EASE Position Paper on Unlocking the Value of Solar + Storage at the Customer Level

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Introduction

One of the main aims of the "Clean Energy for All Europeans" Package, issued by the European Commission in November 2016, is to place customers at the centre of the energy transition. The Package empowers customers by giving them the possibility to produce, store, use, and sell their own electricity and be able to contribute to grid stability. The proposals also aim to foster the deployment of energy storage technologies at all levels of the energy system to support the transition to a sustainable and efficient energy system. This is a major step forward compared to the Third Energy Package of 2009, in which energy storage was not mentioned at all.

In particular, the new article of the proposed Renewable Energy directive on national support schemes for electricity generated from renewable sources states that such support should be provided in a form that is as non-distortive as possible for the functioning of electricity markets. This means that energy storage deployment is expected to no longer be discouraged by the use of distorting feed-in tariffs.

Depending on the tariff and regulatory conditions, energy storage devices can provide a variety of services at all levels of the energy system, including in residential consumers' premises. Small-scale energy storage technologies can be used to optimise self-consumption of solar PV at the residential and community level and enable active consumers to participate fully in electricity markets. Moreover, depending on the regulatory and tariff conditions, energy storage at this level may lead to higher energy system efficiency.

Definitions

'active customer' means a customer or a group of jointly acting customers who consume, store or sell electricity generated on their premises, including through aggregators, or participate in demand response or energy efficiency schemes provided that these activities do not constitute their primary commercial or professional activity (Recast Electricity Directive).

'**renewable self-consumer**' means an active customer as defined in Directive [MDI Directive] who consumes and may store and sell renewable electricity which is generated within his or its premises, including a multi-apartment block, a commercial or shared services site or a closed distribution system, provided that, for non-household renewable self-consumers, those activities do not constitute their primary commercial or professional activity (Recast Renewable Energy Directive).

'**renewable self-consumption**' means the generation and consumption, and, where applicable, storage, of renewable electricity by renewable self-consumers (Recast Renewable Energy Directive).

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The profitability of residential solar + storage systems depends on the cost of the system, the technical performance of the battery or thermal storage system, the generation and demand profile of the household, grid tariffs and charges, and the regulatory framework[1].

Customers have access to an increasingly wide range of energy storage solutions, including stationary solutions such as batteries (lead-acid, Li-ion, flow, etc.) or thermal storage systems, as well as mobile solutions such as electric vehicles. Other small-scale storage solutions could emerge in the future. New business models are being developed and deployed, allowing consumers to access new revenue streams.

The following customer configurations are usually considered:

- Type of customer: household, commercial or industrial
- Type of energy profile: final customer purchasing electricity for his own use or active customer consuming, storing or selling electricity generated on their premises
- Type of Use: homeowner, community, commercial, and industrial

Solar + Storage Benefits

Solar + storage systems can have many benefits, not only for the customer but also for the system at large. However, regulatory and tariff conditions must be designed correctly in order for the storage device to be used optimally. The potential benefits stemming from an optimal use of a solar + storage system include:

For the customer:

- Lower electricity bills through self-consumption (depending on the household's agreements with the utility)
- Demand flexibility (flexible supply of energy to the grid) and active participation
- Ability to actively support transition to clean energy and to reduce household's reliance on fossil fuels
- Increased access to electricity in remote locations at the grid edge
- Back-up power: energy storage systems can offer resilience benefits for the customer against any unexpected outage (due to adverse weather events, for example)

For the distribution grid:

- Potential reduction of peak demand, depending on the economic signals
- Option for investment deferral where economically viable (through a reduction of peak demand or voltage support)
- Congestion mitigation

[1] For a more in-depth look at these different factors, see Fernández-de-Bobadilla et al: *A tool for optimal operation and design of batteries and its applications to self-consumption*, 2018.

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For the electricity system as a whole:

- Increased penetration of renewables; decarbonisation of the electricity sector (and thermal sector for thermal storage solutions)
- Storage capacity that could deal with periods characterised by low demand and high renewable generation (for example in August) would significantly reduce "reverse powerflow" problems that cause additional costs in terms of voltage control management
- More sources of flexibility by consumers providing demand response and actively participating in balancing and ancillary services markets
- Increased security of supply
- Potentially more engaged consumers in the energy system

What is the current market and outlook for solar + storage in Europe?

