NETfficient
Storage for Life

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# Deliverable 5.15

## Social, socio-economic and regulatory measures for local/small storage market uptake

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# 1. Executive Summary

The report summarises conclusions and recommendations for social, socio-economic and regulatory measures for a local/small storage market uptake. It rounds off the findings in the previous Deliverables 5.14 "Regulation analysis and barriers identification report" and Deliverable 6.6 "Business Plan".

The following major conclusions were found:

*C1: There is no "one single approach" for a storage market uptake, especially for local/small storage systems. Instead there are many individual pathways characterised by different local, social and technical aspects, that all could finally lead to investments into storage capacities also available for the grid and the markets.*

*C2: Current social awareness of the (potential) role of local/small storage systems is poor, leading to a lack of self-identification by a broad public. Focussed market introduction programs with adequate monitoring and PR measures would be a good way to overcome this problem.*

*C3: Instead of focussing the discussions regarding the implementation of small storage technologies on simply cost/benefit aspects it would be necessary to also describe social benefits, and to transfer social value into remuneration for investors and operators.*

*C4: Beyond technical necessities, social acceptance of storage technologies requires public political and societal identification with this technology.*

*C5: Social acceptance of a certain technology depends on numerous aspects that need to be considered already during product development and onsite installation.*

*C6: Storage integration into a smart home environment may support the battery market uptake, but is a technical challenge requiring standardised IT solutions and use cases.*

*C7: Electrical storage systems should be an integral part of local collective energy supply concepts, like "tenants' supply solutions", "neighbourhood concepts", "energy communities" etc.*

*C8: Measures to promote local (collective) storage systems can be municipal/regional incentive programs, showcases, and quantified (local) targets for self-sufficiency or $CO_2$ emissions.*

*C9: Integration of electrical storage systems in spacial planning or urban infrastructure planning is an efficient measure for supporting this technology. Technology education of municipal stakeholders and decision makers is necessary for practical implementation.*

*C10: Technical and non-technical standards, regulations and requirements should be formulated as simple and understandable as possible. In any case "translation tools" are needed to allow investors and owners of local/small storage technology to understand their role and responsibilities. Standardisation and regulation should generate trust instead of scaring investors off and occupy lawyers.*

*C11: Legal and regulatory requirements should be scaled depending on the technical system size. Small storage systems should be treatable rather like (intelligent) household appliances than power plants.*

*C12: The special characteristics of batteries have to be adequately reflected in regulations. Legal and technical solutions must be found to allow batteries an easy multi-functional use for serving local needs, energy markets, and grid requirements at the same time.*

*C13: Allowing grid operators to invest in storages systems primarily providing grid services could be a way to lower grid costs and support the local storage market.*

*C14: Current market products of energy and service markets should be evaluated regarding chances to ease access for storage systems. Unconventional solutions (e.g. products with certain probability of delivery) should be also taken into consideration.*

*C15: Simplification of regulatory and technical requirements and solutions for the clustering and pooling of local storage systems could significantly lower the barriers for providing collective services for markets and the grid. A technical standardisation of "flexibility" could help in this process.*

*C16: Creative implementation and marketing solutions could open up chances to involve seemingly "unattractive" customers. Virtual individual batteries could be such a solution for tenants in multi-family houses.*

*C17: The consequent European standardisation of rules and products can significantly foster the market uptake of local/small storage systems.*

## 2. Introduction

Technical subject of the project NETfficient are storage technologies and energy management solutions for using flexibilities of battery systems to provide services for the markets and the electricity grids. Such flexibilities are urgently needed to level out fluctuating generation from renewables, avoid peak-load situations for weak grid infrastructure or provide system services like balancing power. The importance of energy storage for various applications has been described in a working document of the European Commission “Energy storage - the role of electricity” (European Commission, 2017)

Achieving technological progress in battery technology and intelligent battery management systems is only one half of the “battery story”, developing an environment of proper regulations and social acceptance is the other half needed for a success story of integrating storage technologies into the national and European electricity supply system. An investigation in the EU stoRE project[1] dealing with recommendations for the adaptation of political and regulatory framework conditions for energy storage systems in Germany revealed a number of strategic barriers (Weiß, Schulz, & Meister, 2014):

- Lack of clear and official goal for needed energy storage extension
- Lack of a clear definition of the role of energy storage systems and competition with other technologies
- Public opposition and environmental concerns
- High capital costs and risks for investors
- Inadequate grid extension for the transport of renewable energies to neighbouring countries
- Lack of studies on alternative flexibility options
- Uncertainties regarding licensing procedure/environmental standards/water framework directive

The authors also pointed out the relevance of distinct short term, medium term and long term measures for legal adaptation.

A study “Battery Energy Storage in the EU: Barriers, Opportunities, Services and Benefits on European level” carried out by EUROBAT (EUROBAT, 2017) identified the following key barriers to battery energy storage:

- Definition of energy storage (there is no definition of energy storage in the EU legislation)
- Ownership of energy storage systems (it is currently not clear if TSOs and DSOs can own or control storage systems)
- Double grid fees and taxation (lack of framework for energy storage brought some member states to impose double grid fees on storage systems)
- Curtailment and balancing responsibilities (curtailing energy represents a failure of the system and a waste of energy)
- Ancillary services and the value of energy storage (the EU market does not currently recognise the value of ancillary services to balance the grid)
- Electricity pricing (electricity prices should reflect scarcity and transmission costs)

Many of those barriers and aspects will be discussed in the present report and some ideas for solutions are presented. Emphasis is put on rather practical and business oriented aspects, while

[1] www.store-project.eu

issues for "big policy" (like general energy pricing) have already sufficiently been discussed in the reports mentioned above.

Within the NETfficient project, a detailed regulation analysis and identification of barriers has been carried out before with the results being published in Deliverable 5.14. It showed the wide variety of national regulatory frameworks and the different market rules and products in the individual EU countries. One intention of the present Deliverable 5.15 is to give a concise summary of lessons learned during this analysis and make suggestions for future improvements and solutions on an EU perspective. This includes analyses of the position of involved user groups and a more detailed discussion to social economic aspects.

When talking about the "market uptake" of local/small storage systems it is worth to distinguish between two different situations:

- Direct investments into storage systems with the primary intention to provide system services or participate in the energy markets. In such cases the investor/operator of the storage unit is well aware of its technical potential and knows about the markets and services. The investment is typically made after an analysis of proper business models showing sufficient financial return after some time.
- "Indirect" investments into storage systems. This situation arises when the investor/operator buys something completely different (like an electric car or an integral PV home system), which does include a storage unit as one part, but where knowledge about the role and individual properties of the battery is of less importance for the owner. In such a situation the battery owner will mostly have no initial intention to use his battery for additional markets or service, and neither has the competence to assess profitability of this.

