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**Research and Innovation Action**

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Next generation innovative technologies enabling smart grids, storage and energy system integration with increasing share of renewables: distribution network

**Starting date of project:** 1<sup>st</sup> of October 2017

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## D7.9 – Post project impact plan

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## Deliverable reviews

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## Contributions of partners

Description of the contribution of each partner organisation to the work presented in the deliverable.

Partner	Contribution
<b>UdG</b>	Contributions to future collaboration, future dissemination, communication and research activities
<b>UPC</b>	Contributions to regulations, future collaboration, future dissemination, communication and research activities
<b>SIN</b>	Deliverable reviewer and task leader, contributions to broad scale rollout, future collaboration, future dissemination, communication and research activities
<b>JR</b>	Deliverable owner and main contributor.
<b>ICOM</b>	Deliverable reviewer, contributions to future collaboration, future dissemination, communication and research activities
<b>EYPESA</b>	Contributions to DSO business, future collaboration, future dissemination, and communication activities
<b>CS</b>	Contributions to future collaboration, future dissemination, communication and research activities

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773715

## Acronyms and abbreviations

APT	Advanced Persistent Threat
BRIDGE	European Commission initiative which unites Horizon 2020 Smart Grid, Energy Storage, Islands, and Digitalisation
CPS	Cyber Physicals System
DG	Distribution Grid
DSO	Distribution System Operator
CAPEX	Capital Expenditure
EERA	European Energy Research Alliance
GEODE	European association made up of European local distributors of gas and electricity companies
ICT	Information and Communication Technologies
LV	Low Voltage
OPEX	Operational Expenditure
PED	Power Electronic Device
PMU	Phasor Measurement Unit
RES	Renewable Energy Systems
SIG	Stakeholder Innovation Group
TOTEX	Total Expenditure
TSO	Transmission System Operator
WAMS	Wide Area Monitoring System



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## Executive Summary

This document describes the identified areas and actions where the RESOLVD partners plan to be active and get involved in the future to create a sustainable impact. To do so, the consortium identified six fields in order to generate a long-term and maintained impact of the achievements made in the project. The plan addresses regulations, DSO business, broad-scale rollout opportunities, collaborations, dissemination and communication activities as well as research activities.

Concerning regulation, the need to change the Capital expenditures (CAPEX) DSO remuneration to Total expenditures (TOTEX) DSO remuneration has been detected, which would fully exploit the potential of locally distributed renewable battery-powered resources. The partners will continue to promote a change of regulation to the TOTEX approach via different activities like future research activities in incorporating this approach, by organizing seminars and workshops to disseminate this approach and by performing interactions with the regulators at the national level to promote the need for a remuneration model change. For the DSO business, it has turned out that the impact on their business and digitalization efforts benefit a lot, when the company is participating in R&D projects such as RESOLVD. Furthermore, the creation of new companies and new business models are triggered. Stakeholder and SIG members indicated that the RESOLVD solution has the potential for a large-scale roll out in Europe and 38% think that this is possible within 5 years. Future opportunities for collaboration were identified and the different partner skills support a joint application. An annual symposium, scientific dissemination, workshops, conferences and interaction with the SIG are the dissemination and communication activities that will also create a post project impact. Finally, future research activities will contribute to a sustainable impact.

## 1. Introduction

The goal of RESOLVD is to increase the observability and controllability of Low Voltage (LV) electricity distribution networks by the use of innovative ICT, power electronics and sensor infrastructures. This RESOLVD approach facilitates the increase of renewable distributed energy resources in the low voltage grid, which have a positive impact on efficiency while ensuring the quality of supply.

### 1.1. Document Objectives

The objective of this deliverable is to provide a plan that exploits the built network in order to generate a long-term and maintained impact of the achievements made in the project, including further research activities and planned diffusion into regulation bodies. Apart from scientific publications and direct impact via innovative business models and exploitation possibilities outlined in D.6.5, this deliverable describes also other opportunities that can enable a far-reaching impact even beyond the end of the project. The main opportunities identified for the post project impact are the following:

- Impact on regulations
- Impact on DSO business
- Broad-scale rollout opportunities
- Future collaborations
- Future dissemination and communication activities
- Future research activities

### 1.2. Document structure

This section summarizes the work presented in each of the chapters in the report.

