



RESERVE

D6.7 v1.0

Recommendations to Policy Makers, Enterprises and Other Stakeholder Groups for Designing Regulatory Frameworks and Incentive Systems

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Abstract:

This Deliverable reports on recommendations and proposals for making the transition to 100% renewable energy a reality.

Keyword list:

Recommendations, Proposals, Policy Makers, Authorities, Regulators, Enterprises, Stakeholders, Regulatory Framework

Disclaimer:

All information provided reflects the status of the RESERVE project at the time of writing and may be subject to change.

Executive Summary

The climate crisis concerns all of us. Therefore, a comprehensive solution towards 100% renewable energy generation needs to be found. Renewable electricity generation plays a major role in this field. Hence, a disruptive change is expected in the electricity supply. Electricity generation is turning from large generation units towards small and decentralized units with low mechanical inertia. Storage systems will need to be installed due to the high volatility of renewable generation. New ways of controlling voltage and frequency have to be found. Moreover, changes in demand are expected. Self-consumption could increase on account of there being more privately-owned generation units. At the same time, the provided electricity still needs to be affordable and reliable.

To meet the needs of the energy transition towards 100% renewables, RESERVE has conducted a comprehensive stakeholder analysis. Furthermore, based on the pillars of sustainability and corporate social responsibility (CSR), measures have been established to make the energy transition a success. Based on the technical findings of the RESERVE project, the consortium has established the following recommendations for sector actors:

- I. **ENTSO-E and system operators should consider adopting RESERVE's updated network codes and new ancillary services structure**
- II. **A public debate on how to achieve up to 100% RES is needed – RESERVE offers six concrete proposals to kick off the discussion**

Beyond the changes which have to be faced with regard to hardware, business models or the structure of the energy market, a broad debate is needed on how the energy transition towards 100% renewables can be supported in order to achieve the set goals by 2050. Therefore, RESERVE suggests proposals for energy system operators, enterprises and prosumers:

- (1) Energy system operators should consider smart solutions in their investment strategies
- (2) Due to the volatility of RES, a new energy pricing system is needed to encourage new behaviour and investments
- (3) Energy system operators should investigate the use of 5G features when planning their transition to up to 100 % RES-based generation

These suggestions need to be publicly debated to make sure that all stakeholders have the chance to participate in the transition. Policy makers have to support the transformation process towards a fully sustainable energy generation. For this reason, RESERVE also suggests proposals for policy makers, authorities and regulators:

- (4) Further open balancing markets to enhance the participation of owners of RES and storage systems
- (5) Deploy specific targets for the development of the available storage capacity and provide corresponding incentives for storage investments
- (6) Introduce legislation which reflects the true cost of energy, considering social and environmental costs

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1. Introduction

1.1 Structure and Aim of Deliverable 6.7

The energy transition is creating a new market structure with more and smaller entities than we know from the previous market. The well-established top-down market structure with large power plants providing energy through transmission and distribution grids to customers is being increasingly substituted by a mixed model of a top-down and bottom-up market structure.

Additional entities and a changing structure of responsibilities will set a focus on new business ideas and roles. Regulators and policy makers are in charge of establishing frameworks and incentives to support the market changes and the required reorganisation among the different stakeholders.

With the rising share of renewable electricity generation, mechanical inertia will decrease in the system, while decentralization will increase. For example, in Germany nuclear power generation decreased from 170 TWh in 2000 to 76 TWh in 2018 and coal decreased from 291 TWh to 229 TWh in the same time period. Both are forms of generation with high mechanical inertia. Also from 2000 to 2018, the renewable and mostly inertia-free generation increased from 38 to 229 TWh [1]. RESERVE provides solutions for harmonising these developments and for controlling the grid more efficiently. This provides opportunities to involve the customer in the energy transition on the one hand and to set new standards of infrastructure on the other hand.

The described development will require new investments and changes in the payment systems. Not only will the investments be lower than many currently anticipate but also the investments, compared to the damage that global warming and CO₂ emissions are causing, will be much smaller, because failure to act would intensify the climate change. The costs and risks of the climate change are estimated at about 5% of the GDP per year or even 20% when risks are defined over a wider range. The expected consequences range from areas such as “access to water”, through “food production” and “health”, over to “environment” [2].

