Solar + Storage = Opportunities

Solar Trade Association Position Paper on Energy Storage

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SOLAR TRADE ASSOCIATION

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About the Solar Trade Association

Since 1978, the Solar Trade Association (STA) has worked to promote the benefits of solar energy and to make its adoption easy and profitable for domestic and commercial users.

A not-for-profit association, we are funded entirely by our membership, which includes installers, manufacturers, distributors, large scale developers, investors and law firms.

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Executive summary

Over the past year, the STA has been evaluating the opportunities for energy storage in the context of solar power in the UK. It is clear that storage and its interaction with solar will be a very significant building block of the clean and smart energy system the future demands. Consensus is emerging among respected analysts such as the view of bodies such as UBS (Guardian, 2014), National Grid (Energy Post, 2015), Deutsche Bank (Deutsche Bank Markets Research, 2015) and Energy UK (Energy UK, 2016) that solar + storage can play a key role in the energy industry in the timeframe of 5-10 years. Our own analysis suggests that there will be step-changes in cost and innovation that should enable battery storage to establish its place within the UK energy system. However, there are a number of regulatory and economic barriers which could limit the widespread deployment of new, decentralised storage systems if these are not resolved in the short term.

Post the Paris Climate Agreement, there is a clear signal for a move towards a low-carbon energy system. The characteristics of renewables dictate a more decentralised energy system with greater need for the system to respond flexibly to the output of wind and solar in order to balance supply and demand. The highly distributed nature of solar in particular is blurring the line between producers and consumers of power. Energy storage promises to optimise solar output for both individual investors and for the wider power system. The tremendous value this would add to clean power generation has attracted global attention.

Recognising global momentum on storage, the UK government is examining the role a smarter energy system could play to achieve their three objectives of energy sustainability, affordability and security (known as the energy trilemma) through the Smart Energy project jointly run by BEIS and Ofgem. The Government's adviser, the National Infrastructure Commission, has estimated that a more flexible power system could save consumers up to £8bn per annum by 2030 (National Infrastructure Commission, 2016). The flexibility that renewables need therefore also offers tremendous cost benefits. The time is therefore right for the STA to evaluate the role solar + storage could play within that smarter energy system.

The solar + storage market is estimated to be worth $8bn globally by 2026 (Lux Research, Inc., 2016) and there will undoubtedly be opportunities for UK solar companies as the market develops. The nature of these opportunities varies significantly within the different solar sub-markets. The domestic solar + storage market contains a number of different business model options, which will be the subject of innovation over the coming years. The commercial and larger-scale solar + storage markets are more challenging to define, but there will be growing opportunities for STA members to deliver benefits through the addition of storage to their solar offering in the future.

Solar is not the only driver for storage deployment: standalone storage systems – those not tied to solar – can deliver value for the grid by providing services such as balancing, frequency response, voltage support and reinforcement deferral. In this initial paper our focus is on the interaction between solar and storage, and the value that can arise from the combination of both.

On the basis that storage is a long-term game changer, rather than a short-term market bubble, the STA's focus is on laying the foundations to enable a sustainable solar + storage market to develop. These 'foundations' require the development of robust product and installation standards, working with stakeholders, to ensure safety and quality. It also requires a regulatory framework that responds to the

unique characteristics of storage and ensuring that storage systems can participate fully in the markets they could service.

Storage needs to be clearly defined so that an appropriate regulatory framework can be developed at EU and UK level. This should result in a level playing field for the diverse applications of solar + storage across the power system. At this stage, we believe direct financial support from central government for solar + storage systems may not be the right action; we are aware that other countries are providing stimulus to support the development of their storage sectors. Given the rapid speed of progress in storage technology, however, it is likely the economics will be fundamentally more attractive by the time essential regulatory hurdles are overcome in the UK. We call for a continuation of monitored field trials which have already provided a significant amount of value through knowledge sharing.

This position paper identifies our initial proposed actions in the storage field. Over the coming year, we will engage further with relevant bodies to ensure a consistent and strong message is heard on the benefits that solar + storage could deliver to the wider energy system – and to help members understand the role storage can play alongside solar in providing a stable energy supply. We will work with our members to enable them to develop a solar + storage market in the UK, ensuring high-quality and safe installations under a clear and supportive policy and regulatory framework.

The STA's policy asks

A summary of the STA's policy asks, which are set out in detail in the STA policy asks section, are given below.

- Set storage as a **clear strategic priority** for the government through a storage strategy
- Develop a clear regulatory framework for storage
- Drive the development of standards, consumer guidance and best practice
- **Level the playing field** for energy storage by resolving double-charging
- Provide regulatory **clarity** for energy storage including VAT and G59
- **Develop marketplaces for the services storage can provide**
- Disseminate field trial results and encourage the development of case studies

Context

What is energy storage?

Energy storage has existed, in different forms, for centuries. From storage heaters and hot water cylinders to pumped hydro systems, there are significant variations in scale, technology, cost and operations of different energy storage solutions. For those not familiar with the subject, a research note produced by the Parliamentary Office of Science and Technology (POST) in April 2015 and a recent paper by consultants WSP Parsons Brinckerhoff explain the different storage technologies (Parliamentary Office of Science and Technology, 2015), (WSP Parsons Brinckerhoff, 2016). A brief summary of the different types of energy storage is given below.

In the past, energy storage principally took the form of small-scale heat storage (such as domestic storage heaters) or large-scale electricity storage (such as pumped hydro). These played important roles in making the best use of the electricity system when demand was low, and ensuring the security of the system when demand is high.

More recently, the development of other energy storage technologies has accelerated, including batteries, compressed air, flywheels and hydrogen. In particular, the research and innovation by the automotive industry for electric vehicles has driven the costs of batteries down significantly. For example, the cost of lithium ion batteries has fallen from more than $3,000/kWh in 1990 to less than $200/kWh today (National Infrastructure Commission, 2016). Breakthroughs are frequently made at an academic level, with Advanced Research Projects Agency-Energy (ARPA-E) – a branch of the US Department of Energy – recently announcing it had attained some “holy grails in batteries” (Guardian, 2016). Innovation has not been confined to electrical energy storage, with companies such as Sunamp developing small-scale heat batteries (Sunamp).

The different technologies, locations and scales of energy storage systems lead to very different use cases and business models. For example, a domestic battery owned by a householder to maximise their solar self-consumption is very different from a large pumped hydro energy storage system owned by a grid operator to smooth overall demand. The range of models, stakeholders and key players in these different sub-markets is an interesting and complicated landscape that will become clearer over the coming years. This paper does not distinguish between technology or location (behind the meter or in front of the meter): our position is to support the development of any energy storage system which enjoys synergies with solar, whether through directly storing solar energy behind the meter or through providing grid services to enable a greener, smarter and more flexible energy system with higher solar penetrations.

Why is energy storage important?

A number of global trends explain why storage is strategically important in the long term.

Firstly, renewables (solar and wind in particular) are reaching, or are close to reaching, cost parity across the world on a levelised cost basis with conventional centralised generation, either coal, gas or nuclear. This trend is set to continue, as in the long term the costs of renewables will continue to fall. Deutsche Bank analysis last year identified 30 countries and 14 US states where solar is at grid parity and this is set to spread to other countries over the coming years (Deutsche Bank Markets Research, 2015).