Chapter 2 describes regulation issues and a hybrid model called Total expenditures (TOTEX). Chapter 3 describes, from the perspective of a DSO, the impact of participation within R&D projects such as RESOLVD on their business and digitalization efforts. Chapter 4 outlines the views of the SIG members regarding a broad-scale rollout of the RESOLVD solution. In chapter 5, future collaboration opportunities among the partners were identified. Dissemination and communication possibilities in the future are outlined in Chapter 6. Chapter 7 describes future research activities of the partners impacted by the RESOLVD experience. Chapter 8 concludes this report.

## 2. Impact on regulations

The RESOLVD partners published a whitepaper [1] that contains also an analysis of the current regulations and the upcoming regulation initiatives as well as recommendations for the standardization and regulatory bodies. Regarding the DSOs Remuneration one thing has to be accounted for, namely the role of the DSO in the new paradigm shall go a step further and change from a passive management approach, based mainly on years-in-advance network planning plus solving incidences occurring to the infrastructure via network investments, to an active role with constant intervention on the grid.

This change also implies a variation on the DSOs business model and thus sets out if the actual national remuneration model of DSOs fits the new paradigm where, although investments in grid expansion and reinforcement will still be needed, the main aim of the DSO will be the second-by-second management of the feeders to keep the system operating within its margins.

In terms of financial revenues, until today, the business model of DSOs has been based on Capital Expenditure (CAPEX) remuneration, where DSOs are being paid a certain amount for each asset needed to update the grid. Now, the Operational Expenditure model (OPEX) is arising as a possible best fitting alternative for the new paradigm, where DSOs' remuneration comes from the service provided to the grid and not purely from the purchase of assets.

The Energy Research Centre of the Netherlands, in the document [2] from 2007, studied how DG penetration can affect revenues of DSOs business models. At that moment, and still, now, CAPEX was the widespread remuneration method for DSOs and TSOs. Conversely, the document concluded that, while the penetration is low or medium, the appropriate remuneration model may be OPEX due to the predominant regulation of the grid over grid expansion investments. However, if the DG penetration is higher, the appropriate model is not so clear, and thus it can be concluded that further studies would be needed for suggesting a hybrid model.

In [3], from 2014, a deeper look at the effects of DG penetration on DSOs business models gave a conclusion that the tasks assigned to DSOs need to be examined to properly assess the possible change of remuneration model. The possible effects of DG penetration on the remuneration methods found were:

- Decrease of OPEX costs when compared to the classic approach.
- Uncertainty about the effects on CAPEX costs. On the one hand, in the long run, using DER for grid operation can decrease these costs. However, significant short-term expenditures for investment into Smart Grid infrastructure will be needed.

The authors concluded that new regulations would need to focus on incentivizing active system management to cushion the initial costs of DG penetration, such as new investment and grid losses. This leads to a hybrid model where OPEX and CAPEX remuneration models are both applied, also known as Total Expenditure (TOTEX). Pre-conditions for implementing such a model are:

- Redefine actual OPEX and CAPEX structures, including new assets and categories.
- Incentivize the optimal choice between grid investment and active management.

Last but not least, document [4] remarks the weight of the distribution network in the forthcoming years based on the expected, by the International Energy Agency, €600 billion investment in a 20-year period, of which 80% will be allocated on the development of the distribution network. Other than that, it introduces the notion of CAPEX remuneration cost-based (as normal) and OPEX remuneration incentive-based, which should remunerate DSOs according to KPIs related to operational efficiency, system sustainability, etc. This remuneration change of scheme should affect the way that distribution costs are allocated among end-users; in other words, it can

stimulate the DSO to define innovative grid tariffs to direct the consumption or production of grid-users in a system-efficient way [5]. Finally, it also highlights the crucial role of R&D, demanding new member state regulations where demonstration expenses are not treated like other costs owing to their expected benefit for the grid.

From the RESOLVD project perspective, it is necessary to continue work in actions to promote a change of regulation to the TOTEX approach. In particular, the partners foresee the following activities:

- The approach of TOTEX should be included into the ongoing and future research activities, in order to study the remuneration models and approaches needed for a working business model for the use of flexible assets
- Publication of research in open access reports, journals and conference papers, with the goal to promote the need for a remuneration model change
- Organization of seminars and workshops, in order to disseminate the TOTEX approach
- Personal talks and discussions with the regulators at the national level



### 3. Impact on DSO business

Estabanell strengthens its commitment to innovation in the electricity sector, fostering its vision of projecting the results for the improvement of its own network. In addition, Estabanell will explore the creation of new companies and new business models that help diversify its activity and its participation in R&D & I projects, both nationally and internationally, linked to the operation and maintenance of distribution networks and the new energy markets. To do this, it will continue to invest in the digitalization of processes, the deployment of advanced supervision of the electrical network at any voltage level and in low and medium voltage control systems based on power electronics, through its participation in national calls and Horizon Europe.