Future investment must support the introduction of greater RES penetration. Increased storage is needed to dampen RES production peaks and to provide flexibility. A more intelligent way of operating the grid is needed, especially at distribution level. Transmission system operators' (TSOs') and distribution system operators' (DSOs') investment strategies must focus on introducing equipment and systems which boost grid intelligence, take advantage of the support of revamped financial incentives and enable profitable business models based on the new possibilities offered by intelligent solutions.

In this Deliverable, the RESERVE consortium gives two recommendations to system operators as well as to policy makers. Furthermore, the RESERVE consortium sees the need for a broad discussion in order to achieve the energy transition of up to 100% renewable generation in a sustainable way. The suggested debate concerns not only system operators, enterprises and prosumers but also policy makers, authorities and regulators. Starting from new pricing systems and the opening-up of the balancing market to smaller units, and moving on to targets for the installation of new storage opportunities, the debate should have a widespread range and should be supported by all involved stakeholders.

1.2 How to Read this Document

This Deliverable focuses on the outcomes of the RESERVE project. In the past three years we have identified scenarios which visualise the chances and opportunities of an energy generation up to 100% renewable energy sources (RES). Photovoltaic (PV) and wind will lead to a lack of mechanical inertia, which will affect the balancing markets and the system stability.

The Deliverables from WPs 1 to 5 cover the technical issues involved. In WP 6, business cases are identified, a corporate social responsibility (CSR) framework is set and exiting and new network codes are revised. Thanks to workshops and consultations with stakeholders, all of the results have a highly practical component.

D6.2, D6.3 and D6.4 focus on the regulative framework by evaluating existing and new network codes. D6.5 and D6.6 establish a sustainability framework, new business opportunities and market conditions in Europe as well as energy system designs. D6.7 gives, based on the outcomes of the aforementioned Deliverables, recommendations to policy makers, enterprises and other stakeholder groups. D6.7 also designs regulatory frameworks and incentive systems.

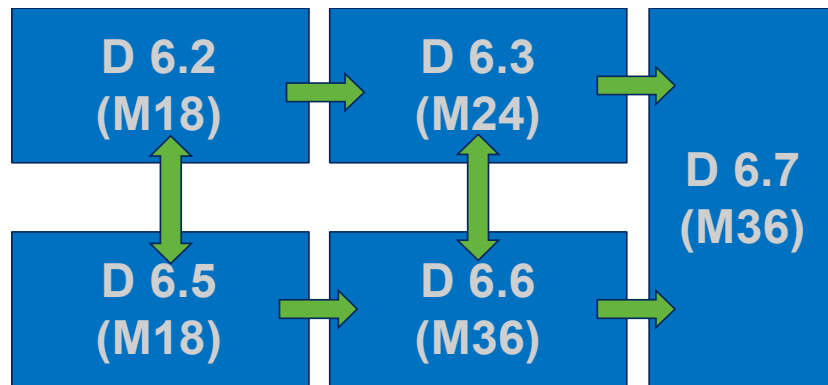


Figure 1.1 Interdependencies between Deliverables

2. Recommendations and Proposals for Making the Transition up to 100% Renewable Energy a Reality

The need for urgent actions in order to address the climate change has never been far from the headlines in recent months. One action supported by many organizations is to further increase the share of renewable energy sources (RES) that are used for energy generation.

The RESERVE project has produced technical results which contribute significantly to enabling the energy sector to increase the percentage of RES-based energy production while simultaneously maintaining the current level of power grid stability. It addresses the technical challenges of developing and validating new concepts and technologies and the regulatory, social, environmental and economic changes needed to enable a transition to a grid driven by up to 100% RES.

