RESERVE

D6.6 v1.0

CSR impact on energy systems business models for the transition towards 100% RES, V2

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Abstract:

This Deliverable reports on rising and on changing business models and their corporate social responsibility (CSR) evaluations as a follow up to Deliverable D6.5.

Keyword list:

Ancillary Service Provider, Corporate Social Responsibility, Business Model, Energy Systems, Energy Transition

Executive Summary

Deliverable 6.6, as a follow up to Deliverable 6.5, improves the assessment of changing and rising business models as a consequence of the energy transition to 100% renewable energy sources (RES). The concept of Corporate Social Responsibility (CSR) and the corresponding pillars of sustainability are included in the evaluation of the models. In several stakeholder workshops and discussions, RESERVE has established a catalogue of sector actors who already are or who will be affected by the energy transition. Based on these findings, network codes and ancillary services have been defined in Deliverable 6.4. The current Deliverable assesses these findings from the perspectives of the economy, the environment and society as well as the field of tension between them. “Technology” is taken into account in addition to the three established perspectives in order to consider the limits of the technological feasibility.

Based on the assumption of a changing market structure towards a mixed bottom-up and top-down model, a case study for the rising business model of an Ancillary Service Provider (ASP) is made in this Deliverable. Furthermore, the cash flow is analysed and changes to the current payment and remuneration structures are underlined. Thereby, Deliverables 6.4 and 6.6 form the basis for recommendations and proposals made in Deliverable 6.7 relating to changing structures in the energy market.

The main outcomes of D6.6 state that in **economic** terms, a successful conversion/adaptation of ancillary services to the technical requirements of the increasing share of RES to 100% will make an important contribution to a secure and reliable power supply in the future. From an **environmental** perspective, a positive contribution to the transition towards 100% RES can be observed in the fact that the achievements of an ASP can contribute to having an electricity supply that is free of CO_2 and other emissions. From a **social** perspective, the ASP can enable many small entities (private individuals and business) to participate in the balancing market, bringing with it potential benefits, such as increased equality between generators and consumers in the electricity market.

Also, the changes in the balancing market will have an impact on the financial structure of the system operators. Since the organisation of the balancing market will be, similarly to that of electricity generation, more decentralised and with smaller equipment, integrative software and service solutions will be more in the focus, and payment and remuneration systems will have to be adapted.

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1. Introduction

1.1 Structure and Aim of Deliverable 6.6

The current Deliverable is an update of D6.5, which was published in M18 of the project. Both look at the future developments of the energy system and the associated business models and their effects from the perspective of Corporate Social Responsibility (CSR).

On the basis of the technical findings in RESERVE, proposals for new and modified network codes and ancillary services have been developed to describe the change to the electricity system that is necessary from RESERVE's perspective for a successful transition towards 100% RES. In order to ensure sustainability in the development and to present the significance and impact of the proposals, we have looked at the proposals from the perspective of CSR and have carried out appropriate evaluations. Chapter 2 provides an overview of the concept of CSR and its significance for RESERVE as well as the results of our analysis of the network codes and ancillary services.

The business aspects of RESERVE are also considered. In chapter 3, the changes in the market structure resulting from the move towards 100% RES are presented first. An important output of RESERVE is the importance of ancillary services. Both their composition and their provision will change significantly. On this basis, the business model of the ancillary service provider will be investigated. In addition to the presentation of different structural options and the arrangement of the cost structure and possible revenue streams, a CSR perspective will also be considered here. Finally, the changes to the business models of the central actors (transmission system operators (TSOs) and distribution system operators (DSOs)) are described.

1.2 How to Read this Document

While WPs 1-5 deal with technical issues, WP6 looks at the corresponding regulatory and economic environments.

In addition to the general work in the entire project and the consultations at WP level and consortium level, D6.6 builds directly on D6.3, D6.4 and D6.5. D6.5 is the first version of D6.6. Contents from D6.5 have been further developed and improved. Analyses in the area of CSR have been continued and the investigation of the market structure and the business models has been deepened. D6.3 and D6.4 provide the proposed network codes and ancillary services developed in RESERVE. Due to the central importance of this regulatory framework, D6.6 examines it in terms of sustainability by using the concept of CSR.

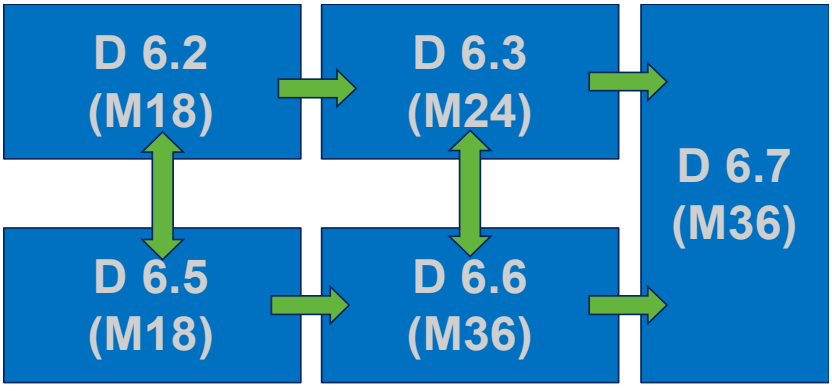


Figure 1-1: Interdependencies between Deliverables

2. Sustainability and CSR Evaluation

2.1 The Concept of CSR in the Framework of RESERVE

Corporate social responsibility (CSR) is recognized as a (usually voluntary) contribution of an individual company, but also of an entire economy, to sustainable development that goes beyond any legal requirements. In 2011, the European Commission interpreted CSR as being the responsibility of companies for the impact of their actions on the whole environment [1].