While this differentiation is of less importance for the technical regulatory framework, the social aspects of the market uptake are completely different for both situations. In the first case a limited number of technical specialists and educated investors will set up business models, in the second case storage units become a part of the daily life of "common people" and they need profound help and easy solutions to discover that their battery can do more than only drive their electric vehicle.

This leads to a first general conclusion:

*C1: There is no "one single approach" for a storage market uptake, especially for local/small storage systems. Instead there are many individual pathways characterised by different local, social and technical aspects, that all could finally lead to investments into storage capacities also available for the grid and the markets.*

Policy makers and decision makers must be aware of this variety when drafting concepts for the promotion of storage technologies and initiating public "marketing".

As of today the predominant storage technology for small and local storage systems are electrochemical storage systems with lithium-ion batteries providing 59% of the global operational power capacity of electrochemical storage technology in mid-2017 (IRENA, 2017). Those typical electrochemical storage technologies are mostly able to store a limited energy volume for only days or some weeks without significant energy losses. Different technologies like power2gas are able to offer long-term storage options with rather high energy volumes which would be especially helpful to level out seasonal changes in renewable generation. Yet on a short to medium-term perspective the power2gas technology is too expensive compared to the general electricity price level to be able to compete with the market. From the technical point of view smaller power2gas systems could be integrated into households and become an alternative technological option (Jusefy, 2018). Since the present working document focusses on market measures for a short- to medium term perspective, power2gas technology will not be considered in the following sections.

This report focusses on the perspective of technology providers aiming to sell their technical storage and energy management solution to customers. It should be mentioned here only once that an uptake of the production (an in future also recycling) of storage technology could generate significant added value and jobs in the EU countries, and that public in the EU countries needs to become aware of the aspect that currently Asian manufacturers dominate battery production. At the end of 2017 a "battery summit" was organised in Brussels showing a potential of 250 billion Euro until 2015 and 4-5 million jobs that could be generated when engaging in battery production (including batteries for electric cars) (Balzer, 2017) (Preiß, 2017).

# 3. Stakeholders

For the analysis of non-technical aspects for the market uptake of local/small storage systems it is important to know which stakeholders and user groups are involved. A comprehensive overview about stakeholders and corresponding value generation aspects in the context of intelligently managed storage systems has been given in Deliverable 6.4 "Roadmap towards Exploitation of Project Results" of the NETfficient project (Project NETffient, 2018), so only a short summary with aspects being especially important for small storage systems should be presented here.

There are mainly 4 groups of stakeholders with some of the stakeholders potentially belonging to more than one group (depending on the situation). Major stakeholders are listed below, together with some information regarding their motivation to engage in storage technology.

***Group 1: Owners and (partly) operators of the storage systems***

- Owners or inhabitants of small family houses, single small businesses
  *Buy and operate storage system in own buildings for increased local consumption of RES generation, lower electricity bills (e.g. by lowering peak-demand price components in the electricity bill), independence from public supply, "green motivation".*

- Large scale housing providers (public/private/charitable), including sheltered housing
  *Same as above, but larger battery capacity and different model for local consumption (delivery of energy to third parties like tenants); in certain cases fulfilment of regulatory requirements like e.g. energy efficiency of the building.*

- Municipalities, energy communities, public sector
  *Collective or public investments into storage systems for community owned properties, communal guidelines for technology use, joint engagement in RES energy supply, cost efficient self-supply, collective engagement.*
  *Different technical solutions for small remote/rural communities and larger municipalities.*

***Group 2: Grid Operators and utilities***

- Local network operator DSO
  *Local power quality control, provision of local grid system services (e.g. voltage control, peak-load shaving), cost savings (e.g. by avoiding grid extension), high safety and reliability of supply. In most cases DSO must be informed of (or have to give consent to) the operation of grid connected electricity storage systems.*

- Network operator TSO
  *Higher level grid services (balancing and reserve power), optimization of grid performance. Grid services are often tendered in a transparent procedure.*

- Utilities (=energy suppliers)
  *Optimization of supply portfolio, contracting solutions (e.g. "Mieterstrom"), integrate RES in a profitable way. Utilities are needed for remaining electricity imports and purchasing electricity exports. Utilities could also use storage systems for internal balancing services.*

***Group 3: Stakeholders with commercial interests***

- Aggregators, service providers, operators of virtual power plants (VPP)
  *Support core business of generating and supplying green energy, energy cost saving, secure supply integrating RES in a profitable way. Key offer is operation and energy management including energy data monitoring.*
  *By building up powerful "virtual storage systems" aggregators constitute a link between the small individual systems and the needs of the market and the grid operators (DSO/TSO).*

- Manufacturers and/or installers of storage systems, maintenance providers
  *Sell components (batteries, inverters, energy management systems) and/or install them at the customers' premises, provide continuous maintenance services*

**Group 4: Decision makers and influencers**

- **Local decision makers with direct competence for concrete projects**
  *Housing companies, management committees of buildings in multiple ownership, local administration.*
  *Set framework conditions for storage system implementation, might initiate new installations, need to give consent to new projects.*

- **Politicians, lobby groups, boards of experts**
  *Not directly involved in the individual business solutions but significantly influence the market conditions for small storage systems.*

In most practical implementations of storage systems representatives of all of the 4 main stakeholder groups are involved. This in turn requires balancing out (or compromising) between the individual interests of each stakeholder. Some individual interests for some specific user groups will be discussed more in detail in the following paragraphs.

# 4. Social aspects of storage technology

In this chapter, social and socio-economic aspects which are relevant in the context of electricity storage should be discussed. They are described under a rather general perspective not just limiting to single technological solutions but generally discussing storage technology as one (potentially) significant element for the future energy supply system. Certainly some of the aspects discussed below are of less importance for certain user groups like PV plant owners, whose installation already had been equipped with a battery system and where some professional installer explained to them the technical opportunities such batteries storages offer. Such plant owners are fully aware of battery technology, know its value and certainly accept this technology. Yet a challenge for future is to significantly extent decentralised storage capacities and attract completely new customer groups to this technology. The following social aspects are important for this process.

Social aspects being especially relevant for collective investments (e.g. by communities) are discussed in the subsequent chapter.

## 4.1 Social awareness

Intelligent local/small electrical storage systems not being integrated into PV systems currently face an awareness problem (except for the very small ones powering household appliances), which small decentralised power generation already has overcome: people fairly know that there is such a technology existing and they have only some abstract feeling that it could be somehow helpful for the public electricity supply (which they expect to be there with 24/7 availability). Almost nobody knows that batteries could do more than only storing PV electricity for some hours and that it could make sense to install smaller decentralised storage units in the distribution grids. And except for some owners of PV storage systems, quite nobody is aware that storage technology for the electricity supply could somehow be relevant for house owners or enterprises.