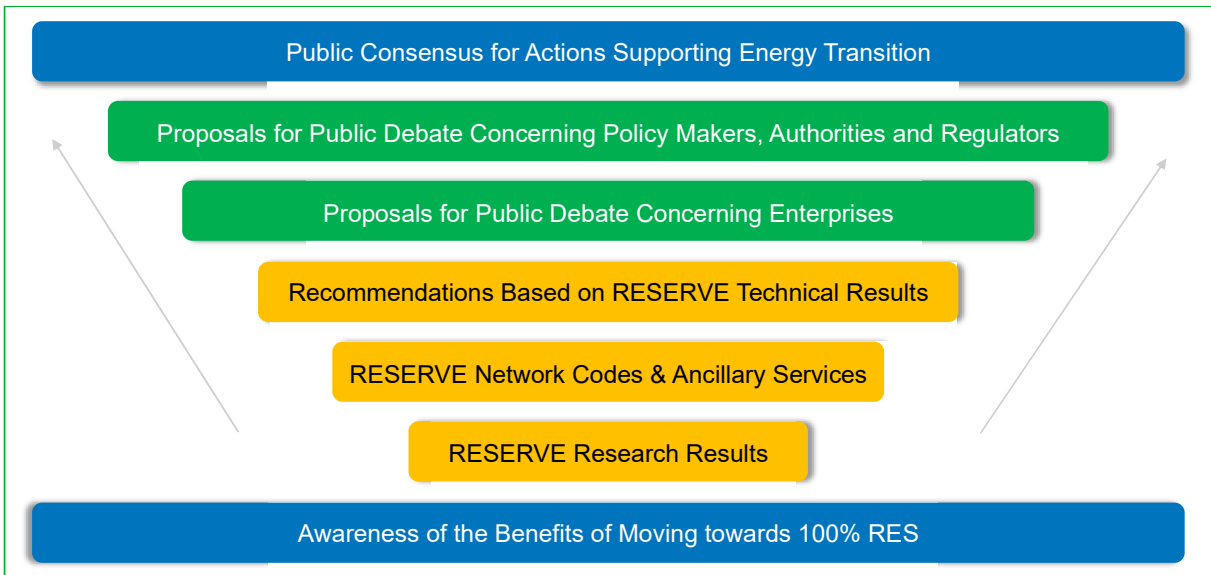


Figure 2.1 Deployment and Impact of RESERVE Recommendations

On this basis, RESERVE has developed recommendations to sector actors. Figure 1 illustrates the process used to define these recommendations. The first recommendation is on the RESERVE network codes and ancillary services. The second one proposes a public debate on five proposals in order to kick off a discussion about the framework for the pathway to 100% RES.

2.1 Recommendations to Sector Actors

# 1	ENTSO-E and system operators should consider adopting RESERVE's updated network codes and new ancillary services structure
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RESERVE has developed proposals for new and updated network codes and ancillary services, which are needed to support the transition to up to 100% RES. They are based on RESERVE's research that has been conducted in the fields of frequency control, power system inertia and voltage control and have been validated in field trials deployed on the Irish grid by the DSO ESB Networks and through simulations based on network data from the Romanian TSO TRANSELECTRICA. RESERVE is involved in an ongoing dialogue with ENTSO-E and EDSO regarding the RESERVE proposals. The modified and new network codes and ancillary services proposed by RESERVE are needed in order to implement a stable power system with a low level of available mechanical inertia. They are intended as the starting points for the development of new standards focused on ensuring the security and restorability of the grid. An extensive list of the RESERVE proposals for updated and new network codes and ancillary services can be found in Deliverables 6.3 and 6.4 [3].

# II	A public debate on how to achieve up to 100% is needed – RESERVE offers six concrete proposals to kick-off the discussion
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During the RESERVE project, partners have held regular discussions on the economic, regulatory and societal changes needed to accompany the successful implementation of the RESERVE technical results in order to enable society to move towards 100% RES. Debates in the field of energy, in particular electricity, are often led by experts but they concern every single private individual. Therefore, it is important that politicians take part in the debate in their role as representatives of the people. We have identified two groups of sector actors who should be in the focus as leaders of a public debate:

- energy system operators, enterprises and prosumers, and
- policy makers, authorities and regulators.

2.2 Suggested Proposals for Energy System Operators, Enterprises and Prosumers

System Operators face major changes in grid structure and grid management due to decentralized and mostly mechanical inertia-free generation. RESERVE suggests a public debate focused on the following proposals:

1)	Energy system operators should consider smart solutions in their investment strategies
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The results of RESERVE propose smart solutions for controlling the grid. Furthermore, RESERVE has developed a programmable inverter which can be used as a wideband grid impedance measurement device. System operators, enterprises (such as Ancillary Service Providers) and prosumers need to consider investing in such advanced equipment.