These new companies from Estabanell will focus on serving the DSO and aggregators sector and thus obtain a complete catalog of functionalities and expertise with great added value, which will allow the market launch of a horizontal solution, "OpenGate for Smart Grids". This will aim at forming a platform serving as a technological base for the management and interoperability of the electricity networks of the future and can be adopted by the players in the sector as an accelerating element of their digital transformation.

This has also been identified in the field of flexibility, as well as the opening of new debates and development of innovative solutions in relation to this mission so that a safe, efficient and clean energy for the 21st century needs to be guaranteed and thus contributing to greater knowledge for the development of the activities of these start-ups. These start-ups need to play a role of an active agent in the energy transition in terms of promoting the entry of new technological solutions and agents to the sector, offering state-of-the-art energy management and strategy models to their clients, and expanding transfer capacities of knowledge to the company.

Therefore, it is an opportunity for industrial development, which may be materialized through technology companies, distributors and utilities with a high interest in innovation / disruptive technologies.

The potential businesses for DSOs are related to the commitment to the large-scale deployment of PEDs with first, second and even third life batteries with the objective of covering:

- Deployment of PED in sites with second-life batteries in buildings and electric mobility recharging centers.
- Deployment of PED access points to networks of telecommunications operators with first-life and / or second-life batteries.
- Deployment of PED together with second and even third life batteries in substations and locations of the distribution network that may require storage.

Estabanell has always been very active and involved in technologies based on power electronics, distribution networks, energy markets, flexibility, and big data and plans to exploit the results through the newly founded companies.
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## 4. Broad-scale rollout opportunities

### 4.1. Feedback from the Stakeholder

To capture the views of the stakeholder regarding the creation of a sustainable impact on the European energy environment, the stakeholders at the final event were asked about their impression regarding a broad scale rollout of the RESOLVD solution.

To gather this information, the following questions were addressed by the participants:

- To what extent do you agree with this statement: 'RESOLVD solution has potential for large scale roll-out in Europe'?
- In your opinion, what barriers could negatively influence the broad scale roll-out of RESOLVD outcomes?
- In what time frame do you see large scale roll-out happening (considering DSO challenges in the near future)?

In total 32 Stakeholders at the final event participated in that survey and gave the following answers listed in the following subsections.

#### 4.1.1. Feedback about the potential for a large scale rollout

More than 90% of the stakeholders participating in the survey found that the RESOLVD solution has the potential for a large scale rollout.

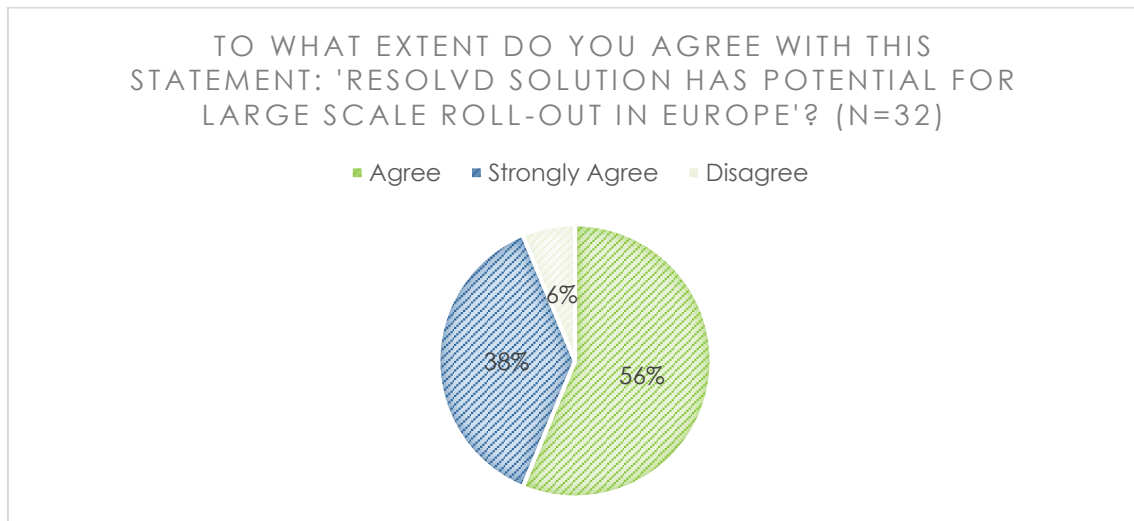


Figure 1: Answer to the potential for a large scale rollout

#### 4.1.2. Feedback regarding barriers

Nearly half of the participants in the survey think that regulations are the biggest obstacles for a broad scale rollout. Besides that, 34% think that business related issues might have a negative influence. Finally, 19% of the respondents believe that integration from the technical perspective would be the biggest barrier.