Meanwhile most people understood the benefits brought by the clean renewable technologies and many people understood the paradigm shift from ‘electricity could only be generated by large power companies’ to ‘everybody can generate electricity himself’. This paradigm shift was achieved by a multi-step process:

*Step 1:*
*Governmental support measures for technology development (still relevant for the other steps as well)*

*Step 2:*
*Significant subsidies for first movers, e.g. German 1000 roofs PV program* (Eichelbrönner & Spitzley, 2012)*, accompanied by a massive monitoring and promotion campaign, first adaptations of standards and regulations, implement restrictions and transformations for old monopoly structures of energy suppliers, proof of readiness of technology*

*Step 3:*
*Gradual reduction of subsidies, start of new business models, further adaptation of regulations for easier market access and technology implementation, both governmental and private marketing and information campaigns*

*Step 4:*
*Establishment of free markets and real competition between technology providers, restricted funding*

While for the RES technologies many EU countries are now in the phase between Step 3 and Step 4, battery technology still mostly sticks between Step 1 and Step 2. There is significant technological progress (with research and development being funded by national and EU programs), but only very few PR work and national/international implementation programmes (like the Germany KfW credit program for small storage systems[2] or tax benefits for battery systems integrated in PV installations in the U.K.[3]) for small and medium size storage technologies. This is surprising considering the political willingness to spend many billions of Euro for grid extension, which at least partly could be saved by using distributed flexible storage systems.

Summarizing the current situation in Europe, the following conclusion can be formulated:

*C2: Current social awareness of the (potential) role of local/small storage systems is poor, leading to a lack of self-identification by a broad public. Focussed market introduction programs with adequate monitoring and PR measures would be a good way to overcome this problem.*

## 4.2 Social benefit and value

Besides the awareness problem, storage technology for electricity supply faces another serious social problem: everybody in the society is expecting that energy suppliers somehow manage to balance (fluctuating) generation and demand, and come up with solutions to transport the electricity from the generation to the demand location. A majority of the people sees this as a collective functionality, without understanding themselves to be part of the solution or at least willingness to pay for it. Different from grid extension measures in the electricity transport grid, local/small storage systems receive no nationalized funding (except subsidy measures) and must be paid locally by involved people or communities.

Since currently the public discussion regarding the general change in electricity supply is predominantly focussed on *costs*, any *value* oriented approaches are simply discriminated. This leads to the situation that decision making processes regarding investments into distributed storage are mostly concentrated on the question of “how much money can we earn?” instead of “what benefit could we generate for ourselves and society?”.

Certainly no one can expect investors to engage in projects leading to a loss of money. Therefore the real challenge is to unveil the actual social benefits of distributed storage capacity and flexibilities, and afterwards implement mechanisms to transfer social benefit into financial remuneration. For this all EU countries are still at the beginning.

*C3: Instead focussing discussions regarding the implementation of small storage technologies on simply cost/benefit aspects it would be necessary to also describe social benefits, and to transfer social value into remuneration for investors and operators.*

[2] https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/F%C3%B6rderprodukte/Erneuerbare-Energien-%E2%80%93-Speicher-(275)/

[3] https://www.solarpowerportal.co.uk/news/residential_storage_secures_tax_break_when_sold_with_solar_panels

## 4.3 Social acceptance

The social benefits discussed in section 4.2 are causally generated from technical necessities like the need for load-generation balancing or the need to alleviate stress on grid infrastructure. Yet it is a well know social phenomenon that for many people pure technical "necessities" are no basis for personal acceptance and even in some cases a concentration on technical arguments raises suspicion regarding the proposed measures. Reasons for this phenomenon are on the one hand the inability of people to fully understand the technical arguments and on the other hand the fact that even "technical necessities" are often influenced by personal opinions or preferences of specialists and experts (or even lobbying groups).

Therefore it is inevitable not to leave the public introduction of storage technology only to professionals explaining the technical (and financial) benefits. In parallel a clear political and societal positioning is necessary to raise a feeling amongst people that storage solutions are actually a good chance for an efficient and reliable energy supply in future. Public campaigns and subsidy programs can be elements of this societal identification.

Certainly the achievement of social acceptance for storage systems as individual technology (not integrated into other systems) is much more difficult than for e.g. electric cars or photovoltaic systems. It is easy to understand the main function for such technologies: a car can bring people from A to B, the PV installation drives electric appliances in the household. But how to explain why battery systems are healthy for the operation of the electricity grids? For storage solutions the technical complexity of the functionalities is the real challenge in the process of generating individual acceptance since most people need to trust somebody telling them something they cannot really understand.

One "trick" to ease this challenge is to design business models for storage systems in a way to combine services for the public (like the provision of balancing energy) with local services (like the increase of self-consumption of locally produced PV energy) and thus giving the battery owner a tangible benefit in combination with doing something good for the public. Social studies reported a high level of acceptance of people owning combined PV/storage solutions and in parallel knowing to contribute to the transition in the energy supply system (Hoffmann, Mohaupt, & Ortmanns, 2018), (Bost, 2015).

*C4: Beyond technical necessities, social acceptance of storage technologies requires public political and societal identification with this technology.*

## 4.4 Technological acceptance

Since the focus of this report is on local/small storage systems only, just a limited number of storage technologies are relevant in this context, with predominantly lithium batteries constituting the majority of systems. Nevertheless, talking about a market uptake of storage systems always needs to reflect the public acceptance of the different storage technologies. This acceptance level can reach from very high acceptance (e.g. for standard lithium batteries) to high rejection as it is currently the case for new pumped hydro storage projects. Reasons for disapproval could be environmental aspects (destroying natural resources for building hydro storage basins), safety concerns (explosion of hydrogen tanks) or being a nuisance to the immediate environment (noise from pumps, unacceptable heat emissions, smells, general appearance). Except for common standardised solutions (like a PV battery hidden in the basement) it is necessary to evaluate such aspects – both during the development of new products and the planning of new installations.

It should be mentioned that single accidents (like the explosion of a battery) could significantly influence technological acceptance if no convincing explanations could be given. It is necessary to maintain a high safety level based on European standards and to prevent non-conform low-price products to become available on the EU markets.

*C5: Social acceptance of a certain technology depends on numerous aspects that need to be considered already during product development and onsite installation.*

# 5. Individual storage solutions

“Individual storage solutions” describe the situation where mostly private house owners (including small businesses) invest in a local storage system installed in their own house and being typically fed by local RES generation. This stakeholder group can be considered to be “pioneers” since they have prepared (and are still preparing) the market for the local storage technology. Different from the U.S., where many local storage systems are installed for backup reasons and a high level of independence (including the option of islanding operation), individual storage systems in Europe are mostly installed in combination with local grid-connected RES generation technologies (like wind or Photovoltaic) and are mostly used to increase self-consumption and level out extreme values in the generation and load profiles (peak-shaving).

