CEO Michael Phelan believes batteries can help unlock the "gigawatts" of flexibility inherent in industrial processes.

Endeco is deploying behind the meter storage at industrial and commercial (I&C) sites to create a level of flexibility that it believes is greater than the sum of the component parts.

CEO Michael Phelan believes that approach helps to reduce risk exposure for both his firm and those it works with.

"We have identified the storage that resides in existing systems," says Phelan.

"You don't need as much battery storage to implement dynamic frequency response in that instance as you would with batteries on their own. So your investment isn't as exposed."

FFR PRICE RISK

Phelan believes some pure-play storage operators may find cause for regret, should firm frequency response (FFR) prices erode.

"If lots of batteries flood the market, many people might lose their shirts, in the way that some did in the STOR market," says Phelan.

Prices for STOR, or short term operating reserve, tanked after peaking around seven years ago as a result of oversupply. They now sit at around a quarter of peak rates.

"People borrowed money to invest in generators, and then STOR prices

Loss leaders?

Some 500MW of battery storage projects took Capacity Market contracts in the December 16 auction, which suggests some confidence from developers and operators that the economic case can be made viable. Phelan, however, remains unconvinced.

"They are nearly all loss making. Basically a lot of speculative people had them and [many] they have sold them on to the utilities because they can't make sense of them, and the utilities obviously want to get a position in the market," Phelan suggests.

"So [many] are loss leaders. That is fairly well known around the corridors of National Grid," claims Phelan. "They just don't make economic sense. That is OK for a utility dipping its toe into the market. But for an investor in London or Dublin, that is probably not ok."

But the Capacity Market contract is a bankable revenue stream on which to stack others, including emerging 'markets' such as DNO/DSO procurement of flexibility. Is it not prudent to take what is available?

"Yes but the DSO piece is probably several years away," says Phelan. "There are opportunities, but I think that batteries on their own will probably go the same way as the diesel generators."

collapsed. Batteries on their own seem to be at a similar stage," warns Phelan.

Phelan says National Grid is prudent not to pay more than necessary and resist longer-term contracts and he believes the system operator has "cottoned-on to the fact that there is gigawatts of storage out there that can be unlocked".

Meanwhile, for customers, he thinks the hybrid approach can mean

a much lower capital outlay.

"Harnessing the assets that are already at customers' sites can mean it is sometimes just a few thousand pounds [to unlock a megawatt of flexibility]. Versus even the cheapest batteries, which by the time they are installed are probably £500,000/MW or more," says Phelan.

That is a primary reason why behind the meter "makes imminent sense," says Phelan, and why



Ireland backs hybrid storage approach

ESB, Ireland's state-owned utility, has a strategic partnership with Endeco following a €3.3m investment in the firm in 2016.

James Tedd, head of energy storage at ESB (pictured, right), says the utility's balance sheet and resource, combined with Endeco's technology and industrial experience, along with falling battery costs and improving communications infrastructure, can enable significant change within the energy system.



"Endeco is a smart energy company, working closely with industrial companies. We are working with them, bringing to bear our experience in all aspects of the power industry," says Tedd. "For example, our 700 engineers are used to working with HV switchgear, ESBI – our specialist engineering team, brings that capability," he adds.

"As a utility, we are able to invest in energy assets for their lifetime, and that allows us to manage one of the big challenges here: the revenues, for a significant investment, are only certain over a period of one or two years, versus 10+ years of the asset lifetime," Tedd continues. "We are well set up to manage that due to our vertically integrated nature."

Tedd says in general, ESB will be the equipment owner with Endeco the operator. For customers, that means "there is zero upfront cost and they are exposed to minimal risk".

While ESB is focusing on storage opportunities across the board, Tedd's remit is focused behind the meter.

"There are various places you could install storage infrastructure. But by being on the demand-side there are various benefits that accrue to demand customers, and various opportunities and benefits that can be unlocked by being in those locations," says Tedd.