Secondly, the move towards a low-carbon energy system – accelerated by the agreement in Paris in December 2015 – is now a priority for governments across the world. The timescale by which this will be achieved, and whether this will be enough to avert dangerous climate change, is a source of debate, but the direction of travel is clear.

Thirdly, the combination of these political and technological drivers means decentralised renewables are likely set to dominate the world's energy supply in the long term, providing cost benefits to consumers. Decentralised, ambient renewables such as wind and solar have a zero or very low marginal cost of generation but their generation profiles are variable. Consequently, supporting variable renewables through greater system flexibility is increasingly important for the development an efficient, low-carbon and secure energy system.

For end-users, storage allows more solar to be consumed as it allows solar to be available around the clock. The benefits are clear and adoption is rapid; in 2015 41% of new solar PV systems in Germany were tied with energy storage (Energy Post, 2016).

For power network operators, flexibility, including demand side response (DSR), energy storage, interconnection and dispatchable generation plants, are vital for the integration of non-dispatchable renewables. Storage already provides flexibility in the power system, notably through pumped hydro, but the importance and diversity of storage systems is set to grow to enable this future energy system. For example, IEA modelling showed 310 GW of additional electrical storage by 2050 (International Energy Agency, 2014) could support the transition to a fully decarbonised electricity system across the United States, Europe, China and India.

In summary, there is a move towards variable renewables and more decentralised and flexible energy systems globally, which have benefits in terms of costs, carbon and certainty (security of supply). Storage can play an increasingly important role in this transition, which provides the potential for a vast market in the long term.

What is the UK government doing about energy storage?

The UK's geographical position as an island with relatively old grid infrastructure increases the potential value that flexible and smart grid infrastructure such as storage could deliver. The Committee on Climate Change in their analysis of the UK power sector in 2030 stated that *"A failure to deliver a significant improvement in flexibility would undermine efforts to reduce emissions and significantly increase costs"* (Committee on Climate Change, 2015).

There are a number of actions that the UK government is taking to develop this area. The Department of Energy and Climate Change (DECC) published a policy paper last December (Department of Energy & Climate Change, 2015) covering the challenges that the energy system faces over the coming years, and how to deliver the government's objective of an affordable, clean and secure energy system through an increased focus on **smarter energy**. DECC states that the benefits of a system of this nature include: less investment in infrastructure (both grid reinforcement and generation plant); reduced balancing costs; and a reduced need for curtailing generation. In other words, flexibility can enable each unit of energy generated or consumed to be managed in a smarter way, leading to a cheaper, greener and more resilient energy system. A much anticipated and soon-to-be published Call for Evidence will detailed further how exactly the new department of Business, Energy and Industrial Strategy (BEIS) intend to take this work forward, and this position paper is intended to consist some of the STA's input into this process.

Ofgem is working together with BEIS on this area, specifically leading on enabling new business models and in facilitating the transition to new roles for distribution network operators (DNOs) and industrial/commercial consumers. However, uncertainty around regulatory changes may hinder development of new models. Ofgem's position paper, published last September (Ofgem, 2015) set out how they intend to support the transition to a more flexible energy system, specifically identifying the following as priorities: clarifying the legal and commercial status of storage; enabling new marketplaces around flexibility; and engaging with the European debate on the role of storage in the energy system. An update on progress and future actions will be set out in the BEIS-Ofgem call for evidence described above.

The National Infrastructure Commission (NIC) was set up last October by HM Treasury to advise on long term strategic infrastructure, such as the electricity system. The NIC's first report in March 2016, "Smart power" (National Infrastructure Commission, 2016), found that £8bn could be saved by 2030 through increased flexibility from a combination of additional interconnectors, energy storage and demand side flexibility. The report specifically recommended that the UK become a world leader in electricity storage, through reviewing the regulatory and legal status of storage, and removing barriers. The timeframe for these reforms was set as *"by Spring 2017"* with the implementation coming *"as soon as possible thereafter"*. In the 2016 Budget in March, the government stated they *"will implement the commission's recommendations, and will work with Ofgem to remove regulatory and policy barriers, positioning the UK to become a world leader in flexibility and smart technologies, including electricity storage."*

Alongside the work that is being done by BEIS, Ofgem and the NIC, there are potential synergies with the government's Electric Vehicle programme. The Office of Low Emission Vehicles (OLEV) envisions an additional 100,000 plug-in cars over the next 2 years (Office for Low Emission Vehicles, 2015), providing a significant amount of electricity storage capacity, if used in the right way.

The uncertainty caused by the merger between DECC and BIS into BEIS, as well as the vote to leave the European Union and the change in government ministers, may have an impact on the timelines in which this work can be done. However, none of the political changes has changed the fundamental reasons why energy storage is important as described on the previous page.

Solar + Storage opportunities in the UK

The government and regulatory work in the area of solar and energy storage represents an opportunity for the STA to demonstrate the value that solar + storage can add. Over the long-term, we see solar forming the core of a smart, flexible low carbon energy system – and the smarter and more flexible the system, the more solar can be accommodated. As a result, there will be diverse and growing opportunities for solar companies in and in cooperation with the storage industry.

In the context of a shift towards a smarter, flexible and more decentralised energy system, there are opportunities that storage could offer for different sub-markets of the solar industry. The areas covered under this analysis are:

- The domestic solar market (new and retrofit);
- Commercial and industrial applications and;
- Opportunities for solar farm developers and owners.

As the focus of this paper is on the solar + storage market, the opportunities for standalone storage (i.e. storage systems not tied to solar either virtually or physically) are not covered. Nevertheless, many of the monetary benefits of storage relate to the range of grid services that it can provide, rather than just the on-site benefits and it is recognised that the same storage system which helps to integrate renewables can also be used to provide services to the grid as a whole.

Additionally, the analysis presented here does not focus on comparisons of "behind the meter" or "in front of the meter", or different storage technologies. Due to the significant variation of possible technologies and system setups, it is not possible to yet define the best energy storage solution in any particular situation. The innovation taking place both technically and commercially means that winners will emerge as the market develops.

Domestic solar + storage

In the domestic solar market, a number of companies are launching products and installers are starting to add a storage offering to their portfolio. There is a lot of excitement around new products – with high profile brands like Tesla (Tesla), Nissan (Energy Storage News, 2016), and E.On (Energy Storage News, 2016) making recent announcements in this area. This enthusiasm drives early adopters who already have solar to retrofit a storage system. Although this is the principal first market for domestic storage systems, there are other opportunities, particularly through developing a clear financial case for new solar + storage systems. The box below illustrates the critical points at which solar + storage becomes attractive, either retrofitting storage to an existing solar system or as part of a bundled new system.

Simplified economics of domestic solar + storage

Bundled new systems

For some customers, simplistic economic analysis delivers an attractive model for bundled solar + battery storage: particularly in cases where there would be low solar self-consumption without storage. For others, further cost reductions in storage are required for economically attractive models. However, simple self-consumption economics are not the only motivator: Energy independence can be a significant driver for some as discussed on the next page. The graph demonstrates this relationship: there is a critical cost point beyond which (from a simple economic viewpoint) storage adds value to the solar business model. This could of course be achieved with batteries, heat storage and electric vehicle synergies.