“Enterprises should have a process in place to integrate social, environmental, ethical human rights, and consumer concerns into their business operations and core strategy in close cooperation with their stakeholders. The aim is:

- to maximize the creation of shared value, which means to create returns on investment for the company’s shareholders at the same time as ensuring benefits for the company’s other stakeholders;
- to identify, prevent and mitigate possible adverse impacts which enterprises may have on society.”

Another definition relevant to the determination of sustainability is that of the Brundtland Commission of 1987 [2]:

“Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Among other things, these definitions and the ideas behind them regarding sustainable development and the resulting responsibility of individual companies to contribute towards this have led to the concept of the three pillars of sustainability: the economy, the environment and society.

This concept implies that for sustainable development, plans and decisions must always consider the impacts within all three pillars. This must be done from not only the actors’ but all stakeholders’ perspective.

The idea behind this concept is the dependence of the three pillars on each other. If one pillar is ignored, over time it will also lead to impairments in the other two areas. An illustrative example is the greenhouse effect, which incurs costs in the long run due to the lack of consideration of ecological sustainability. Currently, such a mode of action can leave the social and economic pillars unaffected or even be beneficial to them. However, future impacts can affect all three pillars. Inter alia, the warming of the world climate in the ecological area could generate political instability, with further impact in the social and economic fields and follow-up costs for society. In particular, the cost of remedial actions can far exceed the costs saved through disregarding environmental sustainability [3].

The takeover of a fertilizer manufacturer by a large chemical manufacturer is a further company-oriented example from the recent past. Despite many critical discussions, including those concerning a weed killer containing glyphosate, the chemical manufacturer decided to go ahead and acquire the other company for purely economic reasons. While for a long time the negative aspects of glyphosate have concerned only the social and the ecological pillar, now their being disregarded is affecting also the economic column in the form of high fines in the USA.

These interdependencies are the reason why, even with a changeover to 100% RES, the consideration of sustainable development and CSR is of great importance. Aligning power grids with a 100% RES power supply primarily addresses the goal of environmental sustainability. It enables reduction and, ultimately, complete avoidance of emissions stemming from power generation. However, achieving 100% RES can only be fully sustainable if economic development finances such changes and if there are no cuts at the social level.

Figure 2-1: The Extended Concept of Corporate Social Responsibility (CSR)

In the course of the RESERVE project, we have found that the conventional concept of the three pillars is not completely appropriate for a comprehensive assessment and evaluation of the measures and products developed by RESERVE. Therefore, with “technology”, we are supplementing an additional component to our evaluation on influences, since the technical developments in RESERVE are so new that their significance cannot be fully mapped over the existing three pillars. From our perspective, the technical aspects form the basis for sustainable improvements in the areas of economy, environment and society. Technology ensures the balance between the three conventional pillars.

2.2 CSR Relevance of Network Codes and Ancillary Services

One of the central results of RESERVE is the development of new and modified network codes and ancillary services. Due to the central importance of regulations in the electricity market, both the network codes and the defined ancillary services will have a significant future influence on all actors in the energy sector. For this reason, we have also evaluated those network codes and ancillary services proposed by RESERVE from an environmental, a social and an economic perspective according to the CSR concept.

Definitions of ancillary services and network codes developed by RESERVE are proposed and analysed one by one from a CSR perspective in D6.3 and D6.4. In the following chapters, we summarise our work in the field of CSR evaluation. In accordance with the previously applied division into the three pillars of economy, environment and society in addition to the aspect of technology, we discuss the holistic proposal lists from D6.3 and D6.4 regarding their impact on the sustainability of RESERVE.

2.2.1 CSR Evaluations of Updated Network Codes

The following is an overview of the CSR evaluations of the updated and new network codes and their potential effects.

Economic	Environmental	Social	Technical
New Approach for Frequency Containment Reserve (FCR)			
Harmonisation of the payment and remuneration structure Introduction of a new service (i.e. FCR) with a fixed fee		Opportunity for small generators to purchase/sell FCR → participation	
Updated Definition of RoCoP			
RoCoP represents a reasonable indicator for determining the amount of remunerations			Additional index for evaluation of generation and storage devices
New Requirements for Frequency Measurement			
Necessary in order to avoid significant financial losses Large financial expenditure is necessary for the needed infrastructure			Necessary in order to meet the characteristics of an increasingly volatile grid
General Points			
Contributing to a still reliable power supply for industry by adapting the grid to new requirements Promoting European equipment manufacturers by a early introduction of future-oriented technical specifications	Contributing to a grid that promotes the transition towards 100% RES and the corresponding savings of CO_2 emissions	Contributing to a still reliable power supply for private households throughout Europe by adapting the grid to new requirements	

Table 2-1: Overview - CSR Evaluation of Updated Network Codes

The network codes have been created with the intention of contributing to a power grid of the future that enables the transition to 100% RES. From this basis, general influences in the three areas of CSR emerge. A functioning and reliable power supply is essential from an economic perspective. The same applies for the social perspective, insofar as affordable and unrestricted access to electricity is a given social standard in Europe. It is also essential to enable the grid to achieve 100% RES in order to reduce CO_2 emissions caused by electricity generation and to meet EU emission targets.