"That makes it a valuable proposition. And also competitive, because you are making use of existing infrastructure rather than greenfield sites which could require new infrastructure."

Harnessing the inherent flexibility in demand is "transformative in the energy system", says Tedd, "and it gives each individual customer a way to create value out of the assets they have. We see huge long-term growth in that area".

What about short term growth? Tedd says ESB has two battery projects under construction, a glass manufacturer in Scotland and a metals company in England, which will be operational by the end of 2017. The firm has several more contracted positions.

"I see us having 25MW on the ground and 25MW under construction by next summer," says Tedd. "In our view there are exponential growth opportunities."

"the companies with a better understanding of the space are probably looking there".

WHY SHOULD I&CS INVEST?

Phelan believes I&C firms have most to gain from a hybrid storage/load approach – and can deliver greater system benefit at lower cost than deploying standalone storage.

"Most of the large traditional industrials that are struggling at the moment are probably the ones with the most flexibility. They are in a position to gain from this. It is a win-win. If their own load is doing most of the balancing with a battery in at the end, they are supportive of that, because it is not driving up their

costs at all," says Phelan.

He believes that paying industrial firms to balance to grid in that way will reverse negative renewables sentiment within the sector due to its shouldering of much of the cost of energy policy.

"They become a beneficiary and are actually part of the solution," says Phelan. "So they now become supporters, because they are helping to manage the entire grid."

ADVICE FOR I&CS

What should I&C firms consider around storage?

"Understand the risk profile. Understand how the markets work; what revenue streams are available

to them. Understand the coverage in terms of certainty of investment. It changes if you look across the hybrid approach as opposed to the battery on its own," says Phelan. "Appetite for risk is the big one."

Is it too soon for the I&C sector to invest?

"I can't see why," says Phelan. With [experienced operators] there is a very strong business case, proof that it works and a very strong cash flow proposition, because they are mostly using their own assets to earn money as opposed to the battery.

"So all of a sudden they are not looking at those long periods of risk that others are looking at."



Michael Phelan, CEO, Endeco

Merit order

Phelan says National Grid's SNAPS document gives an indicator of the direction of travel for flexibility.

"The more renewables you put on the grid, the more support is going to be needed for inertia. That is item one on National Grid's SNAPS report. The first thing is inertia, the second is capacity, the third is voltage," says Phelan.

"The first few line items [of the SNAPS document] give a clue as to [where the market is heading and] what is happening on the customer's site. So at the coal-face, there is probably a few reasons to put the battery behind the meter."

Positives and negatives: end user views

The threat of rule changes to behind the meter arrangements, uncertainty in frequency response markets and short-term contracts make storage projects quite hard to value, says Mark Fitchett, who handles energy procurement for Ineos-owned chemicals firm Inovyn.

"It looked quite interesting a year ago with four-year contracts. That was an interesting proposition and bankable," says Fitchett. "You could build a business case with a degree of certainty."

But the EFR opportunity has been and gone, and other revenue streams "have got a lot less certain over the last year," says Fitchett, citing both embedded benefit changes and threat of falling frequency response revenues due to cannibalisation.

"The only plus side is that batteries have got a lot cheaper," he says, "provided you are not buying in pounds."

However, the firm is open-minded about batteries and is considering where they may deliver some benefit.

"We don't have a ready made site at the moment, but [batteries] are one of a number of options we are looking at."

At Inovyn's large sites with import and export capacity, those projects could potentially be up to 50MW, says Fitchett. While ex-solar developers are beating a path to his door, any investment would likely be self-funded, he adds.

"But that's a big 'if,'" says Fitchett.

While the technology is "relatively simple" to add to a site and "intuitively looks attractive, dig a little deeper and there are a number of concerns you need to look into," he says. "You don't necessarily know the lifetime of these assets and that adds to the uncertainty".

Combined with fluctuating revenue and regulation, that makes it very difficult to take projects to the board for sanction, says Fitchett.