Current regulatory regimes lack support for investments in services and in measurement systems. Supporting such investments would be a potential action which would promote the transition towards 100% RES. The TOTEX approach, proposed by the EU Winter Package [4], is a first step in this direction.

2)	Due to the volatility of RES, a new energy pricing system is needed to encourage new behaviour and investments
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Currently, private customers and most companies are charged for every kWh of energy consumed. To cover peaks and troughs in renewable electricity generation, storage options are needed for maintaining grid stability. Consumers and enterprises have to be incentivised to use electricity during periods of excess generation and to provide additional storage capacity. To achieve this incentivisation, suitable innovative energy pricing schemes must be put in place. For example, a share of the financial savings achieved through changed consumption behaviour could be allocated to consumers and enterprises.

3)	Energy system operators should investigate the use of 5G features when planning their transition to up to 100 % RES based generation
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Future grid operation requires the ability to perform distributed control of the RES, which are spread out over the distribution grid. Measurements must be gathered from the RES and control actions communicated to them. This requires a communications system that encompasses grid control centres, substations and the distributed RES themselves. RESERVE has placed a particular focus on investigating how mobile 5G technologies can provide the communications capabilities required for 100% RES penetration. In particular, 5G's high resilience and low communications latency make it a suitable technology for distributed control applications.

2.3 Suggested Proposals for Policy Makers, Authorities and Regulators

Policy makers, authorities and regulators must address the harmonisation of the European energy system and introduce legislation to support an energy transition towards 100% RES. RESERVE suggests a public debate focused on the following proposals:

4) Further open balancing markets to enhance the participation of owners of RES and storage systems

RESERVE proposes lowering the entry barriers to participation in balancing markets in order to increase the capacity offered for balancing. In Germany, a recent step in this direction was taken with the lowering of the minimum power generating capacity of participating systems in the balancing markets from 5 to 1 Megawatts, enabling many smaller power generators to participate in balancing markets for the first time.

5) Deploy specific targets for the development of the available storage capacity and provide corresponding incentives for storage investments

Increasing the share of power generation from RES needs to be accompanied by a corresponding increase in the capacity of storage facilities in order to maintain grid stability. Depending on regional variations in electricity generation, appropriate targets for storage capacity need to be established. Depending on the perspective, it is expected — in the case of Germany — a demand for between 83 TWh [5] or even 147 TWh [6] of storage capacity by 2050. The timeframe of these targets should reflect RES integration plans up to the final target of achieving 100% RES by 2050. RESERVE suggests the establishment of an intermediate target for 2030.

Incentives have to support the expansion of storage capacities. A higher amount of decentralized power storage capacity can increase local self-consumption which discharges the distribution grid [7]. According to the German regulations for renewable energy, storage capacity provided to the grid should receive attractive remuneration, even for decentralized and small-scale storage capacity. If the price of storage continues to decrease, incentives could be adjusted in the following years.

6) Introduce legislation which reflects the true cost of energy, considering social and environmental costs

If the costs of pollution and measures required to address the climate change are considered as components of the cost of energy, then conventional power is already costlier than is generally appreciated. In this context, the full cost of energy is not reflected in current electricity prices. For example, the costs of the climate change are not covered by today's electricity prices. Were the full costs of energy to be included in the electricity price, as suggested in recently discussed CO₂ tax proposals, the cost of electricity would rise dramatically. The German Environment Agency estimates about 180 Euro per ton of CO₂ to be today's market price if all environmental costs were to be considered [8]. Switching from fossil fuel electricity generation to renewable energy sources would reduce the total cost of energy through reducing the environmental damage caused by the burning of fossil fuels.

3. Application Examples

3.1 Recommendations Based on RESERVE's Technical Results

RESERVE has developed proposals for new and updated network codes and ancillary services. In practice, the proposals have been made because of the changing structures of energy generation and energy consumption. A stable power system with a low level of available mechanical inertia creates the need for new solutions regarding frequency control and the availability of balancing energy.