A specific point to highlight is the potentially high financial burden on all asset owners arising from the network code "New Requirements for Frequency Measurement" and the associated

necessary renewals. As stated in the corresponding proposal, an impact assessment of the costs for all stakeholder groups concerned must be carried out when network codes are implemented. Private consumers in particular must be taken into account if social acceptance of the energy system transformation is to be achieved.

2.2.2 CSR Evaluation of Updated and New Ancillary Services

The following is an overview of the CSR evaluations of the updated and the new ancillary services.

Economic	Environmental	Social	Technical
Linearization of Swing Dynamics			
New submarket for ancillary services		Participation of private entities	
Providing Synthetic Inertia			
New submarket for ancillary services	Environmental impacts caused by possible additional storage assets must be considered		Needed due to the decreasing share of mechanical inertia
New Approach for "Defence Service" and "Restoration Service"			
Reducing the financial losses resulting from regional blackouts			Change of indicator, because "frequency" alone is no longer reliable
Providing Reactive/Active Control for Voltage Control			
Additional costs for the DSO but also the opportunity to reduce losses New (sub)market for ancillary services Market potential for generation- and storage-device owners and ancillary service providers	No resource consumption because no additional assets are needed	Participation of private entities Rising electricity prices could be a burden on those consumers without their own generation and storage devices	A new ancillary service is needed due to the increasing number of entities generating at low voltage level
Providing Input Signal for Frequency Controllers			
Reducing of economic losses caused by disconnection of assets from the grid		Reducing the number of disconnections of privately owned assets from the grid	An input signal for frequency is needed due to the decreasing share of synchronously rotating generators
General Points			
Contributing to a still reliable power supply	Contributing to a grid that promotes the	Contributing to a still reliable power supply	

for industry by adapting the grid to new requirements	transition towards 100% RES and the corresponding savings of CO_2 emissions	for private households throughout Europe by adapting the grid to new requirements Promoting the participation of private consumers in the different fields of ancillary services	

The general impact factors in the three areas of CSR of the new and updated ancillary services are basically the same as those of the network codes. The proposals for new and updated ancillary services developed by RESERVE also have an overarching objective: the creation of a grid that will enable the transition to 100% RES.

Particularly noteworthy are the changed roles and relationships between sector actors, which would be caused by the introduction of the proposed ancillary services. The participation of private entities in ancillary services can be greatly increased by the new and modified ancillary services. This will become especially relevant in the area of new ancillary services for voltage control. The regulators need to consider that private consumers need to be kept informed and protected differently from companies, e.g. via less technical and more easily comprehensible information.

3. New Business Models and Changing Business Models in RESERVE

3.1 A Changing Electricity Market Structure

On the pathway towards 100% RES, the structure of the electricity market has already changed slightly and will go on to change dramatically in the future. The structure of the previous system can be described as follows:

The previous system follows the principle of **top-down** only. Electricity is generated by large-scale generators which feed the electricity into the transmission grid of the TSO. Power is transmitted to DSO networks via the TSO network. These transfer the electricity to the consumer. All market participants are remunerated for their provided services. Thus, the corresponding monetary flow is **bottom-up**.

Already in the former system, various measures are necessary to stabilise the grid due to fluctuations in generation and consumption.

The TSO is responsible for **frequency control**. The ancillary services required for this are provided by large-scale generators.

Voltage control is the responsibility of the respective DSO which controls the stability of the electrical voltage independently without the participation of other actors.