One approach successfully leading to the application of storage solutions in Germany and other countries was the integration of storage systems into building-services packages of prefab-housing (e.g. “Null-Emissions-Häuser” (zero emission buildings)). Showing the technically possible options in such showcases might lead to a “spill over” to traditional house builders.

Experience has shown that for individual private battery owners the aspect of financial profits is of less relevance and long pay-back times are acceptable – as long as the investment in a storage system pays back at all, even during the whole life time. Also the expectation of counteracting rising electricity prices by investing in a battery storage system can be a strong motivation for personal engagement. Ideological/emotional aspects (like the desire for independence) can give a strong motivation too.

Regional or national storage funding programmes like the Germany programme “Netzdienliche PV-Batteriespeicher” (PV-battery storages helpful for grid operation) issued by the State Environment Ministry of Baden-Württemberg (Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg, 2018) can be an important incentive for private house owners to engage themselves in storage technology.

In some countries (e.g. Italy or Spain) electricity tariffs include peak-power (kW) dependent price components also for small customers. By an intelligent battery management solution it could become possible to lower such peak-loads and thus save some of the payments for the grid connection. By the help of the battery it also could become possible to temporarily exceed the maximum (physical) peak power of the local grid connection by the household consumption, what might become relevant after installing new powerful loads (like charging points for EV).

Individual storage systems might profit from the “smart home” development linking many electrical appliances in the home together and opening up options for intelligent load- and generation management as well as prognoses for load and generation curves. This integrated operation management of buildings and houses increases the degrees of freedom for energy management and opens up new individual applications for home storage systems.

One essential requirement for integrating batteries into smart home solutions is the definition of a unique communication standard including proper interfaces and communication protocols. Interoperability of local/small storage systems with the other smart home equipment via smart communication gateways is one technical key-challenge for manufacturers for the next future.

*C6: Storage integration into a smart home environment may support the battery market uptake, but is a technical challenge requiring standardised IT solutions and use cases.*

# 6. Local collective storage solutions

By "local collective storage solutions", partly called "community energy projects", an approach is meant where a number of people living at a same location decide to invest in collaborative storage systems and to jointly benefit both from financial and non-financial results. Such a group of people could be the inhabitants of a multi-storey residential house (forming a joint user group), the owners of neighbouring single- or multi-storey houses or even the people living in a community (small village).

Experience from such collectives and communities often shows an extraordinary engagement in all environmental aspects including innovative energy supply solutions. One example for that was the European project ORIGIN[4] engaging in intelligent energy management solutions in three "neighbourhoods". By identifying the reasons for this special commitment of members of communities it becomes possible to deduce more general social and social-economic aspects that could support the market development for storage systems. These especially involve aspects of the relations between

- the individual people (adjustment of individual habits and relations to neighbours),
- the people and the (inner) community (develop a community structure, develop common goals and visons)
- the people and the (outer) society (level of independence, sorts of imports and exports, networking)
- the people and the technology (technology understanding and acceptance).

## 6.1 The basic technical concept

All local (!) collective storage solutions target on a relatively small, delimited and regional part of the energy supply infrastructure, supplying the members of the collective. This either could be an independent part of the supply grid not belonging to the distribution grid operator like the wiring in houses or small independent grid segments (like in Germany "geschlossene Verteilernetze"), or a virtual grid segment linking localised electricity customers but with the technical infrastructure still partly being used for electricity supply from and to third parties (like the local utility).

The typical technical configuration involves the operation of some distributed (mostly renewable) generation systems feeding into the local grid segment and predominantly supplying the local customers. Excess energy is normally fed back to the public grid, missing energy is being imported from conventional energy suppliers. Only in very rare cases collective supply solutions achieve full autonomy from the public grid. Nevertheless one key target common to all community solutions is the seeking for high self-sufficiency based on the locally generated electricity.

Storage systems are a major solution to achieve this target. They temporarily store excess energy and can feed-it back when needed. Another solution are coupled thermal-electric systems (e.g. CHP) making use of flexibilities in the thermal demand while generating electricity for immediate consumption.

A typical application of this concept are the so called "tenants' electricity supply concepts (Mieterstromkonzepte)" currently applied in Germany (Will, 2017). Details about technical requirements and funding aspects have been given in Deliverable 5.14 and will not be repeated here.

[4] https://ecovillage.org/origin/

## 6.2 Social aspects

It is worth analysing the reasons why members of energy communities and collectives have such a strong desire to engage themselves in innovative technical solutions. Understanding this philosophy helps to devise new (immaterial) incentives for the general market uptake of storage technology.

There are a number of studies about the motivation of especially PV-battery system owners regarding the reasons for their engagement. According to (Figgener, Haberschusz, & al., 2018) the majority of owners stated economic reasons (especially provision against rising power prices) followed by the motivation to contribute to the energy transition. Other motives were technology interest and a higher reliability of supply. In (Bost, 2015) main motivations were independence from the utility, low-risk investment and other economic aspects and contribution to the energy transition process. Similar results were found by (Mohaupt, Macht, Dede, & Gährs, 2018). (Kaschub, 2017) discusses the motivation of users to shift loads by batteries and sees monetary incentives as key aspect besides ecological motivation.

Based on own experience (e.g. the research project ORIGIN[5]), the following social and mental aspects seem important for energy communities besides pure economic considerations:

- Independence
  *Independence from big energy companies, from monopoly distribution and supply structures, from third parties in general*

- Closed supply circles
  *Generation => Distribution => Consumption within the closed area of the buildings or areas*

- Ability to decide and to influence
  *Decide on technology, decide on cost model, decide on service quality, influence the rules and solutions of electricity supply*

- Experience of technology
  *Ability to see, touch and (with some restriction) manage the technology, be able to show technology to family, friends and social networks, on-site education*

- Ownership feeling
  *Be (one of the) owner(s) of the equipment, invest in future for oneself and one's children*

- Local contribution to environmental protection
  *Be able to quantify and present own personal engagement in environmentally friendly and sustainable supply solutions*

- New degrees of freedom
  *Be able to adjust consumption to generation, influence own electricity bill, make use of "smart" technology functions*

- Higher security of supply
  *Have the feeling of a higher supply reliability due to local generation*

[5] https://ecovillage.org/origin/

- Sense of community
  *A joint engagement and use of community commodities leads to community feeling*

Analysing these aspects it can be seen that some of them are only applicable to inhabitants of a local areas/buildings, while quite many others like the ability to decide or immediate experience of technology could also be applied to business concepts beyond the scope of collective solutions.

The actual implementation of collective storage solutions is often driven by single activists being convinced about this technology and being persuasive for the whole community. There is a significant risk especially in existing buildings that tenants and caretakers are reluctant regarding such new technologies because of lack of knowledge about risks and chances or some inherent rejection of anything which is new. Marketing successful showcases projects in the neighbourhood could be one way to overcome such hesitation. Another solution could be the offering of rather easy and focussed services by the local utility, which tenants (and customers) are trusting.