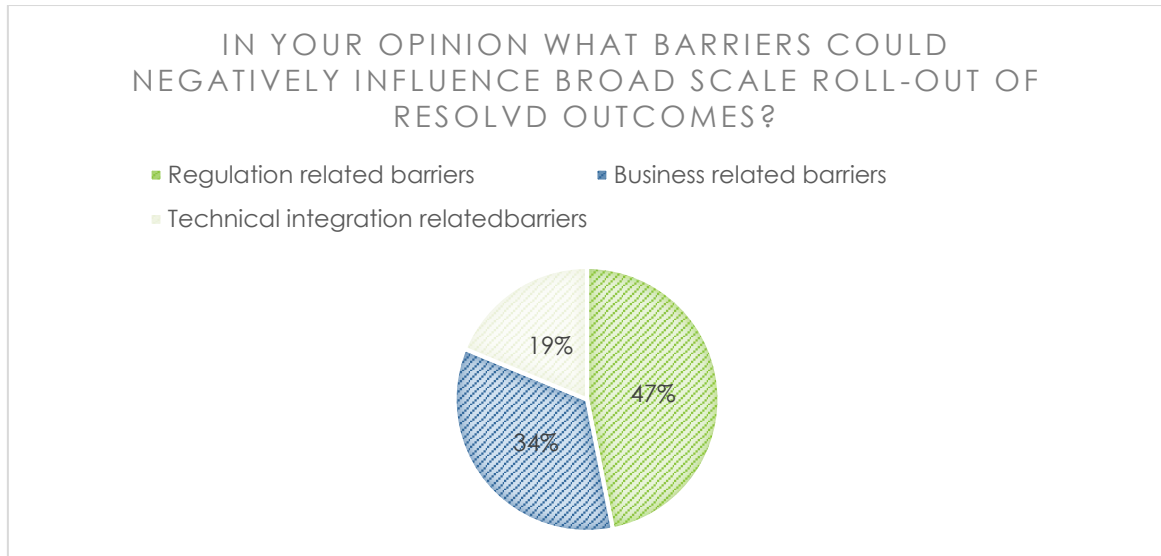


Figure 2: Answer regarding barriers

#### 4.1.3. Feedback to the time frame

The majority - 56%, of the participants of the survey voted that they expect this to happen in 5 to 10 years. But still, 38% of the respondents think that this will happen within the next 5 years, which is very promising and motivating. Only 6 % have the opinion that it is still too early for such a solution.