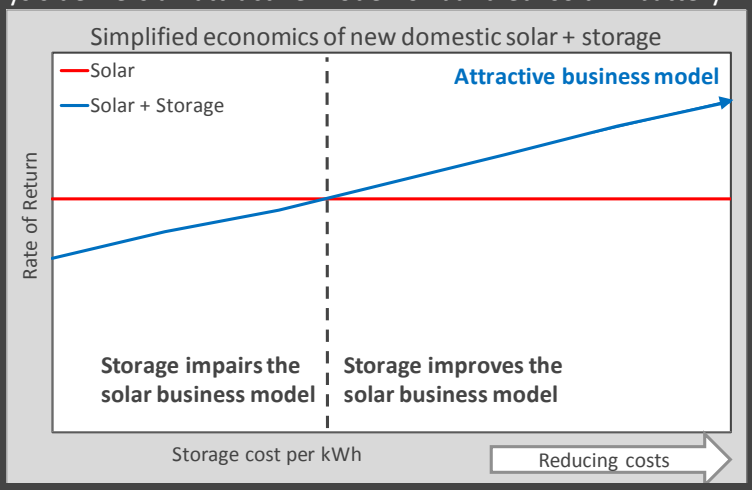


Figure 1: Simplified economics of new domestic solar + storage

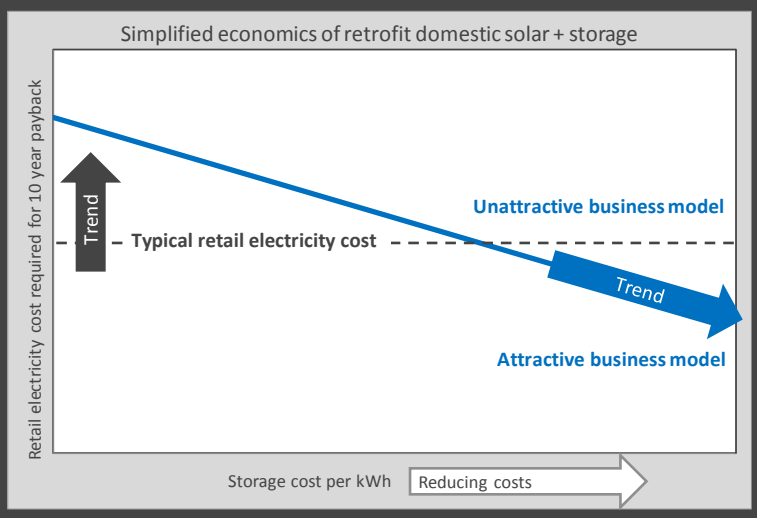


Figure 2: Simplified economics of retrofit domestic solar + storage

Retrofit systems

When retrofitting a good quality and long lasting battery storage system to an existing solar system, the economics pivot on one critical point. If the lifetime cost per kWh (known as the levelised cost of storage) of storing and using solar-generated energy is cheaper than the retail cost of electricity, then the business model is attractive. The graph shows this relationship. The long term trends are clear: storage costs will come down and retail electricity prices will go up. However, our analysis shows we are a number of years away from this being a reality – certainly if self-consumption is the only revenue stream. This simplistic analysis doesn't include other uses of the storage system such as grid services or time of use tariffs, or feed-in tariffs from the solar system . Further detail on the levelised cost of storage can be found in a report by Lazard analysts (Lazard, 2015).

Other market drivers

Economics are not the only driver for purchasing energy storage systems: the diagram below illustrates the range of non-financial drivers that could influence a purchase of a domestic storage system.

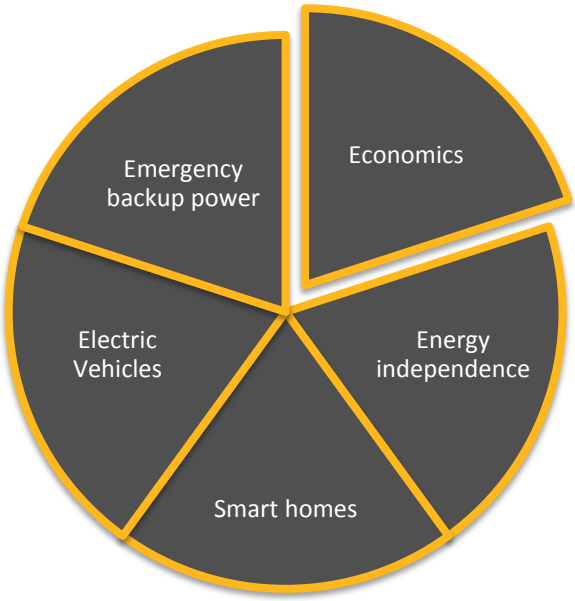


Figure 3: Drivers for domestic solar + storage

As described in the box on the previous page, energy storage costs do not build a viable economic model for all domestic customers. However, in the long term, economics will drive the dominant market when costs pass certain critical points. In the meantime, other drivers will influence the purchase of an energy storage system more strongly as now described.

Reducing reliance on the electricity grid (energy independence) is important for some when purchasing storage systems. Avoiding the risk of blackouts and minimising the amount of energy imported from the grid are both attractive to consumers, and could drive an early part of the domestic solar + storage market.

A growing number of aspirational homeowners are pushing for a smart home, with networked appliances and sensors monitored and controlled through the cloud. Energy is a critical aspect of any smart home concept, and therefore an energy storage system tied to a solar installation could play a key role in the setup of a smart home. Energy storage means that normal appliances don't necessarily need to "smartly" respond automatically to when the solar panels are generating. Further, homeowners need not change their behaviour by turning washing machines and dishwashers on during the day to get best use from their solar. Storage allows clean solar energy to be used by a consumer whenever they want to use it and by minimising their draw from the grid, solar power with storage makes a consumer less dependent on the grid: further reducing energy bills.

The synergies between solar and electric vehicles (EVs) could be significant. Electric vehicles are a readily-available source of energy storage, with many times more storage capacity than a typical home energy

storage solution[1]. Vehicle to Grid (V2G) research is ongoing (My Electric Avenue), (Becky Gough, 2015), and trials have already shown promising results. With potentially 4GW (3.5 - 4GWh) of new energy storage on the system by 2025 in the form of EVs and hybrid vehicles (Innovate UK, 2016), it is key that this capacity is installed in a way that can add value to the grid and local generation.

Domestic Solar + storage business models and revenues

There is no reason that the business model for solar + storage at a domestic level needs to be the same as for solar alone and there are many examples of innovative models being developed (Delta Energy and Environment, 2016). These models principally rely on creating extra value for the grid through services or from selling energy to neighbours.

Peer to peer trading of energy at a local level could provide value for a domestic customer. **SonnenCommunity** (Energy Storage News, 2015) in Germany links solar + storage users together virtually into a cluster, so that they share the use of the solar generation and battery capacity.

Other models adopt an aggregator-owned approach. In this case, a battery is installed in a home but remains owned by an aggregator, who provides balancing services to the grid through utilising a large number of small domestic batteries. British storage company Moixa are developing this through a platform called **GridShare** (Moixa Technology, 2015). In Germany, battery storage company SENEC.IES is running a trial called **Econamic Grid** (SENEC IES) where domestic batteries provide negative balancing reserve for the grid: essentially taking electricity off the system when there is too much generation. The "spare" electricity used to charge the batteries is then provided to the customer for free. Another trial, **Strombank** (ZIRIUS), uses a large-scale battery installed at the distribution level as a "bank", allowing prosumers to deposit excess electricity from solar generation and allowing other consumers to withdraw electricity on the same basis. **Northstar Solar** have developed a model based on new solar+storage systems, with an eye-catching 22,000 homes targeted as part of a council programme (Solar Power Portal, 2016).