- The residential energy storage segment in Europe is experiencing steady growth, which is expected to continue in coming years. In 2017, annual installed capacity in the residential sector was estimated to be 274 MWh. In 2018, the annual market size is expected to reach 334 MWh.
- Germany is the clear leader in this segment with around 89,000 residential battery installations by end-2017. Drivers include high residential PV penetration (with almost 1 million households having installed PV panels), high electricity prices for households, government rebates and low interest loans for battery storage, and emergence of range of new business models in the market.
- Italy is cementing its position as the second largest residential storage market in Europe, with an installed base of around 16,000 residential storage units. Late last year subsidies for solar + storage had been announced in the Lombardia region and other regions are expected to follow suit. This, along with relatively high electricity prices, growing number of market entries and newly emerging business models, is making Italy an increasingly attractive market for residential solar + storage systems with 2018 expected to bring continued growth.
- In contrast, the UK and France are seeing slow growth in residential solar + storage deployments as no significant drivers for residential energy storage exist and issues around policy and regulation need to be resolved. However, decreasing technology costs and feed-in-tariff phase out (specifically in the UK) could see increasing uptake in the coming years.
- As for rest of Europe, markets like Czech Republic, Austria and Sweden are showing significant growth potential in the longer term. In Sweden a subsidy scheme for residential energy storage has already been introduced, while developments in Austria are indicating that a new subsidy scheme is coming soon. Czech Republic is proving to be an increasingly interesting market as more and more players are entering the market with their products and propositions and customer awareness and interest in the technology grows.

Source: EASE/Delta-ee: European Market Monitor on Energy Storage 2.0, June 2018.

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Case Study: District Energy Storage

Small-scale, grid-connected energy storage solutions – or “district batteries” – can have a viable business case supporting the ongoing growth of decentralised energy generation resources. This is one of the key findings of a feasibility study published by DNV GL, based on work by an industry-wide consortium that includes energy storage firm Alfen and flexibility aggregator Peeks. The study finds that – given current costs for lithium-ion battery technology and grid expansion projects – district storage can be both economically and socially viable. Furthermore, the study outlines a decision-making framework to help grid operators and other stakeholders identify and optimise business models and revenue streams for district storage in any market.

Decentralised energy sources such as rooftop solar panels or individual wind turbines are an important part of the transition to a more sustainable energy future. They can help energy users reduce their bills and contribute to a more sustainable energy mix with lower greenhouse gas emissions. But such resources put extra strain on the local electricity distribution infrastructure, which must be prepared to handle any peaks in generation output.

Distribution system operators (DSOs) and transmission system operators (TSOs) can opt to expand the capacity of their network by putting more cables in the ground. However, this may not be the most efficient course of action, since it could be costly, take time, and could become a recurrent expense as more decentralised resources are installed. An alternative is to install batteries close to decentralised resources that could store any excess energy generated and feed it into the grid when demand exceeds supply. But, due to regulations in most countries, such district energy storage solutions cannot be owned by the network operator. Instead an independent player owns the battery facility and sells its capacity as a service to the system operator (TSO or DSO) and other stakeholders. The viability of such services will depend on local grid conditions and having the right stakeholders involved.

The report identifies the necessary conditions and stakeholders for viable district storage services. Furthermore, it shows that a multi-stakeholder approach brings benefits for all parties. For DSOs and TSOs, multi-stakeholder district storage solutions are a much cheaper alternative to expanding the grid. Moreover, they can be installed and fully operational much faster than new grid capacity and with significantly less disturbance to the local environment and population as there is no need to dig up kilometers of roads to lay new cables. District-owned storage could for example support the roll-out of (fast) EV charging infrastructure in a given area, which would otherwise require a costly grid expansion.

For parties interested in installing and operating district storage services, the study shows that long-term contracts are a commercially interesting option, potentially making it easier to find funding for new projects. Meanwhile, end users – whether residential, commercial or industrial – can be confident of a reliable and affordable supply of sustainable electricity.

Source: DNV GL: Feasibility and Scalability of the Community Battery, January 2018.

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Barriers to Solar + Storage

While there is increasing interest in customer energy storage in the EU, the business case is not always clear and there are a number of barriers hampering the profitability of decentralised energy storage. Moreover, the correct regulatory and tariff framework must be in place so that active consumers are incentivised to employ their solar + storage devices in a way that contributes to the optimal, cost-effective operation of the grid. Active consumers should also not lead to higher charges for those consumers who do not have solar + storage devices.

After a thorough review of the "Clean Energy" Package proposals, EASE has identified several key barriers to energy storage at the customer level that still remain to be addressed or clarified.