"Ofgem's intention around behind the meter arrangements is not clear. So who knows where you are two years down the line?" says Fitchett.

He suggests the regulator is "doing a really good job of creating

massive regulatory uncertainty for this whole area".

"So, there is just a lot of compound risk to get a project through," Fitchett adds.

"Intrinsically it should be something that works well [for us]. But there is too much uncertainty. We are keeping an eye on batteries, but it's not top priority."

SME STORAGE: FOOD FOR THOUGHT

Based in Yorkshire, l'Anson Brothers manufactures animal feeds around the clock.

The firm's annual electricity bill is around £500,000 and managing director Chris l'Anson is considering battery storage as a means to mitigate both peak costs and supply quality issues.

"We get brownouts from time to time, not regularly, but perhaps half a dozen times a year, which stops the factory, because it is all automated," he says.

A battery would address that issue due to speed of response. l'Anson says he has a "drawer full of quotes" for a battery system and



RETAIL VALUE

Marks & Spencer is mulling battery storage, potentially to use in tandem with back-up generation and ultimately replace them at the end of asset life.

While initially looking at feasibility of frequency response using batteries, storage is part of a longer-term strategy by the retailer to reduce overall peak demand on the power system and to do so with greener sources, according to energy efficiency manager, Maria Spyrou. The company recently updated its 'Plan A' targets and now aims to make 50% of its load flexible by 2025.



SAGE COUNCIL

Devon County Council has considered energy storage to monetise onsite back-up. But investment levels and paybacks are significant hurdles, given revenue and regulatory uncertainty.

Corporate energy manager, Alastair Mumford, says "the council doesn't really have an appetite" for ten-year paybacks based on uncertain revenue streams, but may pursue a funded route.

"My conclusion is that it is high risk, therefore we don't want to be the primary investor. So [if anything, we may] go down the Power Purchase Agreement route, make little or no capital investment, and share the revenue with the developer," says Mumford, though he admits, "concerns about the sustainability of that market".



LIQUID ASSETS

Welsh Water is examining potential for battery storage. The non-profit water company aims to determine whether storage can help reduce customer bills.

Falling battery prices have generated "renewed interest within our firm towards batteries", according to Welsh Water energy innovation analyst, Andrew Heygate-Brown. "Previously we were looking at 12+ years payback. But that is starting to come down."

The firm, which will be hit by changes to Triad export rules, is considering "all opportunities", he says, large and small.

"For example we have put in two wind turbines, where we might be able to use the batteries on site to store instead of export energy, to use when wind generation is low. But we could also do more at sites where we don't have any renewables – storing energy overnight and using it during higher cost periods."

However, Welsh Water always takes a prudent approach, says Heygate-Brown.

"We will trial a few sites and see what the payback is before committing significant amounts to battery technology."



had originally considered a 1-2MW unit, but it now mulling a smaller battery alongside a generator.

While the business "tends to fund things ourselves", l'Anson is considering both self-funded and finance options, due to competing demands for capital, with production and sales taking precedence.

On a pure battery system, l'Anson says an aggregator has modeled a payback period of 5.5 years. "That looks relatively attractive," he says. "We have been around 118 years, so we can take a longer view than some."

Meanwhile business growth has eaten up surplus production capacity, and the firm has no flexibility in its processes to avoid peak charges.

So will l'Anson go ahead, with either a pure battery or hybrid system in the near-term?

"I would like to ... but there isn't a vast amount of suppliers with experience. A lot of people say they can [do storage]. They all talk a good story, but the complete

package doesn't appear readily available at the moment," says l'Anson.

"It's just the same as if you buy a car. You like to go and see the car and kick the tyres - and there isn't many of these things to go and look at."

COUNCIL MULLS COMPLEXITY

Surrey County Council is at an early stage of considering battery storage as part of "tentative steps" around demand reduction and response.

Energy manager Paul Hasley says the council is mulling two main options: combining storage with the estate's existing generation, both gensets and solar, or using the estate to generate lease revenues from storage developers.