We will continue to monitor these models to see which will be the most successful and widely adopted globally, and to determine their replicability in the UK. When developing their own models STA members might want to explore a range of factors including:

- Who owns the system – is it the domestic customer, your company, or a third party?
- Does the customer pay anything, or is their only cost the "hassle factor" of installation?
- What is the value for the customer?
- Who is responsible for maintenance and upkeep?
- Do the revenue streams stack up, and how long are these guaranteed for?
- Is there additional value having many systems at domestic level, rather than one equivalent system at commercial or grid-scale level?

In general, it seems likely that, in the short term, the revenue stack will be made up from a larger number of smaller benefits, rather than a smaller number of larger benefits, as has been the case with solar thus far.

Many of these revenue streams will come from grid services which could enable the energy system to operate more efficiently and therefore more cheaply for consumers. However, markets for these services

[1] For example, the Tesla Model S has a battery storage capacity of 60-90kWh, whereas the Tesla Powerwall has a capacity of 6.4kWh.

are presently for the system operator, rather than the transmission or distribution assets themselves. It will be important to capture this value through the development of marketplaces for localised balancing services, and this is one of the STA's key policy asks. Creating marketplaces at a local level can enable solar + storage to deliver value to the grid, for the benefit of consumers.

A typical stack at the domestic level could include some of the following streams. Note that this is illustrative, to demonstrate the broad range of revenue streams or potential use cases – the size of individual stack components does not denote relative value.

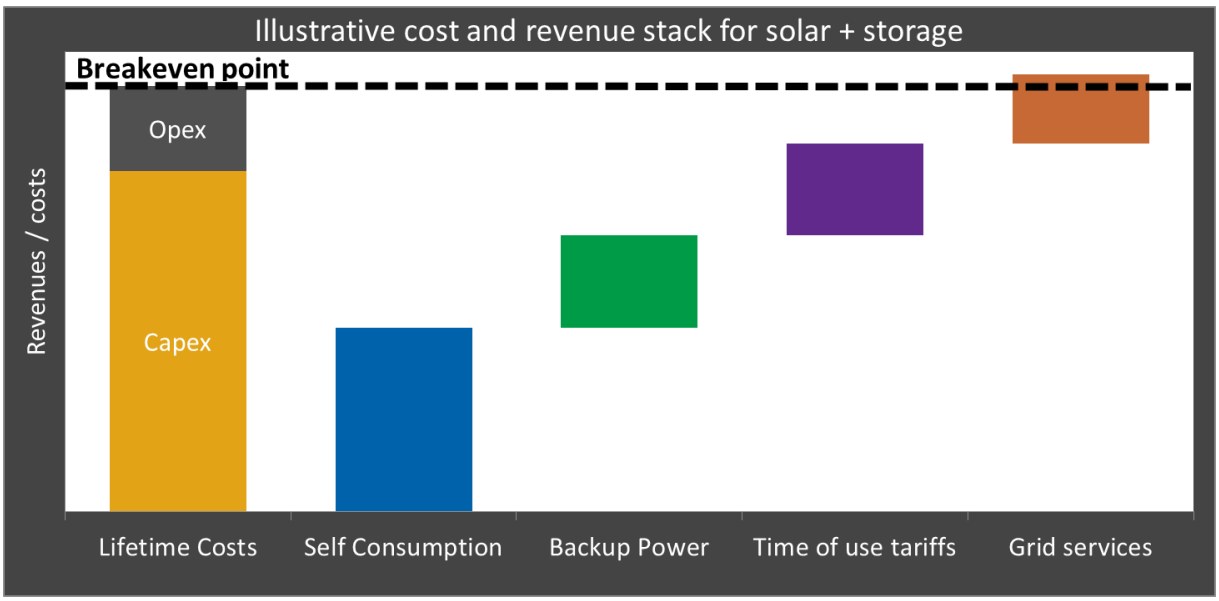


Figure 4: Illustrative cost and revenue stack for solar + storage. The size of each stack will vary for each individual customer

The more services, the higher the complexity of the model – introducing multiple contracts between a storage owner and the DNO, utility, energy services provider could prove a bridge too far for a domestic customer, and additional questions are raised on use and ownership of the system and the energy stored within it. These issues will need to be resolved in the coming years by market entrants setting up their business models.

To illustrate the wide range of possibilities, two domestic solar + storage business models are discussed below: the simple self-funded case and an aggregator-owned case. These are by no means the only two models that will exist in the future for domestic solar + storage. However, they are, in our view, the clearest and simplest that currently exists in the UK and other markets such as Germany and the US.

The simple case - Self-funded

In this simplest case, the solar + storage system is funded, owned and operated by the homeowner, who accrues the benefits of maximising their self-consumption (as well as potentially selling grid services). This is broadly comparable with the equivalent solar model where an initial investment is paid back through self-consumed energy and Feed-in-Tariffs.

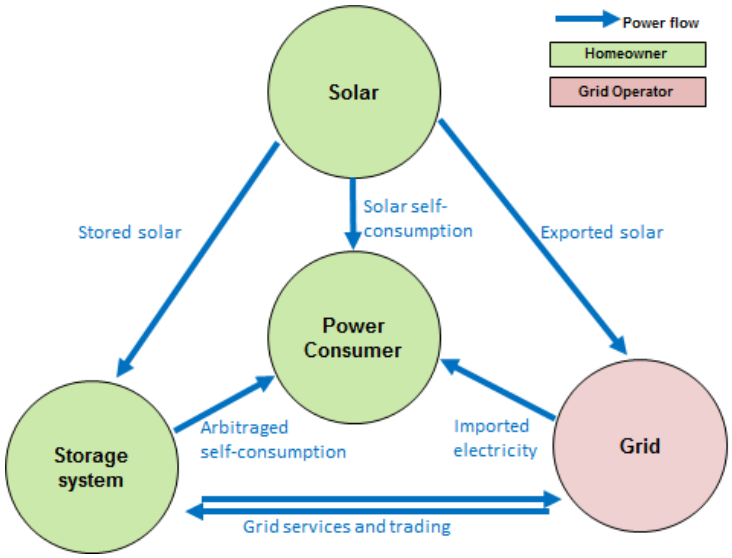


Figure 5: Ownership and power flows for domestic solar+ storage: homeowner-owned model