1. Remuneration and incentives, business models

- Customers should be able to participate in the market for providing their PV-plus-storage installations and delivering services that support the electric grid.
- There is a need to define ways for PV-plus-storage to access markets for energy and ancillary services, with clear and fair remuneration that reflects the market value of the electricity and ancillary services delivered by customers.
- A clear view is needed of the combination of services energy storage can deliver to the grid, as well as clear regulation and rule definition for active customers' service provision to the network operators. This allows for stackable revenues to strengthen the business case for storage (e.g. partly regulated services, partly market capacity energy and balancing, connection costs).
- Allow customers' storage units to generate revenue from various flexibility, network, and energy services, such as congestion management, curtailment mitigation, balancing services, capacity market, ancillary services, and energy provision. Service provision should be uniquely defined considering not only traditional resources (generation and network devices) but the capacities of all the present energy and system resources, including customers' flexibility, and energy/power management with storage.
- Ensure non-discriminatory market and network access for energy storage, prosumers, and district energy systems. This is required to allow gaining revenues from various existing and future markets and to stack them.

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2. Fees & taxes, metering & billing, pricing

- Clear definition of grid fees and taxation to avoid double taxation of stored energy (e.g. if an active consumer stores electricity from the grid at a time of excess generation and feeds electricity back into the grid at a later time) and ensure a fair contribution to system costs to avoid consumers' divide.

- Rules should be developed to clarify what classifies as 'before' and 'behind' the meter for district energy systems.

- Discriminatory network and connection charges for PV-plus-storage units must be removed.

- Active customers and district energy systems need adequate and transparent (dynamic) tariff setting for internal (behind-the-meter) and external (in-front-of-the-meter) energy streams. Dynamic pricing schemes and market signals are required to incentivise behavioural changes.

- Tariffs must be designed fairly as to not hamper active customers' participation and contribution to system efficiency. Local optimisation of behaviour of individual customers and district energy systems is needed to ensure that their behaviour would not be suboptimal for the central system (local sub optimisation).

- As fixed system costs are mostly retrieved through energy sales, system operators will struggle to retrieve the costs associated with the central distribution and transmission networks and peak generation. To make the system sustainable and avoid consumer divide (i.e. those who decide to remain pure consumers pay higher network and system charges due to distortive low tariffs paid by active customers), self-consumers should contribute fairly to all system costs. Regulated costs must be recovered by regulated tariffs. A good tariff design is enough to contribute to globally efficient decisions from customers. If grid defection (coming from short term efficient decisions made by customers) leads to sunk costs, this means that the regulator did not define suitable rules for network planning and compensations for regulated businesses should never be allocated to tariffs. Grid defection should not be promoted with artificial incentives and subsidies wherever the network option is cheaper.

3. Technical and operational standards

- Clear technical and operational standards for the operation and grid connection of customers' PV-plus-storage units are needed.

- Operational standards and schemes for prosumer interactions should be allowed and defined, physical or virtual, including in virtual power plants, power purchase agreements, and P2P interactions.

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Case Study: Household Energy Storage in Denmark

In 2014, the Danish Technological Institute, together with the company Lithium Balance, carried out a study investigating how to maximise the use of self-generated electricity in single-family houses in Denmark. The storage devices (5.1 kWh Li-ion battery coupled with an AC inverter, 4.8 kWh Li-ion battery coupled with a DC inverter, and a heat pump) were tested in a system built in the Energy Flex Laboratory House. The installation was supplied with electricity from rooftop PV and the consumption was simulated minute-by-minute to roughly match the electricity use of a single-family house.

Both battery systems performed well in this test, with storage efficiencies of around 75% for the AC-coupled battery and 70% for the DC-coupled battery. Inverter functioning and dimensioning was found to have a significant effect on the battery system performance. The researchers concluded that a technically and economically reasonable battery size would be about 1kWh of battery storage per kW of installed PV. Alternatively, the battery can be dimensioned to cover the household's consumption of electricity at night.

The heat pump coupled with a 180 L hot water tank was able to absorb up to 5kWh of excess electricity. However, the experiment showed that it was not as easy to store energy in the form of hot water as expected, due to a strongly decreasing efficiency with increasing hot water temperature.