Hasley says the latter option may be its eventual route forward, given that much of its back-up generators are relatively small and its solar generation, while collectively totaling around a megawatt, is widely dispersed across council

buildings and schools.

"What probably has more potential for us, as a county-wide landlord, is looking at our property portfolio and trying to map that across the distribution network, to see where the pinchpoints are," says Hasley.

The council's estate falls across two DNO areas, SSE and UKPN.

"If it turns out we have areas of land next to substations with capacity, that might be of interest to a developer. That is potentially a bigger opportunity for us, but is dependent on getting the information from the network."

Hasley says while storage and flexibility are non-core to the council, "we know there are opportunities out there and we are interested in exploring them".

However, while there are a number of different ways of accessing flexibility markets, "they all seem quite complex", says Hasley.

"Trying to work out which is the best fit for an individual site or estate can be quite challenging."

National Grid supercharges its support for storage

With the appetite for battery storage growing among UK businesses, System Operator (SO) National Grid is taking positive steps to support this expanding interest.

In its role as SO, the company has a duty to balance supply and demand on Great Britain's energy grid. Storage has the potential to become a valuable way to offer greater flexibility on the system, with its ability to absorb surplus electricity at times when there is excess power being generated and then release it when needed.

In a move to improve prospects for the storage sector, National Grid is reviewing all of its balancing products to make them more accessible to all shapes and sizes of energy provider. Balancing products allow businesses to earn more revenue, reduce bills and cut their carbon footprints.

MAKING STORAGE INVESTMENTS PAY THEIR WAY

By expanding the scope of these services, National Grid will help to level the playing field for storage projects. This should give those businesses investing in storage greater confidence that they'll be able to compete equally with other technologies.

The product review builds on work already undertaken by National Grid to create more opportunities for storage providers. One product in particular, Enhanced Frequency Response, has proved extremely popular with storage providers, and a number of contracts have already been signed.

Enhanced Frequency Response (EFR) is National Grid's superfast frequency response service where providers help balance the grid in under a second. This makes it an ideal option for battery storage.

National Grid is currently assessing the first storage providers to be awarded EFR tenders and therefore has no immediate plans to procure more. However, fast-responding frequency response will be a requirement that is included in the

business's simplified product offering.

LEADING THE CHARGE WITH POWER RESPONSIVE

The work National Grid is doing sits under the umbrella of its Power Responsive programme, which was established in 2015 to get more providers involved in demand side response (DSR).

DSR is where businesses increase, decrease or shift their energy use – in response to a signal from National Grid – to help balance the grid.

As it moved into its second year, Power Responsive increased its focus on energy storage and its growing relevance to a future energy mix.

Now in year three, the programme is taking its commitment to storage a stage further. First on the agenda has been to bring together its Storage Working Group and DSR Provider Group to create an all-new Power Responsive Flexibility Forum.

The thinking behind this move is that National Grid sees DSR and storage as complementary technologies for providing wide-scale flexibility and meeting the future needs of the network.

The new forum will bring the battery and DSR communities together to hear the latest developments from organisations such as the Department for Business,

Energy & Industrial Strategy (BEIS), regulator Ofgem and National Grid. It will also provide a free and open platform for businesses to share their concerns or questions on storage directly with the SO.

Next, the Power Responsive team will be investigating the role of decentralised forms of energy storage in meeting flexibility requirements. In other words, storage projects not connected to the transmission system.

If successful, this could create even more opportunities for the storage sector.

USEFUL RESOURCES TO GET INVOLVED

National Grid, alongside the Major Energy Users' Council (MEUC), will soon publish an updated version of its popular DSR guide, which will now incorporate storage. It's a comprehensive overview that gives companies all the information they need to profit from the latest opportunities in DSR and storage. It will be available on the Power Responsive website from November.

If your business would like to get involved in future Flexibility Forums or to find out more about taking part in the flexible electricity system of tomorrow, visit www.powerresponsive.com





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