D6.4 suggests concrete changes for ancillary services and network codes. For system operators, ancillary services have to be provided, which include a new approach involving a “Defence service” and a “Restoration service” to prevent black-outs stemming from a lack of pulse generators. An input signal for frequency controllers is suggested as an ancillary service. Furthermore, reactive as well as active power for voltage control has to be provided to system operators in order to support grid stability.

For the technical implementation of the new standards, network codes are updated in D6.4. Subsequently, a new generation of converters will be needed in order to support a smarter, faster and more flexible operation of the grid. Also, the relationship between DSOs and TSOs has to consider decentralized electricity generation.

For future applications, the structure and remit of system operators will change. Cooperation has to grow between TSOs and DSOs but also between system operators and ancillary service providers. However, the energy transition towards 100% renewable electricity generation requires new structures of grid infrastructures, but also in remunerations for system operators and upcoming ancillary service providers.

Disruptive changes in consequence of the energy transition will affect many stakeholders. Therefore a broad debate is needed between energy system operators, enterprises and prosumers on the one hand and on the other hand policy makers, authorities and regulators. All identified groups are already involved and their needs have to be considered in order to make the energy transition sustainable. Recent examples of such broad approaches of participation are the movements of “Fridays for Future”, “Parents for Future” and “Scientists for Future”. Within a short period of time, these movements have induced the public interest in the climate crisis to rise strongly. Another example would be that of the so-called Coal Commission in Germany, which has been created to negotiate the termination of coal and lignite mining. The Commission was created out of the main stakeholder groups and tried to find a compromise in the field of the tension of climate, employment and dependencies on other countries in terms of energy carriers and energy supply.

3.2 Proposals for Public Debate Concerning Enterprises

The changes in the energy supply towards volatile renewable generation with a low share of mechanical inertia will be followed by the necessary changes in energy-related enterprises. All participants — i.e. generators, system operators, service providers and prosumers — are invited to debate on the proposals made here. With a higher amount of decentralized generation and natural variations of renewable generation, smart solutions can help to control the grid more efficiently. The programmable inverter, developed by RESERVE, can help to manage the grid faster and more targetedly. To open up the sector towards smart and software-based solutions, regulatory regimes must be adapted. Currently supported investment strategies are based on hardware. With the proposed TOTEX approach of the EU Winter Package [4], a first step in the direction of recognizing the mixed structure of grid management has been made. To enforce this development, further discussions are needed and new stakeholders, such as ancillary service providers, should be involved in this debate. Also, other service providers who play a role in the digitalization of the grid should be included. The use of the new communication standard 5G should be discussed. With a minimum of latency, a real-time controlling of the grid is possible, and frequency management will become more efficient.

With the changing of the focus towards services and software-based management, not only will the investment strategies have to be adapted but also a debate on the pricing system in general will have to be allowed. In this context, also the energy-based remuneration (EUR/kWh) has to be questioned. RESERVE consortium expects that consuming energy and providing storage within certain timeframes will be even more beneficial in future and should be considered in the pricing structure. Consumers and enterprises have to be incentivised to use electricity during periods of excess generation and to provide additional storage capacity. For example, a share of

the savings achieved through changed consumption behaviour could be returned to consumers and enterprises. The availability on demand for storage or energy can be supported by integrating other energy streams, such as the heating sector or the mobility sector, into the strategy of a holistic energy supply in future. So-called sector coupling should be part of the discussions that stakeholders hold.

3.3 Proposals for Public Debate Concerning Policy Makers, Authorities and Regulators

The energy transition is a fundamental change concerning large infrastructures as well as behavioural aspects of society. Consequently, policy makers, authorities and regulators need to address the harmonisation of the European energy system and introduce legislation to support an energy transition towards 100% RES. The suggested debate that RESERVE consequently addresses is about opening up the balancing market and deploying specific targets for the development of storage capacity. Also, the debate on a new pricing system should be taken up. Prices of certain products or actions have to not only reflect the benefit to the system but also take into account the impact on society and the environment. If the costs of pollution and measures required to address the climate change are considered as components of the cost of energy, then conventional power is already costlier than is generally appreciated. To reflect these costs in the energy prices, it is suggested to implement a pricing structure that is not only reliable on the needs of the grid but also on the true costs. With the recently discussed CO₂ tax, the costs for coal- and lignite-generated power would rise dramatically. Thus, the investment in renewable generators would be even more beneficial. For instance, Switzerland has implemented a CO₂ tax with a general compensation for tax payers. This model supports the idea of charging persons and industries which consume an over-average amount of energy. In a public debate, the model could be adapted to implement a pan-European system where the impact on the environment and on society is taken into account.