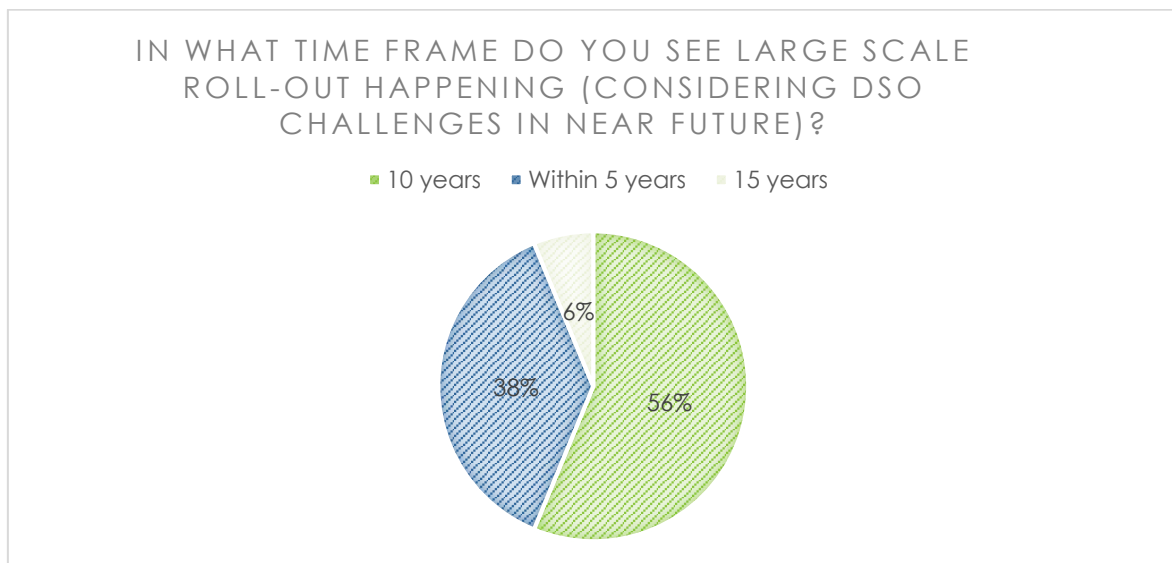


Figure 3: Answer the possible timeframe

#### 4.2. Rollout factors

The consortium members identified the following factors supporting or opposing a smooth rollout.

Supporting:

- An innovative solution that can be adapted to multiple situations;
- An integrated solution;
- A single integrator should be in charge of the solution;
- External amplifiers could be used for this: BRIDGE, technological platforms, and alliances (e.g.: EERA, GEODE, etc.);
- Patch- and Change management.

Opposing:

- A clear regulatory framework is needed;
- The economic feasibility of the solution should be clear;
- Individual setup needed.

The survey indicated that the RESOLVD solution has the potential for a large scale rollout in Europe. This is a very positive result and supports the overall and individual exploitation plans of the partners listed in Deliverable 6.5.

## 5. Future collaborations

The different business orientation of the individual partners encourages the efforts to undertake another joint project to further leverage or expand the expertise gained in RESOLVD and to further utilize the different partner skills. This section identifies opportunities in the context of European or international funded possibilities where the RESOLVD partners see opportunities to further leverage or expand their expertise gained in RESOLVD.

### 5.1. Horizon Europe

Several upcoming Horizon Europe calls could be identified as a suitable opportunity for a future collaboration. Due to the various draft work programmes available during the preparation of this report, no uniform notation was applicable. A short description of the calls is listed in Annex !. Table 1 list the calls and denotes the interest of each individual partner.

HEU calls in year 2021	CS	EYPESA	ICOM	JR	UdG	UPC	SIN
C5-D3-ESGS-16-2021: Reinforcing digitalization related know-how of local energy ecosystems	x	x	x	x	x	x	
C5-D3-ESGS-05-2021: Reliability and resilience of the grid: Measures for cybersecurity, vulnerabilities, failures, risks, and privacy	x	x	x	x	x	x	x
C5-D2-CS-05-2021: Positive Energy Districts			x		x	x	x
C5-D3-ESGS-08-2021: Demonstration of advanced Power Electronics for application in the energy sector	x	x				x	x
CL3-2021-INFRA-01-01: European infrastructures and their autonomy safeguarded against systemic risks	x	x		x			
CL5-2021-D3-01-05: Increasing energy system flexibility based on sector-integration services to consumers (that benefits system management by DSOs and TSOs)	x	x	x	x	x	x	x
CL5-2021-D3-01-04: Energy Sector Integration: Integrating and combining energy systems to a cost-optimised and flexible energy system of systems,	x	x	x	x	x	x	
MISS-2021-CIT-01-01: Supporting national, regional, and local authorities across Europe to prepare for the transition towards climate neutrality within cities		x			x	x	
CL5-2021-D2-01-12: Fostering a just transition in Europe		x					x
CL5-2021-D3-01-11: Establish the grounds for a common European energy data space		x		x	x	x	x
CL5-2021-D4-01-03: Advanced data-driven monitoring of building stock energy performance	x	x		x	x	x	x
HEU calls in year 2022	CS	EYPESA	ICOM	JR	UdG	UPC	SIN
C5-D2-CS-15-2022: Positive Energy Districts			x		x	x	x

C5-D3-ESGS-11-2022: Interoperable solutions for flexibility services using distributed energy storage	X	X	X		X	X	X
C5-D3-ESGS-13-2022: Demonstration of innovative forms of storage and their successful operation and integration into innovative energy systems and grid architectures	X	X	X			X	X
C5-D3-ESGS-03-2022: Supporting the action of consumers in the energy market and guide them to act as prosumers, communities, and other active forms of active participation in the energy activities	X	X		X	X	X	X
CL3-2022-INFRA-01-02: Autonomous systems used for infrastructure protection	X			X			
CL3-2022-CS-01-01: Improved monitoring of threats, intrusion detection, and response in complex and heterogeneous digital systems and infrastructures	X		X	X			
CL5-2022-D3-01-10 Interoperable solutions for flexibility services using distributed energy storage	X	X	X		X	X	
CL5-2022-D3-01-13: Energy system modelling, optimisation and planning tools	X	X	X		X	X	

Table 1: Partner interested in specific call

## 5.2. Other tenders

Besides Horizon Europe the flowing calls were identified as potentially suitable, but no further steps were undertaken with regard to submission.