## 6.3 Relevance and risks

Collective storage solutions are a strong driver for personal engagement of people in this technology. With no doubt they can lead to new investments and sustainable local supply solutions. This is one reason why currently such solutions receive strong public support in some EU countries, and large research and demonstration actions like the German "C/sells" project[6] develop amongst other approaches solutions for a cellular cluster of (more or less) independent smaller collective supply cells ("C/sells Cities").

Yet this approach neglects the fact of geographic heterogeneity of both natural generation resources and especially industrial or commercial electrical loads. There is some risk of seclusion of such communities from the national electricity supply challenge, which is both a technical seclusion and a mental seclusion ("why should I care how industry gets sufficient electricity?"). Such a trend in public opinion might complicate the implementation of technical measures being reasonable or necessary on a national economic scale and in the worst case might result in desolidarization on a national scale. Therefore it is the opinion of the author of this study that it will be an actual and difficult challenge for the mid-term future to carefully balance collective supply solutions and national/international supply tasks in a way to harvest the benefits of both approaches. On a short run collective initiatives are a good way to raise awareness and readiness of people towards new technological solutions.

## 6.4 Conclusions

Not forgetting the risks discussed in 6.3 it is reasonable to support collective supply solutions and to develop business models for storage technology being implemented in such applications.

*C7: Electrical storage systems should be an integral part of local collective energy supply concepts, like "tenants' supply solutions", "neighbourhood concepts", "energy communities" etc.*

[6] https://www.smartgrids-bw.net/csells/csells-ueberblick/

Certainly a public support from municipal politicians and governments could be a strong help for such initiatives. This support could either directly address collective solutions or give indirect support by defining local targets for energy related parameters (like self-sufficiency or $CO_2$-emissions) or implementing financial support schemes (tax relieves, subsidies for implementation).

*C8: Measures to promote local (collective) storage systems can be municipal/regional incentive programs, showcases, and quantified (local) targets for self-sufficiency or $CO_2$ emissions.*

# 7. Spatial and urban planning

## 7.1 Spatial planning as driver for storage

Depending on national regulations, some planning authorities (usually municipalities) are able to state conditions for planning consent relating to the use of renewable resources. A requirement to integrate storage could be an extension to the renewable energy requirements. Such requirements would be stated in the local development plan or other nationally defined planning instruments. At planning stage the main concern would be related to allowing sufficient space for individual or communal energy storage. This will be especially relevant for power-to-gas projects which may make more sense as communal project and may have extensive spacial requirements. Examples exist throughout Europe where planning conditions are extremely strict for certain local developments, e.g. Zero carbon Communities - Carmarthenshire County Council, UK.

Drivers for ambitions planning requirements are either sensitive surroundings (e.g. areas of outstanding natural beauty) or infrastructure restrictions (e.g. off-grid development).

Alternatively, the use of renewables may be imposed through national building regulations, affecting the construction project not at the stage of the planning permission but further down the line, at detailed design stage. These may set targets on maximum energy demand or maximum CO2 for the building, which can only be met using renewables.  It is conceivable that in future daily or annual energy profiles for new buildings could be defined in greater detail, thus forcing the use of storage.

## 7.2 Urban infrastructure planning

The discussion of local collective storage solutions in chapter 6 addressed the situation of a collective of people (living in a house, a village, a community etc.) jointly engaging in local energy supply and the integration of storage technology in this. Aside of such solutions with <u>everybody</u> getting involved, storage technology might also become an important aspect for the general infrastructure planning for cities or municipalities. In such scenarios local inhabitants might (and should) get involved (on voluntary basis), but the planning guidelines and concrete technical investment decisions are elaborated by experts and municipal stakeholders. In this context it should be mentioned that cities are responsible for roughly two-thirds of global primary energy consumption, and therefore expected to play an essential role in reaching European climate change targets (Cajot, Peter, Bahu, Koch, & Maréchal, 2015).

The integration of energy planning into urban infrastructure planning is a very challenging task. (Thery & Zarate, 2009) describe this challenge the following way: "*Energy planning consists in determining the optimal mix of energy sources to satisfy a given energy demand. The major difficulties of this issue lie in its multi scales aspect (temporal and geographical), but also in the necessity to take into account the quantitative (economic, technical) but also qualitative (environmental impact, social criterion) criteria*".

During the last years energy planning received a major boost in the awareness of cities and communities, driven by European and national climate targets, by visibility of consequences from climate change and R&D actions supporting the implementation of innovative energy supply concepts. There is also a significant public visibility, driven by initiatives and associations, like the "Energy Cities", the European Association of local authorities in energy transition[7].

Experience shows that campaigns of urban energy planning concentrate predominantly on electrical and thermal generation technologies (installation of wind, PV, CHP) and on measures for energy savings. Most urban infrastructure planners are not aware of the particular technical capabilities of electricity storage systems in the context of grid operation and market services. This lack of information is somewhat compensated by local utilities advising municipal stakeholders. Yet the well-known conservative attitude of most traditional utilities (partly fed by restrictions to spend money on innovative solutions, partly fed by outdated regulations) makes them hesitate to introduce to the stakeholder new technical solutions endangering traditional business and operation concepts.

So a major challenge to integrate the application of storage technology in urban infrastructure planning is "technology education" for stakeholders and investors. This education could be achieved by corresponding information campaigns (initiated by the EU, the states or the regional governments), best-practice examples with adequate marketing of the results or by inviting representatives of the storage industry or services providers to present concepts and solutions tailored for the individual cities and communities.

It should be pointed out that an excellent chance for integrating storage solutions is to consider this technology at a very early stage of the planning of new buildings or districts. This avoids conflicts with existing infrastructure (or architectural conflicts) and allows adjusting the portfolio of energy generation and distribution measures properly. In cooperation with the local distribution grid operator it also could help to save costs for the grid infrastructure.

*C9: Integration of electrical storage systems in spacial planning or urban infrastructure planning is an efficient measure for supporting this technology. Technology education of municipal stakeholders and decision makers is necessary for practical implementation.*

[7] http://www.energy-cities.eu

# 8. Regulatory measures

As has been explained in the introduction, this report follows Deliverable 5.14 "Regulation analysis and barriers identification report". This former Deliverable analysed the regulatory situation in a number of EU countries and identifies regulatory problems that could hamper business concepts for local/small storage capacities. As a next step the present report should give a number of proposals and examples of how regulations could be adapted to overcome existing barriers.

For these regulatory barriers the technological background will not be repeated again here if already been described in Deliverable 5.14.