To support the positive effect which such a pricing structure would have on new investments in renewable energies, also storage capacities have to be created. Depending on regional variations in electricity generation, appropriate targets for storage capacity need to be established. The timeframe of these targets should reflect RES integration plans, up to the final target of achieving 100% RES by 2050. According to the goals of the total amount of renewable generation, a total goal of the amount of storage capacity could be set. Also, the different needs for storage should be reflected in these targets to meet the requirements of the future grid infrastructure. With incentives, according to the German Renewable Energy Act, storage capacity provided to the grid should receive attractive remunerations. This is suggested not only for large-scale storage capacities but also for small-scale and decentralized storage. Ancillary service providers could also take advantage of this if more decentralized storage was available to control the grid via decentralized storage capacities.

To accelerate the idea of small-scale decentralized generation and storage, RESERVE suggests a debate on opening up balancing markets to enhance the participation of RES and storage system owners. Also, ancillary service providers could enter the balancing market more easily. Similarly to the German measure taken for the balancing market, the lowering of the minimum power generating capacity from 5 to 1 Megawatts could bring an added value to the European system. It should be discussed whether the model of ancillary service providers and an adapted pricing structure would help to make the European infrastructure more flexible and able to support the more volatile renewable generation up to 100%.

4. Conclusion

The recommendations and suggestions made here are based on a comprehensive stakeholder analysis, on a technical assessment towards up to 100% RES generation and on the consideration of societal needs.

RESERVE suggests two recommendations to system operators, enterprises and prosumers as well as to policy makers, authorities and regulators. In a strongly regulated market system like the energy market, regulations can be enablers or barriers of change. Hence, in a disruptive change like that of the energy transition, authorities, policy makers and regulators will have a massive impact on the success of the process of transition. To set pan-European standards in hardware, software and regulations is one of the most important tasks that authorities will have to deal with in the next years in order to implement renewables.

Also, the harmonisation of the market system has to be promoted by the authorities and policy makers who are in charge. Only with a harmonised grid can Europe design its energy transition in the most efficient way. The proposed network codes support this pursuit.

RESERVE's recommendations are addressed to system operators and other enterprises in Europe. The recommendations are also addressed to existing companies as well as to new entities. A structural change in the market system will lead to new challenges within the electricity distribution system.

Furthermore, RESERVE suggests a public debate on six points concerning energy system operators, enterprises and prosumers as well as policy makers, authorities and regulators.

The future market model will benefit from interactive solutions coordinated with information technologies. Services, such as the provision of ancillary services or balancing power, will have an impact on pricing and investment structures. Following that, next to a new pricing system also an open balancing market should be discussed in order to enhance smaller units of generation or storage. The expansion of storage should also be supported by set goals of policy makers comparable to the goals in renewable generation.

The results of RESERVE provide recommendations and suggestions for a broad discussion. Assessed by the baseline approach of sustainability, stakeholder groups have been identified, clustered and considered within the suggested solutions. By implementing the developed findings, climate goals in Europe will be strongly supported and the energy transition will be a success. A harmonised pan-European grid with a possibility of generating up to 100% of electricity via renewables will be the result of the discussion initiated by RESERVE's proposals and recommendations.

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6. List of Abbreviations

ASP	Ancillary Service Provider
CSR	Corporate Social Responsibility
DSO	Distribution System Operator
kWh	Kilo-Watt Hour
MW	Mega-Watt
PV	Photovoltaic
RES	Renewable Energy Sources
TOTEX	Total Expenditures
TSO	Transmission System Operator
TWh	Terra-Watt Hour
WP	Work Package