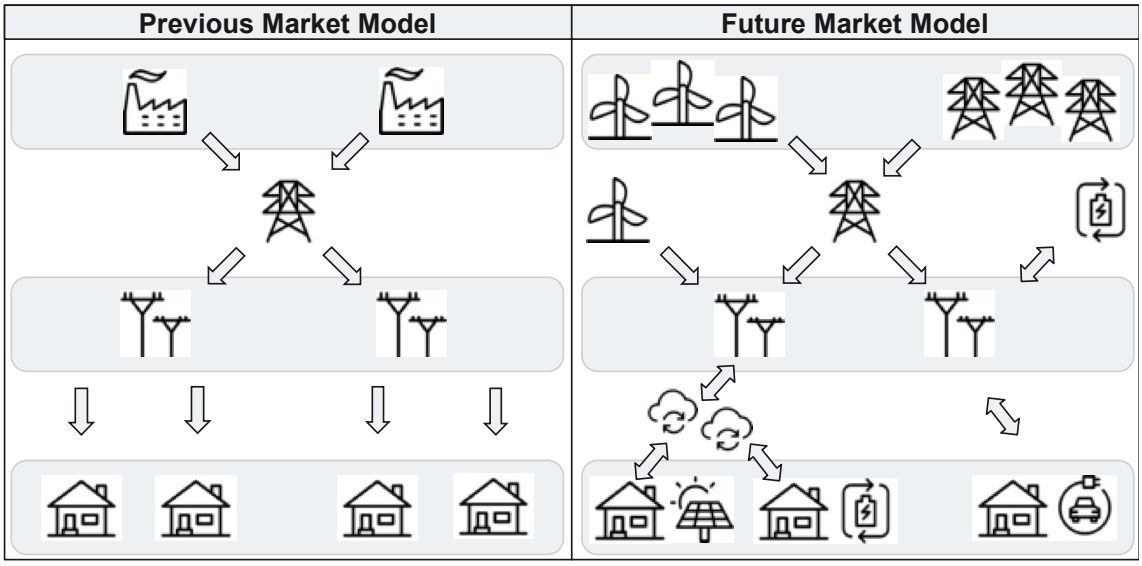


Figure 3-1: Changes in the Electricity Market Structure

As can be seen in the figure above, the future structure of the market will no longer be characterised solely by the principle of **top-down** but also by the principle of **bottom-up**.

The additional principle of **bottom-up** concerns both the flow of electrical energy and the provision of ancillary services as well as the connections regarding **frequency** and **voltage control**.

The generation of electrical energy will still be able to take place on a large scale, e.g. at large-scale wind farms. In addition, there will be generating units which feed directly into the electrical grid at medium voltage (MV) and low voltage (LV) levels and storage units at the same levels.

Small-scale entities, such as private and commercial consumers, will become prosumers and will provide self-generated energy, but will also source some energy from the DSO's network. The flow of electricity will be two-way: **top-down** and **bottom-up**. Both of these flows will have to be remunerated adequately. This applies for the common electricity suppliers and for the organisations which represent and/or bundle the prosumers. These organisations can also be the electricity suppliers or the aggregators or, in the area of ancillary services, specialised ancillary service providers.

Responsibilities for **frequency control** and **voltage control** will remain with the TSOs and DSOs; however, the partners that they will collaborate with in this regard will change.

In a 100% RES scenario, the TSO will no longer have enough conventional large-scale generators available for procuring ancillary services. In future, these services will have to be provided by additional sources as well. It will be necessary to integrate as many consuming and producing units as possible at all levels into the task of providing ancillary services.

With today's grid infrastructure, the DSOs will barely be able to stabilise the electrical voltage independently. Due to the two-way flow of electricity, interaction with the respective actors in the distribution grid, even each small-scale entity, like a private prosumer, is needed. With regard to this aspect, RESERVE proposes two new ancillary services: Providing reactive power for voltage control and Providing active power for voltage control.

The transition towards a system with **bottom-up** components and the required interaction with private entities too will create a necessity for overall technical and economic coordination. For the TSOs and DSOs it is not feasible to interact with every single (private) prosumer. Likewise, no small-scale entity (private or commercial) will be interested in operating autonomously in the electricity market every day.

The coordination and bundling of single entities can be done by a so-called ancillary service provider (ASP). The ancillary service provider will be a role performed by a separate actor or by existing actors, such as the aggregator or an energy supplier. The concept of the ancillary service provider, possible structure designs and relevant aspects from the perspective of CSR are discussed in the following section.

3.2 A Case Study for an Ancillary Service Provider (ASP)

3.2.1 The Concept of an Ancillary Service Provider (ASP)

One of the central objects under consideration in RESERVE is that of the so-called ancillary services in the area of frequency control and, newly, in the field of voltage control, as already presented in D6.3 and D6.4. Even under today's technical conditions with the current electricity mix of conventional and renewable generation sources, these ancillary services are used to balance differences between generation and consumption and to keep the transmission grid stable. In the scenario of a transition to 100% RES, however, things will change in the future. On the one hand, conventional power generators are particularly suitable for the provision of ancillary services for frequency control due to their reliability, controllability and size. If their share of electricity generation decreases, they must be replaced not only in terms of generation capacity but also in respect of their today's role in the balancing market. On the other hand, the investigations in RESERVE have shown that in addition to the existing ancillary services, further grid control measures will be necessary in the future, as the characteristics of the grid will change.

RESERVE shows the need for introducing a "Fast Control Market" alongside the existing balancing market. The RoCoF (Rate of Change of Frequency) control services researched in RESERVE will then be traded there. Corresponding approaches in the field of ancillary services can be found in the "Proposal List from RESERVE Project regarding Regulatory Framework", which is also dealt with in D6.4. Furthermore, one outcome of D6.4 is that there is an upcoming need of DSOs to receive voltage control-related ancillary services at the LV level. Based on these results, we have focused on the Ancillary Service Provider as an actor of increasing importance in the field of new and changing business models.

In the following, we present the business model of the Ancillary Service Provider in detail. We consider the different possibilities of the exact arrangement of the business model and also consider financial aspects estimating the economic potential. The whole process is rounded off by a CSR evaluation, which adds an ecological and a social perspective to the economic assessment.

3.2.2 The Business Model of an Ancillary Service Provider

The basic orientation of an **Ancillary Service Provider** (ASP) can be described easily: The main business of an ASP is to provide ancillary services. The possibility or necessity to establish such an activity as a central business activity and not only as a secondary activity to power generation has already been described.