## 8.1 Simplification of regulations

Unfortunately there seems to be a trend in the European Union of immensely increasing the number "pages" containing mandatory information related to rules and requirements for all sorts of renewable technologies, including storage systems. The following example illustrates this situation: the first German Feed-In Law[8] was a 5-pages document everybody was able to understand. Introducing this law was a big success and the birth hour of the grid-connected PV era in Germany. The current feed-in law[9] is a 134 pages document where even experts (and lawyers) are disputing how to interpret the single paragraphs. "Normal" people are simply scared by the vast number of requirements and the multiple pitfalls leading to potential fines for doing something wrong.

Figure 1 shows a (somewhat outdated) summary of laws and regulations applicable to stationary battery systems in Germany. House owners and potential investors for storage units are normally not able to comprehend all this information and to understand, which parts are relevant for them and what they shall do. Even craftsmen in small companies (e.g. installers of PV-battery systems) start losing the overview risking to make mistakes they could be blamed for.

Certainly a high level of standardisation and a well elaborated system of laws and standards is required to make provisions for all possible situations and problems. Yet there must be a "translation" methodology allowing end users and small enterprises to understand the basic concepts and to adequately assess risks and chances of their investment. One positive example for this is a leaflet issued by Swissolar explaining on 7 pages in a very illustrative way not only the technological basics of electricity storage systems, but also the standards and installation requirements (Swissolar, 2016).

This need for explanation and simplification of rules and regulations applies not only to technical aspects but to financial transactions and market rules as well. Owners of home storage systems do not want to understand details of energy retail markets nor do they want to conclude legal contracts to a dozen of institutions they never heard of. So forcing them to sign multiple pages of legal small-print will just raise dislike even if being advised to do so by professional consultants.

Regarding the simplification of standards and regulation, differences should be made between different technologies and sizes. Laws like the German Feed-In law address all different renewable generation technologies with almost all conceivable power ratings at the same time, showing the same complexity of requirements for multi-MW power plants and for small installations with few

[8] Gesetz für den Vorrang Erneuerbarer Energien (Erneuerbare-Energien-Gesetz – EEG) sowie zur Änderung des Energiewirtschaftsgesetzes und des Mineralölsteuergesetzes, 29.März 2000
[9] Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energie-Gesetz – EEG 2017), 21.6.2018

kilowatts. While certainly a big power plant cannot be simply connected to the grid without considering numerous technical and legal aspects, a different approach should be able for e.g. smaller battery systems where it should be possible to treat them almost like household appliances and offer simple and standardised business concepts.

DGS Berlin

Gesetze, Richtlinien und Normen zu stationären Batterieanlagen in PV-Anlagen

**Gesetzlicher Rahmen und Richtlinien**
Produktsicherheitsgesetz (ProdSG) einschließlich CE-Konformitätserklärung
Verordnung über den Bau von Betriebsräumen für elektrische Anlagen (EltBauVO)
EMV Richtlinie 2004/108/EG für Akku und Laderegler
Niederspannungsrichtlinie NS-RL 2006/108/EG
Musterbauordnung (insb. Brandschutz)
Musterleitungsanlagenrichtlinie (MLAR)
**Transport**
DIN EN 62281 VDE 0509-6:2012-07 Sicherheit von Primär- und Sekundär-Lithiumbatterien beim Transport
EU-Transportvorschrift: UN-Manual „Test and Criteria"III, 38.3 Rev.5 Lithium-Metall- und –Ionen-Batterien
Batterien und Batterieanlagen (Sicherheits- und Produktnormen)
DIN EN 62620 VDE 0510-35:2011-05 Akkumulatoren und Batterien mit alkalischen oder anderen nichtsäurehaltigen Elektrolyten
DIN EN 61056-1 Bleibatterien für allgemeine Anwendungen (verschlossen) Teil 1: Allgemeine Anforderungen, Eigenschaften – Prüfverfahren
DIN EN 61056-2 VDE 0510-26:2013-06 Bleibatterien für allgemeine Anwendungen (verschlossen) Teil 2: Maße, Anschlüsse und Kennzeichnung
DIN EN 60896-11:2003-07 Ortsfeste Blei-Akkumulatoren Teil 11: Geschlossene Batterien – Allgemeine Anforderungen und Prüfverfahren
DIN EN 60896-21:2004-12 Ortsfeste Blei-Akkumulatoren Teil 21: Verschlossene Bauarten – Prüfverfahren
DIN EN 60896-22:2004-12 , "Ortsfeste Blei-Akkumulatoren- Teil 22: Verschlossene Bauarten – Anforderungen
IEC 62485-2 (2010-06) Ed. 1.0 Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries
UL1642 Standard for Safety for Lithium-Batteries
BATSO 01 Manual for Evaluation of Energy System for Light Electric Vehicle (LEV) – Secondary Lithium Batteries
**Installation**
VDE 0100-Reihe insbesondere Teile 410, 420, 430, 530, 540, 551,560: 712:
VDE AR 2100-712: 2013-07 - Mindestanforderungen an den DC-Bereich einer PV-Anlage im Falle einer Brandbekämpfung oder technische Hilfeleistung
VDE 0185-305: 2011-10 Blitzschutz insbesondere Teil 3: Beiblatt 5: Blitz- und Überspannungsschutz für PV Stromversorgungssysteme
VDE AR N 4105: 2011-08 – Erzeugungsanlagen am Niederspannungsnetz
FNN/VDE Hinweis 2013-06 Anschluss und Betrieb von Speichern am Niederspannungsnetz
EN 62305-3 (VDE 0185-305) Blitzschutz insbesondere Teil3 Beiblatt 5: Blitz- und Überspannungsschutz für PV-Stromversorgungssysteme, 2009-10
Inbetriebnahme, Wiederholende Prüfungen und Dokumentation
VDE 0126-23: 2010-09 PV-Systeme –Systemdokumentation, Inbetriebnahmeprüfung und wiederkehrende Prüfungen , VDE 0105-100: VDE 0100-600:
**PV-Speichersysteme**
DIN EN 50272 VDE 0510: Sicherheitsanforderungen an Batterien und Batterieanlagen
DIN EN 61427-1 VDE 0510-40:2013-07 Wiederaufladbare Zellen und Batterien für die Speicherung erneuerbarer Energien
**Laderegler**
DIN EN 62509 VDE 0126-15:2012 Leistung und Funktion von Photovoltaik-Batteriereglern
DIN EN 60335-2-29 VDE 0700-29:2010-11 : Besondere Anforderungen für Batterieladegeräte …
**PV-Systemtechnik**
DIN EN 62109-VDE 0126-14 Sicherheit von Wechselrichtern zur Anwendung in photovoltaischen Energiesystemen, Teil 1:+2
DIN EN 62093 VDE 0126-20:2005-12 BOS-Bauteile für photovoltaische Systeme Bauarteignung natürliche Umgebung

Figure 1: Laws, regulations and standards for stationary battery systems in PV-installations (Haselhuhn, 2013)

Yet the discussions about small PV plug-in systems during the last years (which is almost no problem in Austria but was a heavy problem in Germany) show the reluctance of standardisation bodies to ease technical requirements for units with smaller nominal power.