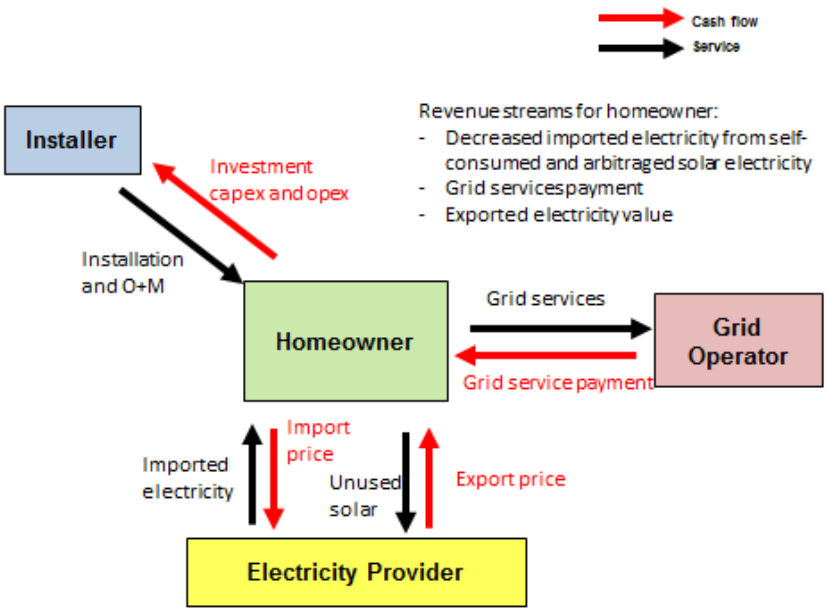


Figure 6: Stakeholder relationship map for domestic solar + storage: homeowner-owned model

This model is the simplest case, as the solar, storage and consumption is all owned and operated by the homeowner. However, in this case the onus would be on the homeowner to provide grid services which could involve complicated bidding and contractual arrangements – if they are able to provide services individually at all, due to their small scale.

Aggregator-owned and operated – the PPA model

In this model, the solar and storage system are owned by a third party aggregator, who operates the system on behalf of the homeowner. In return, the homeowner pays for the energy consumed from the solar or storage system through a PPA-style setup. This model allows economies of scale to be implemented and the storage to be used in an aggregated level to provide grid services, giving value to the aggregator. The aggregator could deliver only the energy from the solar + storage system, or all of the homeowner's energy needs through becoming an energy supplier.

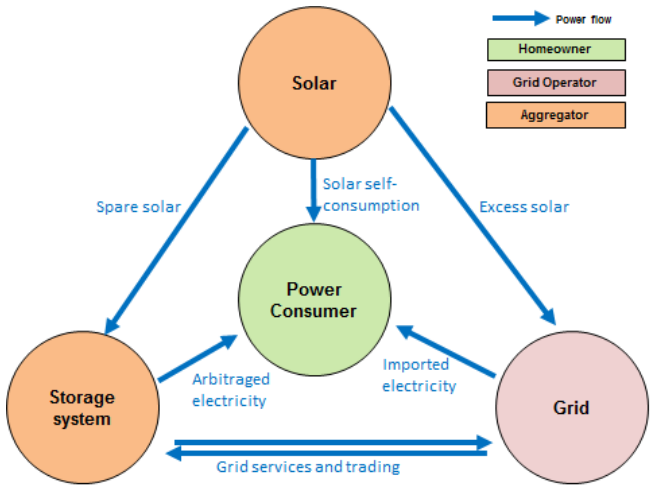


Figure 7: Ownership and power flows for domestic solar+ storage: aggregator-owned model

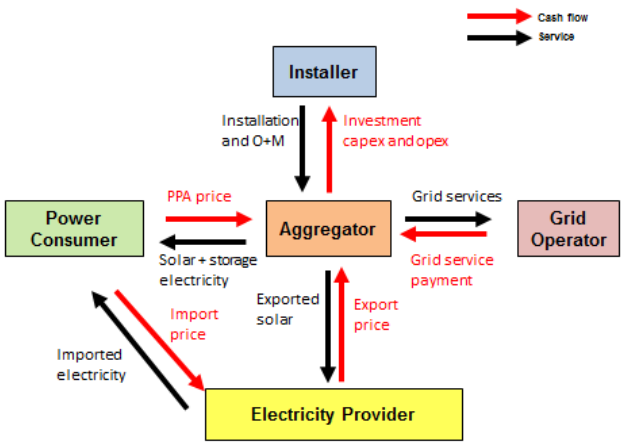


Figure 8: Stakeholder relationship map for domestic solar + storage: aggregator-owned model

Under this model, the aggregator is responsible for the installation, operation and maintenance of the solar and storage system. The power consumer (homeowner) benefits from a reduced energy bill through the PPA - which must be less than the retail electricity price for the model to be attractive to the homeowner. The aggregator also accrues value from the provision of grid services, which they can deliver at scale through the aggregation and control of a large number of domestic solar + storage systems.In the future a hybrid of the electricity provider and aggregator may provide a compelling offering for customers.

Commercial and industrial solar + storage

The proposition for solar + storage is different for a commercial customer to a domestic one. Domestic and small commercial customers are not exposed to price volatility, whereas larger commercial consumers are directly exposed to short-term fluctuations in energy prices through half hourly metering. For a commercial customer, there is value in minimising that exposure through a combination of solar and storage. For example, customers are charged high prices for using the network during the three times of highest demand in the winter (known as Triads). Predicting and minimising likely exposure to these periods through storage, while also using solar + storage for energy arbitrage in the spring, summer and autumn could enable businesses to reduce their energy bills significantly. In the long term, this can be very attractive for businesses, but a clear business model has not been developed yet. This could be contrasted with demand side response (DSR), in which a number of companies have already developed attractive offerings including Kiwi Power, Flexitricity and Limejump (National Grid). The commercial DSR market could provide the blueprint under which a commercial solar + storage market develops. Indeed the former head of the National Grid, Steve Holliday, specifically identifies the commercial sector as having by far the greatest potential to drive efficient use of power through smart controls (Holliday, 2016). Storage will be a major tool in the smart power box.

In a similar way to the domestic solar + storage market, the potential revenue streams available are varied and not necessarily guaranteed in the long term: unlike, for example, the Feed in Tariff or long-term PPAs for standalone solar. There are a number of services that storage systems located on commercial properties can provide, with or without solar, including: frequency response; capacity reserve; power factor correction and an uninterruptible power supply (UPS). Success in this area would come from creating a model which is attractive through a combination of reduced energy bills (from solar generation, used at times of most value through storage to reduce exposure to volatility) and additional revenue from other sources such as grid balancing services and UPS replacement. Ownership of the equipment could either lie with the company itself, if the investment was attractive enough to compete with core business investment, or a third party, similar to the solar PPA model. In both of these cases, the market opportunities are significant.

Solar farms + storage

Solar farms and energy storage seem intuitively to be a perfect match. Grid connections are typically underutilised due to the variable nature of solar generation (and lack of solar export at night), space is typically available and planning permission is either already available or relatively simple to obtain. Regulatory issues, along with barriers of cost and revenue stream reliability, cause this picture to become far more complicated.

A significant amount of the work being done on storage at large scale is DNO-led and standalone, focussing on primarily avoiding network upgrade costs, rather than solar developer-led. However, there are opportunities for solar farm developers; storage can be an opportunity for large-scale solar farms through providing ancillary and balancing services for the grid, or alternatively for optimising the solar farm's output through shifting and smoothing, leading to a higher PPA rate.

The number of new storage projects built at the large scale in the UK over the past year is not significant, despite the few high-profile projects. Our understanding is that a lot of members are looking at grid connections, planning and other development work for solar + storage projects, but very few plants have been built yet. Additional exploratory work is ongoing for retrofitting energy storage systems onto existing solar farms, but regulatory clarity remains a barrier. We will continue to monitor the progress that

companies are making in this area and support discussions with regulators and policymakers to smooth this process.