The value proposition offered by an ASP is the ancillary services provided to the respective TSO and/or DSO. This is done on the existing balancing market, where the existing ancillary services Frequency Containment Reserve (Primary Control) and Frequency Restoration Reserve

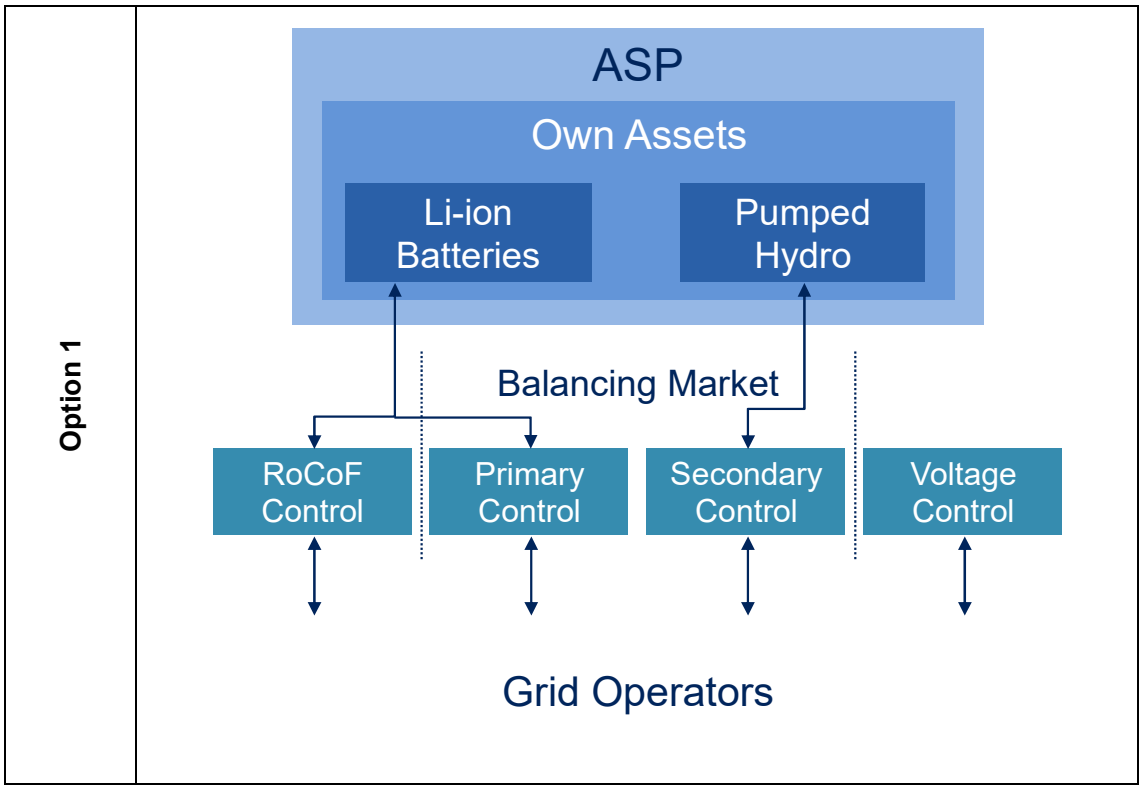
(Secondary Control) are traded. In addition, RoCoF control services will be offered on the aforementioned “Fast Control Market” to the operator responsible for network stabilisation.

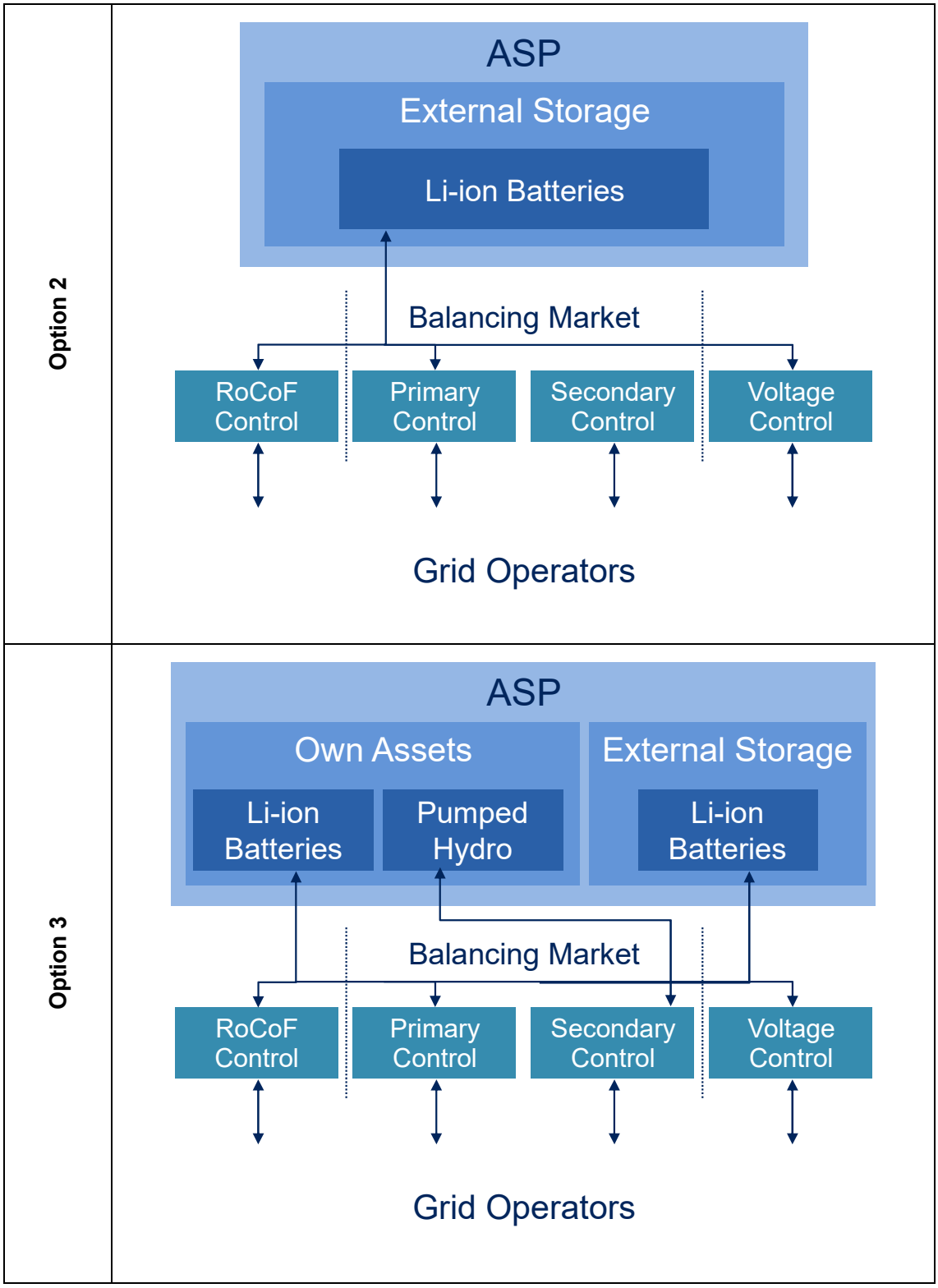
In addition there are the ancillary services for the voltage control of the DSO. In this respect, an ASP cannot operate with a central asset but can only offer the bundling of assets from end users, since these services must be provided locally.