The researchers also developed an excel tool to help homeowners and retailers calculate the technical and economic benefits of coupling PV systems with storage. This tool indicates that at the costs of today's battery systems, it is just barely profitable for Danish consumers to invest in their own PV + battery system. The example suggests that household consumption of electricity from rooftop PV increases from approx. 25% to 50% when coupled with a battery. With a price difference of 1.62 DKK per kWh on purchased and sold electricity, this 5 kWh battery would yield annual savings of 2,258 DKK, and thus the investment could be recouped in 11 years.

Given the expected price declines in Li-ion technology, this business case will be much stronger within a few years. The more commercial activities consumers may participate in with their storage device, the higher the return on investment (ROI). For households, the ROI depends on: future tariffs and grid fees, price development for batteries and PV systems, practical life of battery packs, and the price for installation, operation, and maintenance of the PV + storage system.

The study also showed that thermal energy storage is proven and cost-effective technology and can therefore be a good alternative to energy storage in batteries. The downside is that the energy can only be recovered as heat, so when no hot water or heating is needed, the energy will be lost.

Source: Katik et al.: Optimal udnyttelse af solcelleel i enfamiliehus' (Optimal use of solar PV in single-family house), 2016.

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4. Need for Improved Communication and Education for Consumers

- Public information/education campaigns are needed to help raise awareness of the possibilities for customers to actively participate in the energy system, explain the challenges of renewables integration, and educate customers on how they can act in a way that benefits the grid.
- The development of innovative demand response services through storage should incentivise consumers to be more active and empower them, giving them more choice and more control over their electricity consumption.
- The use of energy storage systems will offer resilience benefits for the customer against any unexpected outage (due to adverse weather events, for example).
- Aggregation can allow customer storage and demand response to access the market through flexibility services but they should compete on a level playing field with the rest of players (suppliers, generators), particularly regarding balancing responsibility and regulated costs burden (access tariffs, policy costs, etc.)

  The potential as well as perceived risk of battery safety and environmental impact needs to be understood and addressed through communication and consumer education.

Policy Recommendations

Based on the above barriers, EASE proposes the following recommendations to improve the business case for solar + storage at the residential and community levels with the understanding that the improvement must not come from any cost-shift imposed to other non-PV or non-storage customers:

1. Technical barriers

TECHNICAL/OPERATIONAL STANDARDS: Functionalities and connection requirements for energy storage and combined installations with RES could be made explicit. Herein could be defined what can be classified as 'before' and 'behind' the meter, especially in the context of district energy systems or large-scale storage.

2. Economic barriers

REMUNERATION/INCENTIVES: Clear, fair, and non-discriminatory valuation and remuneration frameworks should be established. Within district storage energy systems, tariff setting and metering should be made explicit and flexible, in order for owners of the storage system to benefit of providing flexibility services to the regional grid operator. Again, it must be clear that any tariff and metering scheme should be fair to other users of the grid.

FEES/TAXES: Fair and non-discriminatory charges are being stipulated; however, the explicit inclusion of a provision that prevents double charging of energy storage for network and market usage could be established. Double charging to storage generally comes from the

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fact that generation is charged for delivering power to the grid; that is the arrangement that must be reviewed rather than requesting special treatment for storage as being different to other assets.

VALUE/BUSINESS CASE: It could be explicitly defined which functions energy storage can provide to the network and system, and the combination of services they can provide as this allows for stackable revenues that strengthen the business case of storage.

3. Market barriers

REGISTRATION AND CAPACITY BANDS: In the "Clean Energy for All Europeans" Package small consumers and small distributed generation installations are defined with a maximal capacity and annual electricity injection into the central grid. It should be defined what are the storage capacity/consumption/injection bands, when do they qualify as 'small' and when do they need to be available to the system operator. This classification might lead to additional cost for storage owners related to registration requirements.

BALANCING/REDISPATCHING: In all "Clean Energy for All Europeans" Package provisions regarding this matter, only demand response and curtailment are explicitly considered. However, energy storage could also prevent curtailment and could potentially be 'redispatched' as well. This could be explicitly included.

4. Legal barriers

DEFINITION ENERGY STORAGE: The analysis of energy storage as a separate asset with characteristics and services of generators and consumers must be carefully studied.

DEMAND RESPONSE: Several provisions and sections/chapters in the Electricity Directive/Regulation work out the functionality and regulatory framework around demand response (DR). Energy storage is in some provisions implied under DR and in others seen as a separate class. This could be made consistent across all provisions. Energy storage can fulfil more functionalities (e.g. generation, curtailment mitigation, consumption…) and could thus be seen and identified on equal footing with DR in each relevant provisions.

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References and Further Reading

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