Revenue streams and marketplaces for large-scale storage

The diagram below, reproduced from a US report on battery storage (Rocky Mountain Institute, 2015), gives a summary of the different services that battery storage can provide to system operators, customers and utilities. Although this is within a US rather than UK context, and also only considers batteries rather than broader energy storage, the diagram clearly illustrates the wide range of different values which storage could add to the grid, as well as other market actors.

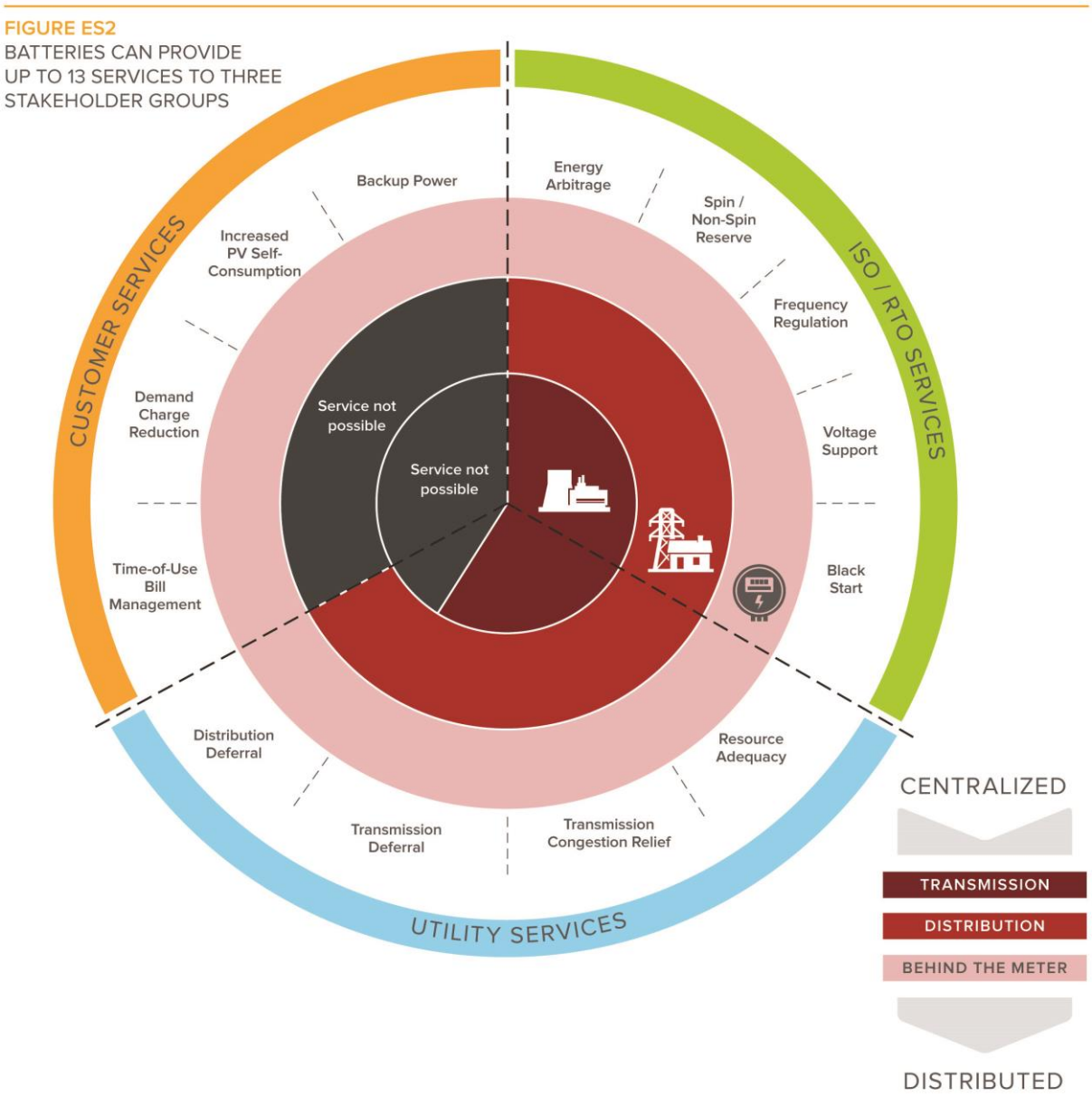


Figure 9: Services that can be provided through energy storage in the form of batteries.

Source: Rocky Mountain Institute (Rocky Mountain Institute, 2015) - reproduced with permission.

The revenues that can be provided at the larger scale storage systems can be attractive, but the complexity and risk associated with a large number of small and often short-term revenue streams is providing a barrier to this market. In addition, this combination approach to revenue streams is proving more difficult to finance.

Although the recent National Grid enhanced frequency response (EFR) tender is an exception to this (National Grid), this market is only 200MW currently with the potential for 600MW of future procurement (Lin, 2016). The first tender in the summer of 2016 has shown the capability of the market to deliver at low cost – although whether the winning tenders reflect true costs is up for debate – and has provided a starting point for some companies in the UK market. Further tenders and developing other services will be critical for the large-scale deployment of storage systems over the coming years.

Energy storage is underrepresented in other markets such as the Capacity Market and Short Term Operating Reserve (STOR). This is partly due to cost but also systemic problems such as the lack of a definition and resulting regulatory framework for storage. Regulations and definitions are discussed in the STA Policy Asks section.

Two reports (UK Power Networks) (UK Power Networks) from the Smarter Networks Storage project cover the investment case and business model structure. Although these reports present a DNO perspective, there is significant detail about the different structures, revenue streams and commercial arrangements which are of relevance to potential large-scale solar + storage developers. In particular, Appendix 1 of the Business Model consultation covers the different services and revenues that a grid-level storage system can provide. Further detail on revenue streams and their risks is available in recent reports by Everoze (Everoze for Scottish Renewables, 2016) and Regen SW (Regen SW, 2016).

Due to the information available in the above reports and the potential commercial sensitivity around tenders for balancing services, a detailed analysis of the different services available for large-scale storage is not provided herein. It is clear that the EFR tender has been the first marketplace driving commercial grid-scale storage in the UK, but there are other valuable services over the coming years which will drive wider market uptake.

The Solar Trade Association's position on energy storage

Through extensive consultation with our members, the Solar Trade Association has considered carefully what our position on energy storage should be, and what the immediate priorities are.

We are excited about the value that solar and storage can together add to the energy system, leading to a more efficient, cleaner and more secure future network. However, this optimism is tempered by realism that energy storage systems are not commercially economic yet for all customers, and that more work needs to be done by industry, government and regulators to support the continuing cost reductions. The benefits of a clear strategy can deliver are significant: for example, in 2015 over a third (41%) of all solar systems installed by German homeowners were tied with battery storage systems. (Energy Post, 2016)

With this understanding the STA's immediate focus will be on **laying the foundations for a strong and sustainable solar + storage market**. We will endeavour to ensure that the solar + storage industry can develop naturally with a strategic long-term vision, a clear regulatory framework, and strong standards and consumer guidelines.

Domestic solar + storage priorities

There is huge potential for solar + storage to deliver at a domestic level. However, we are concerned about the potential for exaggerating the impact storage can have now. A need for storage is at times being used as a negative for solar, rather than a missing part of the overall puzzle. For example, there is some perception of storage as the solution required before increasing solar penetration, rather than a technology that can allow both industries to flourish far beyond even the large volume of solar that could be accommodated cost-effectively in our electricity system. As noted by analysts at Greentech Media, *"The future of Germany's energy storage market is bright, and the solar market will surely benefit as storage prices decline"* (Green Tech Media, 2016). The UK will eventually follow Germany's lead.