*C10: Technical and non-technical standards, regulations and requirements should be formulated as simple and understandable as possible. In any case "translation tools" are needed to allow investors and owners of local/small storage technology to understand their role and responsibilities. Standardisation and regulation should generate trust instead of scaring investors off and occupy lawyers.*

*C11: Legal and regulatory requirements should be scaled depending on the technical system size. Small storage systems should be treatable rather like (intelligent) household appliances than power plants.*

## 8.2 Adequate representation of storage systems in regulations

As has been explained in deliverable 5.14, currently the different laws, regulations and rules in the EU countries do not adequately reflect the special technical features of storage systems. Since they sometimes act like generators, sometimes like loads, the historic classification schemes are not applicable anymore and mostly need to be updated. This situation becomes especially complicated if the origin of the energy stored in a battery matters for legal or accounting reasons (like the payment of RES feed-in tariffs or the calculation of taxes). Since a battery could store electricity imported from the public grid and electricity generated locally by RES generation at the same time, new metering and accounting concepts are needed for that. A lack of such concepts often leads to hard restrictions for the battery operation (like forbidding dual use concepts).

There is urgent need both in national legislation and EU standardisation to revise all regulations applicable to storage systems still not reflecting this technical aspect.

*C12: The special characteristics of batteries have to be adequately reflected in regulations. Legal and technical solutions must be found to allow batteries an easy multi-functional use, serving local needs, energy markets, and grid requirements at the same time.*

One special aspect of regulation is the role grid operators are allowed to play in the context of storage systems. In many countries grid operators are not allowed to operate own generation or load units in order not to interfere with the free trading on the energy markets. They are just allowed to own and operate grid infrastructure and procure energy losses of their grids. Following this philosophy grid operators are normally not allowed to invest in energy storage technology except very short term storages for maintaining grid quality.

This restriction leads to a missing of the opportunity of fully utilize the ability of battery systems to provide many helpful grid services starting from peak-shaving, voltage control up to support for black start situations in the grid. Seen from a national economic perspective it might be reasonable to allow grid operators to invest into battery storage systems if this would lead to the saving of grid costs exceeding battery investment and operation costs. Certainly grid operators would have to prove that grid services are the primary function of such batteries, but secondary services for energy markets should not be fully excluded.

In this context it should be mentioned that some research actions (like the national project NEMAR[10]) propose a different approach by letting owners of battery systems offer local grid services to the grid operators via local market places. From the perspective of the grid operators this solution has the flaw that investors for the storage units will adjust technology, location and operation management in a way to maximize individual profit and not to achieve the largest (and long-term reliable) benefit for the grid operation. In contrast to this, storage units owned by grid operators could offer secondary services via such a market platform as well, but the grid operators determining the flexibility they are able to provide to that market under the condition of prioritized grid services.

*C13: Allowing grid operators to invest in storages systems primarily providing grid services could be a way to lower grid costs and support the local storage market.*

## 8.3 Market adaptation for storage participation

One of the most serious obstacles for storage market uptake is the limited energy capacity most storage technologies have. Different from quite all other generation technologies battery storages

[10] https://www.ise.fraunhofer.de/de/forschungsprojekte/nemar-netzbewirtschaftung-als-neue-marktrolle.html

are not able to permanently maintain a certain load state (except OFF) but need to reload if emptied or stop charging when reaching the upper load capacity. This situation leads to significant challenges to meet lower limits for trading volumes at the energy markets and exclusion from most markets for balancing power. There are some approaches of how to tackle this problem. Besides the most simple one – just not to participate the market – the most common one is the aggregation of a number of battery systems or a combination with different technologies. So by combining batteries with e.g. CHP plants it becomes possible to recharge batteries just by powering up the CHP units. Meanwhile this approach is reflected in the regulations in some EU countries and market participation with such heterogeneous pools became possible there.

Nevertheless pooling requires a number of technical and formal provisions needing financing and manpower effort. Such provisions are a continuous monitoring and operation management of the pool by a centralised pool operator, educated prognoses of the local behaviour of the distributed units (especially if RES generation is involved) and numerous contracts between all parties involved.

An alternative solution might be an adaptation of market requirements in a way to reflect (and accept) the specific physical properties of storage systems. This could involve lowering the minimum power limits for market participation, shortening the time frames for required service provision or shortening the lead time for letting the storage units enter the bidding.

Besides such "simple" measures there is also room for inventing "revolutionary" new market products. One common feature for almost all battery systems is the problem to predict the state of charge some time ahead. Looking at a number of PV batteries in households it is obvious that the state of charge is not only determined by the local PV generation but strongly depends from the household load profile. So even knowing the PV generation profile, the battery state-of-charge could only be estimated with some probability. A fully unconventional market concept could take this probability into account and accept market participants delivering their "product" with a certain probability only. This would allow batteries to bring more of their power capacity (kW) to the market and alleviate market access for all battery systems with a rather high uncertainty of momentary state-of-charge. In such a scenario the markets need to buy more capacity than is really needed, but the larger number of market participants would lead to a lowering of the market price on the other hand.

Necessarily such concepts need to be carefully simulated and assessed in advance, yet decision makers should get encouraged to also think about such unconventional solutions.

*C14: Current market products of energy and service markets should be evaluated regarding chances to ease access for storage systems. Unconventional solutions (e.g. products with certain probability of delivery) should be also taken into consideration.*

## 8.4 Easy clustering solutions

The importance of aggregating and clustering single storage units was already addressed in the previous chapters. Because of the relevance of this approach it should be pointed out here again. Within the current market and regulation framework aggregating a number of single storage units is a proper way to become admissible to market places or to get able to provide system services.

Current clustering solutions require many contractual and technical preconditions and involve many different stakeholders. So a service provider wanting to aggregate charging power from distributed EV charging stations has to close contracts with

- each of the individual grid operators responsible for the individual charging points,
- each owner of a charging station,
- the involved service platform (e.g. the energy market),
- balancing responsible parties, and so on.

As of today only a limited number of daring "pioneers" run such trans-regional clustering businesses and some of them already gave up after some time.

One measure to exploit the local flexibility of distributed grid connected storage systems could be to develop completely new approaches with most simple solutions for inducing and rewarding system supporting behaviour of the battery systems (or their owners, respectively). The perhaps simplest solution could be to transmit a price signal from the grid operator to battery owners with reimbursing supportive behaviour just via the electricity bill. This price signal could be evaluated manually by the battery owner or automatically by some intelligent energy management. Such a solution would require no additional contracts or monitoring technology to be implemented (except communication of the price signal), but would lead to a reaction of the "pool" with some limited probability (this aspect already has been discussed in section 8.3). The price signal could be generated either from requirements of the grid operators (which would involve the opportunity to generated locally different price signals) or from energy markets. For the latter purpose the grid operator would only have a relay function from the electricity supplier (linking to the market) and the final customer. Concepts for balancing the energy market requirements and the grid needs are necessary for such a solution.