**ERANET: Joint Call 2020 (MlCall20) on digital transformation for green energy transition**

Source: [https://www.eranet-smartenergysystems.eu/Calls/EnerDigit\\_Calls\\_funding/Joint\\_Call\\_2020](https://www.eranet-smartenergysystems.eu/Calls/EnerDigit_Calls_funding/Joint_Call_2020)

Scope: By accelerating the implementation, adaption and knowledge creation of digital solutions in energy systems and networks, this call supports the following objectives:

- Advance the green energy transition in all sectors of the energy system while ensuring security of supply
- Shaping new transnational business and investment opportunities by sector coupling and development of new value chains in innovative and cost-effective energy solutions, thereby creating new employment opportunities and contributing to the development of an environmentally sustainable financial growth
- Ensuring social sustainability and coherence with digitalisation in other sectors in the progression of the green energy transition

**JOINT CALL FOR PROPOSALS FOR RESEARCH AND INNOVATION PROJECTS ON URBAN TRANSFORMATION CAPACITIES**

ERA-NET Cofund Urban Transformation Capacities

Source: [https://jpi-urbaneurope.eu/wp-content/uploads/2021/02/Joint-Call-for-Proposals\\_ENUTC\\_1.2.pdf](https://jpi-urbaneurope.eu/wp-content/uploads/2021/02/Joint-Call-for-Proposals_ENUTC_1.2.pdf)

<p>Scope: The goal of this call is to generate transnational research and innovation projects to support capacity building for urban transformation. The call addresses the topics and challenges crosscutting:</p> <ul style="list-style-type: none"> <li>• Urban circular economies;</li> <li>• Community-based developments and urban innovation ecosystems; and Robust and resilient urban infrastructure and built environment.</li> </ul>
<p><i>Next Generation EU</i></p> <p>Source: <a href="https://ec.europa.eu/info/strategy/recovery-plan-europe_en#nextgenerationeu">https://ec.europa.eu/info/strategy/recovery-plan-europe_en#nextgenerationeu</a></p> <p>Scope: Instrument to help repair the immediate economic and social damage brought about by the coronavirus pandemic. Post-COVID-19 Europe will be greener, more digital, more resilient, and a better fit for the current and forthcoming challenges.</p>

Table 2: List of other tender possibilities

<p>Future collaborations are actively planned and, as can be seen in Table 1, there are two calls where all partners are interested in. Considering that the final and official version of the Horizon Europe Work Programme is not officially available at the time of writing this deliverable, no formal preparatory steps have been initiated in this regard. According to currently available information, the Work Programme should be published by the end of April 2020. This date is just before the planned final review of RESOLVD and the partners agreed to address the issue of a joint submission at that time again.</p>
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## 6. Future dissemination and communication activities

Due to the COVID19 pandemic, a lot of fairs and conferences were postponed and later changed to virtual events. This also affected the planned dissemination and communication activities that should have been taken place during the project duration.

In the following sub-chapters, all actions related to further dissemination and communication activities are listed.

### 6.1. Annual Symposium post-RESOLVD

The UPC plans, after the project finalization, to organize a yearly symposium in the field of smart grid and renewable energy integration in distribution grids.

The objective of this symposium is:

- Exchange of knowledge on ongoing activities in the field
- Dissemination of results of related research and innovation project
- Exploitation of results so far of RESOLVD and other activities
- Exploring collaboration possibilities between the partners, e.g.:
  - Exchange of researchers
  - Preparing proposal for future calls in Horizon Europe or similar
  - Sharing data and common publications.

The symposium should be open for partners outside of the RESOLVD project if the field of expertise fits in the initiative. The event will be held in an online format. A preliminary agenda and date for the first event are presented below.