There is also a risk that storage could be mis-sold. The contractual complexity described in the market opportunities section could lead to problematic long-term contracts, and the lack of a simple business model could mean that customers are sold a storage system on the basis of assumptions which may not be valid. This means that installer standards are essential: see the box on the next page for further detail on our position on safety, quality and standards.

In July 2015 we changed the name of our PV Rooftop Working Group into the PV Rooftop and Storage Working Group, and a regular agenda point within this group is now our Storage Forum, allowing members to share experiences on smaller-scale storage in the rooftop market and define the STA's actions within this area. This group will help to support the STA's work on quality, safety and standards through dissemination and industry feedback, and will also provide a litmus test for the uptake of storage in the UK to inform our wider position. Finally, we will work with this group to consider how best the market for storage in the UK can be incentivised and what the drivers and levers are for solar + storage at the rooftop scale.

We will also continue to maintain a watching brief on the storage market both in the UK and internationally. The work up to this point in analysing and following the market does not stop with the publication of this report and storage is a fast-moving, ever-changing market. Clearly there is a lot to learn from the German market and our strong relationship with the German solar trade association (BSW-Solar) as well as SolarPower Europe and the Global Solar Council will enable us to keep up to date with rapid developments internationally.

The work described above requires a close relationship with the relevant bodies, which we will continue to develop. We will liaise with key stakeholders within government, regulators, other trade associations at UK and EU level and market leading-companies, to ensure there is a consistent position across the industry which is communicated clearly and effectively at all levels.

Safety, quality and standards

The installed base of domestic storage systems which will be in place by 2025 could deliver significant benefits for the electricity system – but only if quality and good standards are maintained, both in terms of physical installation and contractual arrangements. A important priority for the STA is therefore to work, together with other bodies, to develop safety guidelines and quality standards for storage at a domestic level. We are actively contributing to this through contributing to the Institute of Engineering and Technology (IET) Committee producing a Storage Code of Practice. The IET has already published a Technical Brief covering electrical energy storage technology based on electrochemical batteries, and their associated charging control and protection systems (IET, 2016). The full Code of Practice is intended to be published in early 2017.

Alongside the work with the IET which is described above, the STA has also been working with the National Solar Centre (NSC) and Renewable Energy Consumer Code (RECC) on their technical installer guide (Cotterell, 2016) and consumer guidance (BRE and RECC, 2016), which provides information for installers and consumers on expectations, technologies and cost/benefits. We would recommend all installers provide prospective customers with the consumer guidance and to follow the technical guidance when installing domestic storage systems. In addition, we are represented on the British Standards Institute (BSI) Energy Storage standards committee, ESL/120 (British Standards Institute). We will continue to engage with the NSC, RECC, IET and BSI to monitor the implementation of these guides and develop a clear set of standards.

Safety is another key area which has been raised strongly by our members. This in part is related to the standards, ensuring that each installation is installed in such a way to minimise risks. However, there are other specific pieces of work which can help support the safe installation of domestic storage systems. The industry in Germany has developed some of these documents already: for example, specific safety guidelines and a guidebook for firefighters. Working together with other relevant bodies, we will seek to enable domestic storage systems to be installed with safety as a top priority.

Large scale storage priorities

For larger-scale solar + storage, our current priority is to work first on adapting the regulatory framework to classify electricity storage separately, and therefore allow the market for storage to develop naturally over the coming years as costs come down and economic offerings at the large scale are developed. In other words, we see the STA's role is to undertake the regulatory foundations and build a market in such a way that our members can succeed in the solar farm + storage market. Further details on this are given in the STA policy asks section.

Beyond the key actions and policy asks which are elaborated in the following section, we remain flexible to react to member demand. We would welcome feedback on our approach and the actions we can take to empower members.

Grants and other financial incentives

Financial incentives are typically required in early-stage markets to bring forward investment and innovation. This incentive typically tapers to zero as the costs reduce, leading to a zero-subsidy environment. This model has been successfully applied with the Feed in Tariff for solar (notwithstanding short-term cliff edge drops which have damaged this stable tapering path to zero subsidy) and also successfully with a storage grant in Germany (German Federal Ministry for Economic Affairs and Energy).

A number of policies exist in the US to accelerate the deployment of storage (Department of Energy). To take one example, California has set a requirement of 1.3GW of storage by 2020 which must be procured by California's three largest utilities. Clear regulated targets such as these provide impetus to the market: a UK storage strategy could deliver similar benefits.

There are potential opportunities for indirect incentives to be considered in the UK, such as the recent Carbon Trust Energy Technology List consultation for Enhanced Capital Allowances (ECAs). ECAs could deliver the dual objectives of building industry experience through deployment and ensuring high-quality installations through a differentiated list of eligible products. We would welcome the inclusion of storage within the ETL for these reasons.

Although we agree that a storage grant for domestic installations, along with some other financial incentive at larger scales (such as Enhanced Capital Allowances or other tax-related benefits) could be a way of kick-starting the storage market in the UK, we believe it is important to first ensure every installation is done well. Therefore, our focus in the short term will instead be on setting up the necessary installation and product standards to ensure high-quality and safe installations, alongside developing the regulatory framework and marketplaces for services to allow the industry to build over the next couple of years on the way to becoming a true energy game-changer.

STA actions for the next year

In order to support our policy asks, which are set out in the next section, the STA will need to undertake a series of actions. These actions are listed below:

- Present the evidence clearly to government officials, ministers and other decision makers of the strategic importance and benefits that solar + storage can deliver.
- Work with government, regulators and European colleagues to define and implement the right regulatory framework as quickly as possible.
- Work with the government and regulator on the Smart Energy call for evidence and resulting roadmap, representing our members through this process.
- Work with the UK government and regulators to clarify the existing policy positions for storage in terms of VAT and retrofitting to existing RO sites.
- Develop technical and safety standards with bodies such as the IET (Storage Code of Practice), BSI (energy storage standards committee) and MCS (storage guidance for installers and consumers).
- Consider, with our members, what changes could enable solar + storage to compete in balancing and capacity marketplaces more effectively under a level playing field.
- Support discussions between industry, regulators, DNOs and government, allowing our members to demonstrate the services they can provide to the market.
- Disseminate the work done by existing field trials, developing a set of clear case studies to demonstrate the range of real-world projects that the industry has delivered.