Ancillary services can be provided by an ASP in two ways. In the first option, only the company's own storage units are used, which are controlled in such a way that they can provide balancing power as optimally as possible. In extension to this, the provision of balancing power can be provided by the assets of others through cooperation with an aggregator or by one's own activity as an aggregator.

In addition, a further value proposition can be derived from the aforementioned business activities. At present, the supply of electrical power also entails the obligation to provide ancillary services. In line with the proposals for revised and for new network codes in D6.4, there will also be an obligation to provide certain control services in the future, which will become rather more important than today (E.g.: AS 3b: Providing Fast Synthetic Inertia). In order to give those market participants who are unable to meet these obligations the opportunity of generation and distribution, the obligation can be contractually assumed by an ASP for a corresponding fee.

Table 3-1: Possible ASP Structures





3.2.2.1 CAPEX:

The most important investment object for an ASP is its own assets, which are used for electricity storage unless only external storage units are used. The relevant storage options according to the current status are Li-ion batteries and pumped storage plants. With the Li-ion batteries, a distinction must be made between the areas of application for which the batteries are suitable and which properties are primarily required. A distinction also has to be made between batteries with high retrievable power and those with a high long-term capacity. Overall, batteries are suitable for providing services on the existing balancing market for Primary Control and on the future balancing market for RoCoF Control.

Pumped storage plants require a certain amount of time to start up, but can provide larger capacities. They are particularly suitable for ancillary services in the area of secondary control. Their application possibilities are severely limited by geographical conditions and the extremely high investment costs.

In addition, there is the infrastructure required for central control for all forms of ASP. This will require investments in assets, in infrastructure and in software solutions. For 2020 Horvath et. al. [4] forecast a capacity of one kWh battery storage having investment costs of about 108 Euro. For 80% share of renewables in the electricity generation in Germany, Hartmann [5] says there is a need for 6.3 TWh decentralised storage capacity in Germany, which alone would create investment costs of about 680 million Euro in total. With a higher share of decentralised renewable energy generation, a higher amount of storage will be needed; for 100% renewable generation, Hartmann [5] estimates about 83 TWh, Child et. al. [6] even estimate 147 TWh for Germany alone. With the above mentioned model, ASPs will have to compensate the investment costs by reducing other costs in order to be financially beneficial.

3.2.2.2 OPEX:

The following costs will be incurred during operation: In the case of own systems, these will have to be maintained and repaired. This can be done by own employees or by external service providers. This will involve personnel costs. Specific costs of the activity as an ASP will be compensation payments and/or remunerations for the external supply of storage capacities. These can be performance-related or fixed remuneration.

3.2.2.3 Fixed Payments

In the case that the ASP will also offer the service of assuming the obligation to offer ancillary services to third parties, payment will be required. As this is a continuous service, a fixed payment will be appropriate.

3.2.2.4 Variable Payments

The offering and provision of ancillary services will lead to variable payments (at least at the status quo). As explained above, ancillary services can be offered on the balancing market in three different categories. In the area of primary control, remuneration will be exclusively based on the capacity provided for this ancillary service. A total capacity of 3,000 MW is currently available for primary control in the ENTSO-E area. Even though the demand for primary control has declined slightly in recent years, its share of the total costs for ancillary services is increasing. As the share of RES increases, the demand for primary control is expected to increase accordingly. On the supply side, conventional power generators will be eliminated. Nevertheless, the opening of the market will add new suppliers. The decisive factor for future prices will be which of the expected developments will have a greater impact.