### Symposium on smart grid and renewable energy integration in distribution grids

#### Agenda

**Date:** 8/2/2022 (preliminary)

**Place:** Zoom Meeting

10:00-10:15	Welcome	UPC
10:15-10:30	PED and further power electronic development	UPC
10:30-10:45	Prediction of renewables and related services	UdG
10:45-11:00	Recent development of ICT integration	ICOM
11:00-11:15	Break	
11:15-11:30	Recent development in PMU and WAMS	CS
11:30-11:45	Recent development in the DSO business	EST
11:45-12:00	Recent cyber threats in the smart energy environment	JR
12:00-12:15	Break	
12:15-12:30	Exploitation	SIN
12:30-13:00	Discussion on the further collaboration	UPC
13:00-13:15	Next steps	UPC



## 6.2. Scientific dissemination

For the results of the research done in the project that could not be published during the project duration, the plan is to preferably publish them in Journals, and if possible, in open access journals. Possible Journals and conferences are Energy, Applied Energy, International Journal of Electrical Power & Energy Systems, IEEE Transactions of Smart Grid, Sustainable Energy, Grids and Networks, Energy research and Social Science, Energies, Transactions on Sustainable Energy (IEEE), IEEE Intelligent Systems, Applied Artificial Intelligence, Engineering Applications of Artificial Intelligence. IEEE International Conference on Innovative Smart Grid Technologies Europe, IEEE International Conference on Smart Grid Communications, IEEE International Conference on Power and Energy, International Conference and Exhibition on Electricity Distribution (CIRED), International Joint Conference on Artificial Intelligence (IJCAI), European Conference on Artificial Intelligence (ECAI), etc.

UdG will promote joint publications with current RESOLVD consortium partners.

## 6.3. Workshops

Event	Date	Description of activity
RESOLVD Norway workshops	Between April and June 2021	4 workshops with Norwegian DSOs and other industry actors to discuss exploitation opportunities for the RESOLVD solutions.
ASEME workshop	TBD	Explain and share the specific uses from Associates DSO perspective and analyze new profitable investments
GEODE	TBD	Explain and share the specific uses from Associates DSO perspective and analyze new profitable investments
ENTRA	TBD	Explain and share the specific uses from Associates DSO perspective and analyze new profitable investments

Table 3 List of planned workshops

## 6.4. Conferences

The following dissemination and communication activities were identified:

Event	Date	Description of activity
Enlit Europe, Milan, Italy	30.11.-2.12. 2021	
SIN Partner conference	21.10.2021	Yearly conference targeting SIN's partner organisations from the 2 industrial clusters, startups from the in house incubator, and municipalities SIN provides services to.
Annual Industrial Forum at Politechnical School (Girona)	Yearly	Booth presence of UdG presenting to local industry, data driven methods to provide enhanced energy grid services, flexibility solutions, tools focusing on the efficient operation of the LV grid.
Summer School of Fault Diagnosis	Biannual	The group participates in the organization of the biannual International summer School of Fault Diagnosis of Complex Systems.
CIGRE symposium 2021	1.06 – 4.06.2021	The topic of the Symposium will be "Reshaping the Electric Power System Infrastructure".
<a href="#">15th Conference of Slovenian Electric Power Engineers CIGRE-CIRED</a>	19.10-21.10.2021 (Annual)	The conference will provide the opportunity to meet and discuss with experts and companies that shape the Slovenian electric system of today and of tomorrow.

Table 4 List of planned conferences

### 6.5. Stakeholder innovation group

To maintain activity with the Stakeholders innovation group (SIG) is very important to increase the long term impact of the developed RESOLVD components and to obtain hints from that community network in what direction further improvements should be made.

- **CS** is certainly interested in keeping contact with the stakeholders innovation group in order to analyze potential collaborations in the future as a follow-up on the activities developed by the company during the project execution.
- **EyPESA** is interested to participate in further SIG activities. They can contribute with the DSO perspective and electrical network upgrade based on RESOLVD solution, as well as with driving new challenges. No additional budget is required for the occasional participation.
- **ICOM** can carry on its participation in this initiative. Should the scope of it remain as it is now (i.e. occasional participation on domain specific workshops) no additional budget will be needed.
- **JR** can participate in workshops or similar follow-up activities. In case of physical events, some travel budget may be needed.
- **UdG** will certainly maintain contact (via mail, linked-in group, etc.) with the SIG members. At this stage, no specific activities are planned, but future collaborations could be considered.
- **UPC** can participate in further activities related to the PED and related power electronic solutions. A budget for these activities should be granted.
- **SIN** has the capability to maintain activities with SIG. The additional budget will be from future project funding. We shall also use finances from the RESOLVD Norway project.