Another approach to facilitate clustering of various storage units could be a standardisation of the clustering functionality and integrating this in the firmware of the single technical units. A first step in this direction was the standardisation of communication protocols for the smart grid operation and the introduction of smart metering gateways for households and other consumers. The next step could be a translation of "flexibility" into data fields and communication protocols and the definition of standardised behaviour states of flexible technical units.

*C15: Simplification of regulatory and technical requirements and solutions for the clustering and pooling of local storage systems could significantly lower the barriers for providing collective services for markets and the grid. A technical standardisation of "flexibility" could help in this process.*

## 8.5 Creative participation solutions

Subject of section 8.4 was the aggregation of many single "physical" batteries into one large "virtual" storage system offering services to the grid and the markets. In certain situations an opposite approach might be helpful to increase the interest of people in storage systems.

Many people in cities are living in apartment houses and are not able to install PV systems in their own premises. They however may be interested in the use of electricity storage systems motivated by a power-rating related part of their electricity bill. Certainly they could install small battery systems in their apartments, which for that purpose have to be designed in a proper way of appearance and handling. Yet many people will object to install batteries in their living rooms because of safety aspects or missing space. For such situations one solution could be a larger battery unit in the basement of the building being virtually split into single small batteries available for the apartment owners. With the help of smart metering and energy management solutions it becomes possible to aggregate the operation requirements of all virtual batteries and translate it into a net operation scheme for the (larger) physical battery. Besides costs savings resulting from the larger battery power this approach would also allow to combine complementary load profiles of single households, saving unnecessary load cycles of multiple smaller batteries.

The only challenge for that approach is the necessity of one person/company being responsible for the (large) physical storage unit organising all necessary requirements like contracts, maintenance, metering etc. Local utilities supplying customers in that house could be a natural choice for this responsibility because of existing customers' relations. Yet technical and legal requirements need to allow such solutions, and easy handling procedures are an important prerequisite in order not to scare-off potential customers.

Considered from a more general perspective, one element of a market uptake of storage systems could be to find business models for seemingly "unattractive" customers with either difficult technical/local circumstances for battery installations or untypical interests regarding battery use. Addressing customers with significant power price in their bill could be one promising approach.

*C16: Creative implementation and marketing solutions could open up chances to involve seemingly "unattractive" customers. Virtual individual batteries could be such a solution for tenants in multi-family houses.*

## 8.6 European standardisation of rules and products

One key result of the recherché carried out for Deliverable 5.14 was the remaining heterogeneity of national rules and regulations.

On the one hand there are already some significant achievements like the market coupling of the energy wholesale markets or an ongoing unification of the regulation regarding primary reserve power (frequency containment reserve FCR). On the other hand there are most different definitions for the other balancing power market products in the different EU countries, even starting with the nomenclature (Table 1). Also the technical and financial rules for self-consumption are mostly different.

Besides technical aspects, taxes and levies are another factor influencing the market uptake of some technology and being defined strictly on national basis. Even though this certainly will remain a national matter even on a long term, some common European tax principles could significantly alleviate the market uptake of storage systems. Just as a simple example it would be reasonable to exempt storage units from all taxes to be paid by final energy consumers for all energy they completely return to the grid.

Table 1: Summary for nomenclature for frequency control reserves in the selected countries

<table>
<tr><th></th><th>Primary Control</th><th>Secondary Control</th><th colspan="2">Tertiary Control</th></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">Frequency Containment Reserve</td><td colspan="2">Frequency Restoration Reserve</td><td rowspan="2">Restoration Reserve</td></tr>
<tr><td>Automatic</td><td>Manual</td></tr>
<tr><td>Germany</td><td>Primary Control Reserve</td><td>Secondary Control Reserve</td><td>Minute Reserve</td><td>N/A</td></tr>
<tr><td>Spain</td><td>Primary Regulation</td><td>Secondary Regulation</td><td>Tertiary Regulation</td><td>Deviation Management</td></tr>
<tr><td rowspan="2">Sweden</td><td>FCR-Disturbance</td><td rowspan="2">FRR-A</td><td rowspan="2">FRR-M:<br>Fast active reserve (forecast, disturbance and counter trading) and Slow active reserve</td><td rowspan="2">N/A</td></tr>
<tr><td>FCR-Normal</td></tr>
<tr><td rowspan="2">Great Britain</td><td>Primary, secondary and high response (Mandatory and Firm)</td><td rowspan="2">N/A</td><td rowspan="2">Fast Reserve</td><td rowspan="2">Short Term Operating Reserve, Demand Turn Up and BM-Startup</td></tr>
<tr><td>Enhanced Frequency Response</td></tr>
</table>

Some of the benefits of a European standardisation of rules and regulations for storage systems are

- Services from storage systems could be offered in cross-border cooperation if applicable.
- The storage units and corresponding energy management systems could be designed in a way that they are by design compatible with requirements in all of the EU countries. This saves costs, shortens periods for technological progress and allows the integration of all “intelligent” functions already at an early technological development stage.
- An increased competition and higher market liquidity lowers the costs for system and market services.
- Lessons learned and success stories from different countries become comparable.

*C17: The consequent European standardisation of rules and products can significantly foster the market uptake of local/small storage systems.*

# 9. Conclusion

The previous chapters revealed four major challenges for the market uptake of local/small storage systems:

- Storage systems need more awareness and social acceptance.
- Rules and regulations need to be adapted to the new technical component "storage system".
- Technical and market solutions for smaller systems must be as simple and understandable as possible.
- Rules and regulations should become harmonized in the EU countries.

Another aspect, viable business models, has been discussed in detail in Deliverable 6.6 "Business Plan".

Taking aside the many facets of these aspects, one key questions remains to be answered by the European society: what role should local/small storage systems play in the process of energy transition?

Many developments and projects like the NETfficient one led to a high technical maturity of local/small storage technology including intelligent energy management and multi-sectoral integration. It has been proven that distributed storage system could have major benefits for local and national grid operation and for the provision of system services. Investors and stakeholders are ready for the market uptake given a sound framework of business models, regulations and social acceptance. So there is an urgent need for politicians and stakeholders to compare the national economic costs and benefits of different competing options (like grid extension vs. intelligently managed storage systems). It is necessary to develop mechanisms that can transform national economic benefits into economic reasonable business opportunities motivating investors to go ahead. Overcoming social and regulatory barriers in this process is one necessary step in this process.

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