The newly developed ancillary service “RoCoF Control” does not exist yet. A trading volume or possible prices are therefore not yet known. Due to its characteristics, however, a structure similar to that of primary control seems to make sense. This applies on the one hand to the tendering of the capacity provided for this ancillary service and on the other hand to the remuneration exclusively on the basis of capacity. Due to the expected very small service units in both positive and negative directions, the introduction of a work price is not reasonable.

Secondary control is also remunerated according to the capacity provided for this ancillary service. In addition, the energy provided is paid after the ancillary service has been provided. Currently, this ancillary service is the one with the largest share of sales.

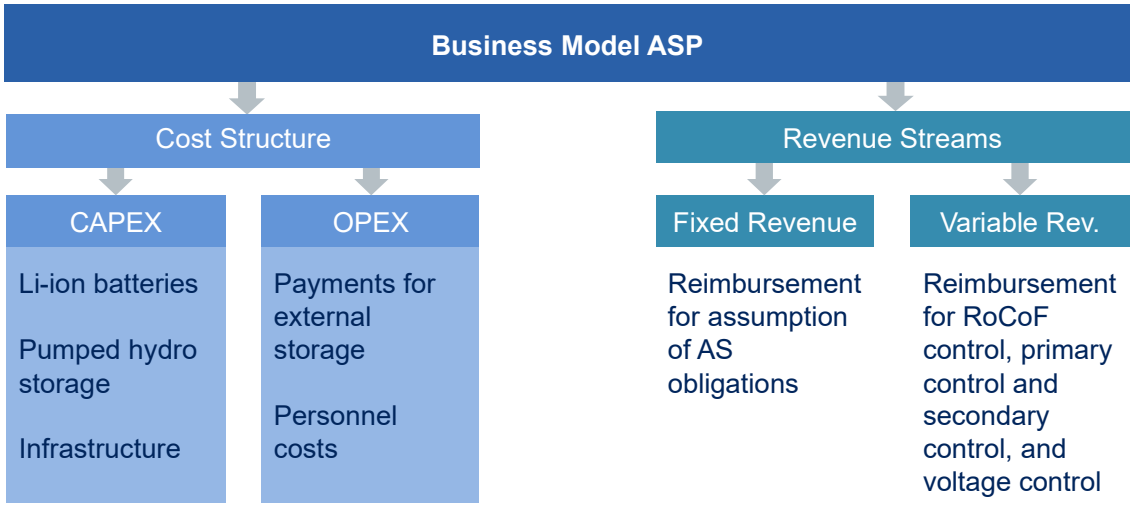


Figure 3-2: Business Model ASP

3.2.3 Evaluation of the Case Study from a CSR Perspective

In **economic** terms, it should be noted that a successful conversion/adaptation of ancillary services to the technical requirements of the increasing share of RES towards 100% will make an important contribution to a secure and reliable power supply in the future. This is an elementary pillar for a successful European economy and to avoid payments for rebuilding measures resulting from the climate crisis. With the future reduction of the use of fossil fuels, even in the sectors of transportation and heating, the dependence on a functioning power supply will increase further.

Nevertheless, on the one hand, the rising demand for ancillary services could also lead to an additional financial burden on the economy as a whole. On the other hand, there will be savings through increased efficiency and reduced transmission losses due to the coordinative function of the ASP.

Furthermore, ASPs can eventually gain a basic profit by offering purchase power agreements (PPAs). Since they can compete with the offered capacities, it is important to evaluate the financial benefit of such agreements.

From an **environmental** perspective, a positive contribution to the transition towards 100% RES can be observed. The achievements of an ASP can contribute to having an electricity supply that is free of CO_2 emissions and other emissions. This contribution can be classified as extremely valuable in the environmental field.

However, great attention must be paid to ensuring that this positive contribution is not diminished by environmental damage to the storage units. In the case of batteries in particular, it has not yet been fully clarified as to how sustainable and resource-saving production and environmentally friendly disposal can be achieved.

With a constantly growing demand for batteries, solutions for recycling must be found and made mandatory.

In the **social** field, the ASP is to be seen as a potential employer who may also be able to employ people who lose their jobs as a result of the abolition of conventional power generation. In addition, the ASP can enable many small entities (private and business) to participate in the balancing market along with potential benefits, thereby increasing equality in the electricity market. On the other hand, costs and remuneration on the electricity market are always a social issue, at least from the point of view of private customers. Now and in the future, access to affordable electricity must be seen as a basic need.

3.3 Changing Business Models

3.3.1 Transmission System Operator (TSO)

In today's electricity grid, the TSO as transmission grid operator is responsible for providing and running an appropriate grid infrastructure at high and medium voltage levels and for ensuring

frequency stability. These fundamental tasks will remain unchanged in the future but nevertheless there will be some changes that must be considered for the technically and economically successful future of the TSO.

With the transition to 100% RES penetration, the share of inertia-driven electricity generation will steadily decrease. Thus, the aspects of frequency stabilisation and ancillary services will become more relevant. Furthermore, the transmission flows will change: On the one hand the electricity generation will be located at all voltage levels and will be much more decentralised. On the other hand, there will be a requirement for energy shifts across a country due to the volatility of RES and the need for far-intensified interactions with other TSOs beyond national borders.