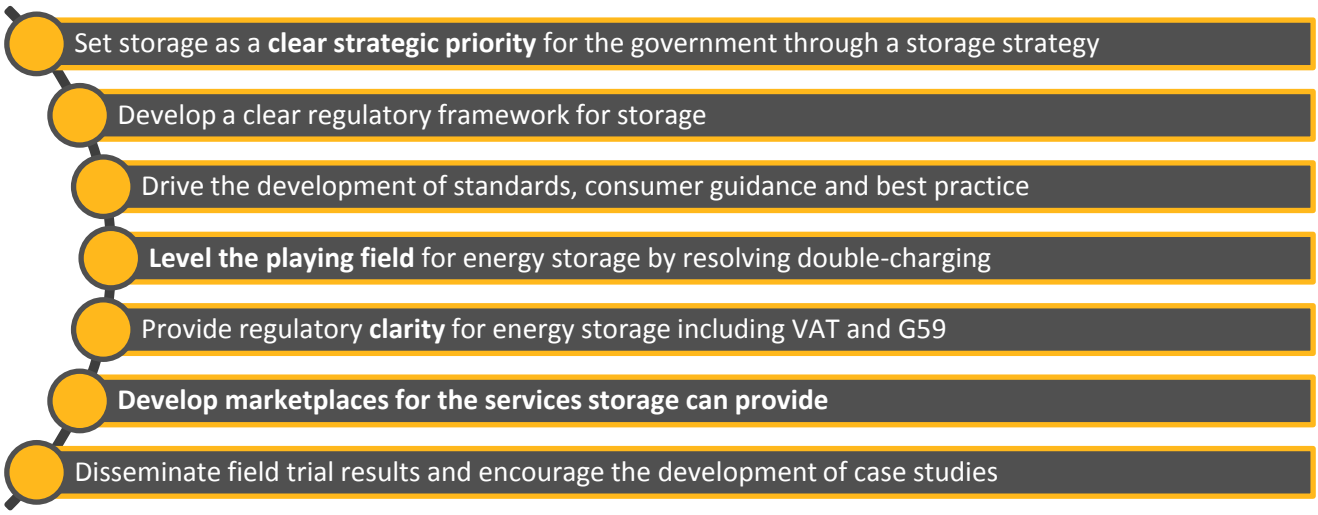
- Work with the relevant bodies to demonstrate the benefits that solar + storage can provide for new homes, and contribute to the future development of building standards in this area.
- Continue to closely monitor the economics of storage and evolving business models.

Alongside the actions to support our asks directly, there are a number of other actions which the STA has done and will continue to do:

- Incorporating a Storage Forum in our quarterly PV rooftop + storage working group to share installer experiences and discuss what the STA can do to support members.
- Maintaining a watching brief on the storage market both in the UK and internationally.
- Liaising with key UK bodies, including government, regulators, trade associations and market leaders, to clearly set out our member's views.

STA policy asks

The STA's focus will be on creating the right environment to enable a safe and high-quality solar + storage industry to flourish. Although financial benefits through subsidies may be one way of incentivising storage deployment in the short term, we believe it is more important to set up the right regulatory framework with a focus on quality to allow the market to innovate. This will predominately come from engaging with the Smart Energy call for evidence, as well as with other government bodies and processes. Our policy asks are listed below and then described in turn:



A storage strategy

Storage needs to be a **clear strategic priority** for the government – realising the full deployment potential of solar will depend on it. A number of reports and studies commissioned by government advisors and departments including the Committee on Climate Change, the National Infrastructure Commission, DECC and Ofgem state the benefits of a smarter, more flexible energy system. Now is the time to present how that vision will be achieved in practice, through DECC's Smart Energy workstream.

A clear regulatory framework

There is no legal definition of storage either at the EU level or at the UK level. Projects that have already been built are classed as a subset of generation, which consequently means that they are subject to the obligations and charging treatment of a generator and which are often inappropriate. This regulatory framework needs to therefore be adapted and a separate asset class and activity developed for storage.

Given that this is a problem across Europe, we are working with SolarPower Europe to define storage at a European level (SolarPower Europe, 2016), and we hope this can be implemented as quickly as possible. Achieving a clear classification for electricity storage as a new asset class within EU legislation and regulations that can then be transposed into UK regulations is an important long-term goal. However, given the timescales involved, it is important that work is also undertaken at UK level as well to solve the immediate problem of double-charging, discussed below.

A level playing field by eliminating double-charging

By **levelling the playing field** for energy storage with appropriate legislation, the government can reap the benefits of the many services energy storage can provide. Many of the structural issues causing energy storage to struggle in these markets are caused by the lack of a definition or clear regulatory framework – see above – which will take a long time to solve. However, there is one specific issue that could be solved relatively simply: double charging. As electrical storage systems are treated as generation, they are subject to network usage charges on that basis. Any electricity which is stored and then used is charged twice: firstly for importing and storing the energy (intermediary consumption) and secondly for discharging and using that energy (final consumption). Levying charges on *final* consumption and not *all* consumption generically would solve this double-charging problem, and this change could be achieved on a much quicker timescale than developing an entirely new asset class for energy storage at EU and UK level.

Clarity on existing regulations

There are a number of existing regulations and policies which currently are unclear for the interaction of solar and energy storage. These include the position of energy storage within existing Renewable Obligation solar farms, VAT for domestic solar + storage and grid connection processes for domestic solar + storage (G83/G59/G100). As a result, there is confusion in the industry about the situation for these policies, and no confirmed positions from government or regulators on these. We call on the government to work with us and our members to urgently clarify the existing status of these regulatory issues and how they can incentivise the use of energy storage alongside solar.

Standards to enable a high-quality industry run safely

The importance of minimum standards for consumer confidence cannot be overstated. It is crucial that the storage systems that are installed in the coming years are sold fairly, installed well from good components in a way that is safe and effective. Poor consumer experiences and bad reputations can damage markets before they can take off. Many standards and guidelines were developed in Germany as part of their storage grant programme which could be easily replicated, including legal frameworks for storage recycling, a fire fighting guidebook, safety guidelines and technical standards. The industry through the IET is working towards a Code of Practice for storage, and the development of standards and guidelines should be strongly supported and driven by the government as part of their Storage Strategy.

Marketplaces for services

Energy storage systems embedded in distribution networks can provide significant value to those networks. However, this value cannot be currently realised through balancing marketplaces, as distribution network operators (DNOs) are unable to procure services as National Grid can as they are distribution *network* operators (DNOs) rather than distribution *system* operators (DSOs). This means that a significant amount is spent on passive grid reinforcement, even if by spending a lesser amount DNOs could actively procure storage or other services that would mean the upgrades were not required. The development of marketplaces for grid services at the distribution level could be a key driver of energy storage systems, but requires action from the government to push this through. This could either be provided by transitioning DNOs into DSOs, or by allowing other bodies to become DSOs and provide those marketplaces.

Dissemination of trial results and case studies

The Low Carbon Networks Fund (LCNF) (Ofgem) and Innovate UK (Innovate UK) programmes have developed a significant amount of understanding for energy storage systems, and the knowledge gained through running these trials must be disseminated as widely as possible. Further work to develop projects and showcase case studies on the real-world applications of storage can enable learning across the sector and should be actively encouraged.

Building regulations

It is important that new houses are built to be futureproofed, as they are intended to be standing for over 50 years; within this timeframe the electricity system is intended to be fully decarbonised. The government should therefore consider how energy storage and solar should be treated within **building regulations for new homes**, such that the homes that are built in the coming years can participate in and deliver benefits to the wider energy system.

Next steps

Solar, together with storage, has a major role (if not *the* major role) to play in the transformation of the UK's energy system into a truly smart 21st century system. Together with our members, we are seeking to enable this transformation as quickly and efficiently as possible. Our actions and asks described are intended to bring this about in the most effective way.

We invite feedback from members and wider stakeholders on this paper and on actions and priorities beyond those we have set out. If you would like to request a meeting with our team or have specific comments, please email policy@solar-trade.org.uk.

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