These developments cause the need for extensive adaptions of the grid infrastructure. This applies to normal high-voltage lines but also to new technologies, such as adapted ICT infrastructures and new control technologies.

Consequently, the cost structure of the TSO will be affected, especially in the area of capital expenditures (CAPEX). Since a TSO is not a participant of a free market, the regulatory framework must be changed so that the TSO can claim these costs. We take up this point in the recommendations proposed by RESERVE (D6.7).

The changes in ancillary services will also have an impact on the financial structure of the TSO. With the proposed RoCoF Control Service, a new service will require remuneration. At the same time, the structure of the providers of the existing ancillary services will also change. For example, there will be the collaboration with ASPs.

3.3.2 Distribution System Operator (DSO)

As with the TSO, the basic concept and business model of the DSO will not change. The activities of providing and operating the regional electricity grid and ensuring voltage stability will remain the same.

Nevertheless, the framework conditions under which the tasks must be performed are changing. Due to the sharp increase in the number of generation units that will feed into the DSO's grid, the flow of electricity in the distribution grid will change. The regulation of voltage stability will no longer function through an exclusive top-down approach; the individual generation and storage units will have to be integrated. This requires far-reaching expansions in control technology. RESERVE will supply, among other things, an inverter that can be controlled for these purposes. An ICT infrastructure will have to be provided for the necessary communication, due to the new grid management structure. Future scenarios could involve DSOs requesting only request on-line information that is provided by the inverters for controlling purposes.

As explained above, the DSO will need to obtain external ancillary services for the voltage control. There will be costs for organisation and in particular for paying for the purchased services. On the other hand, there will be potential savings through the reduction of transmission losses. Both aspects must be taken into account in the regulatory remuneration of the DSO.

In addition, as the share of RES increases, the distribution networks will have to be included in frequency control activities in the future. Increased interaction with the respective TSO will become particularly important here.

As already described for the TSO, the remuneration of the DSO is characterised by regulatory framework conditions; a DSO operates within conditions of a natural monopoly. In order to be able to continue to operate reliably and in a manner that will serve the system in the future, DSOs will have to make far-reaching capital expenditures in infrastructures that were not needed before. This will only happen if these developments are taken into account when calculating the remunerations. The fact has also been incorporated into our RESERVE recommendations for policy makers (see D6.7).

4. Conclusion

One of the most important outputs of the RESERVE project is that of the proposals for new and for modified network codes and for ancillary services. The suggestions that RESERVE makes are to design the grid structure for a successful future of the electrical grid on its way to 100% RES, based on the technical findings of RESERVE. To ensure that this development is sustainable and successful, the proposals for network codes and ancillary services have been evaluated from the perspective of CSR.

The CSR evaluations show that the proposals have a positive impact in all areas of sustainability. In the **economic field**, the contribution to an efficient grid which ensures reliable power supply for private customers and for industry is indispensable for an economically successful Europe. Also, the overall costs to establish a renewable power supply are lower than the follow-up costs of the climate crisis caused by emitted greenhouse gases. New sub-markets and new opportunities for economic activity will arise from the regulations governing ancillary services. The avoidance of redundancies, for instance in storage opportunities, through laws, regulatory changes and coordination measures will lead to macroeconomic savings, which will benefit the electricity prices for customers. From an **environmental perspective,** the greatest influence lies in contributing to a grid of the future that runs with less CO_2-emitting electricity generation. In the **social field**, the increase in the participation of private individuals in ancillary services and the associated revenue opportunities are supported by the findings of RESERVE.

However, aspects that have the potential to jeopardise sustainable success have also been identified. For example, the new and modified ancillary services must be remunerated by the service taker and thus represent an additional financial burden on system operators. With regard to both economic and social sustainability, the payment structure of the energy supply needs to be assessed for the future market system. From an environmental perspective, storage opportunities will have to be assessed regarding their impact on the environment and on society. This applies in particular to batteries, which are made of hard-to-mine metals, and where the key questions about the recycling process have not yet been answered.

The “towards 100% RES” concept is bringing significant changes with it for the market structure in the field of electrical energy. The most far-reaching transition is that of the change from an exclusive top-down structure to one that is both top-down and bottom-up. TSOs and DSOs will continue to exist, but their roles in the grid will change in part. Since the system operators have always operated in a natural monopoly, policy makers, authorities and regulators all bear responsibility for the success of the energy transition. This is reflected in the recommendations of D6.7.

5. References

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6. List of Figures

7. List of Abbreviations

ASP	Ancillary Service Provider
CAPEX	Capital Expenditures
CSR	Corporate Social Responsibility
DSO	Distribution System Operator
FCR	Frequency Containment Reserve
ICT	Information and Communication Technologies
kWh	Kilo-Watt Hour
LV	Low Voltage
MV	Medium Voltage
MW	Mega-Watt
OPEX	Operational Expenditures
PPA	Purchase Power Agreement
RES	Renewable Energy Source
RoCoF	Rate of Change of Frequency
RoCoP	Rate of Change of Power
TSO	Transmission System Operator
TWh	Terra-Watt Hour
WP	Work Package