The planned dissemination and communication activities listed above will have an impact at different levels. As mentioned in D7.6 there are still 6 journal publications submitted or under preparation which will create a significant post project impact. Due to the COVID19 pandemic, every partner is now familiar with virtual meetings and the planned symposium in August which is also open for partners outside of the RESOLVD project, and which offers a good opportunity of knowledge exchange. A continuation is also planned, so that after the first event organized by UPC, such a symposium will be held annually in the future, with a new main responsible partner and evolving agenda topics. Such an event also offers an opportunity to use the established networks such as the SIG to promote things and discuss new themes in this application area.

All partners commit to maintain the activity with the SIG, and this indicates that the composition of the members was well chosen and that their opinion is still in demand. Due to the active participation of SIG members in various events in the past, future participation can be expected and will also be planned (e.g. annual symposium).

RESOLVD has been invited in the future ENLIT event, which will be a good opportunity to show the results to a broader audience.

## 7. Future research activities

Based on the individual research expertise the partners obtained via RESOLVD, the following planned research activities will broaden the post project impact.

### 7.1. CS

The RESOLVD project helped the CS team to get a deeper insight into the real problems of the DSO from the field. Consequently, the research activities led to the development of a hybrid edge-cloud framework, which is specifically designed for environments with poor connectivity and capable of supporting PMU-based applications. The focus of CS in the RESOLVD project was in showcasing the applicability of fault localization on the proposed framework. The plan for the future is to extend the functionality of the framework and to continue with a research on related topics such as demand-response and phasor-based control for RES. For such an approach algorithms will need to be implemented partially at the edge and partially in the cloud. The RESOLVD project and all of the aforementioned topics are positively affecting the CS research group in terms of one on-going PhD work.

### 7.2. ICOM

Implementation of novel tools that will become part of the toolbox offered to the DSOs for the sake of enhanced monitoring and control of the distribution grid. Implementation of novel tools for the aggregation, optimization, management, and trading of demand side flexibility.

### 7.3. JR

Based on the Security by Design method, which incorporates the risk-based Threat modelling approach, JR will continue research in the area of formal verification and probabilistic model checking.

AI based cyber-attack detection methods are also being researched, with the goal to identify advanced persistent threats (APTs) in cyber physicals systems (CPS) of critical infrastructures such as the systems at the energy domain.

Adversarial AI will impact the threat landscape by volume and velocity of attacks and in a way that was once impossible when human interaction was necessary. To secure systems, and also the in-house-AI, against such adversarial AI attacks is a very challenging task, and it is a research topic of JR.

At the area of privacy preserving technologies, federated data analytics is one area where JR is interested in.

### 7.4. UdG

Permanent and senior members of the group belong to the **Electronic, informatics and Automatic Department**, where they lead the course on "AI a basic research tool" under the umbrella of the Doctoral School and coordinate the [Master on Industrial Internet of Things](#). RESOLVD results are positively impacting UDG activities in terms of research, teaching and training:

- PhD has finished during the project (Data-Driven Approaches for Event Detection, Fault Location, Resilience Assessment, and Enhancements in Power Systems Sustentation expected: Jan 2021)
- 1 on-going PhD: Flexibility management in interconnected microgrids (Marc Cañigüeral)
- 1 potential candidate for new PhD - Master thesis on smart grids Automation (Alex Segura, member of the group)
- Talent recruitment, through the application of post-doc National and TECNIO SPRING (Marie-Curie) fellow-ships
- Case study on LV smart grids and SGAM analysis in the degree subject: "Smart grids" (degree on Electric engineering and degree on Industrial electronics and Automation).

UdG will continue its research on data driven methods to provide enhanced energy services. Particularly the efforts will be put on the development of flexibility solutions, tools and energy grid services, targeting the resilient and efficient operation of the LV grid. UdG has already presented the project *FLEXibility Management for Energy Communities (FLEMA)*, pending resolution at the moment of writing this document, to the Spanish Funding Agencies.

UdG could consider complementary disciplines in collaboration with other Research groups, such as SSH (Social Science and Humanities), to provide also a citizen centric approach in the context of the energy transition.

### 7.5. UPC

The role of the UPC in RESOLVD was to develop advanced power electronic technology together with innovation in the use of batteries for the grid. The UPC research group is keen to continue with the following research actions:

- a. Explore enhanced capabilities of the PED. In this action, the research group will present research projects related to the new capabilities of the PED to national research and innovation agencies. The idea is to develop a proof-of-concept project for these new capabilities.
- b. Increasing efficiency and feasibility of the solution. For now, the power electronic usage is limited due to the investment cost of the solution and the operation cost (which is related to losses). The UPC will investigate new materials and switching technologies to lower equipment costs and losses. National and international projects are aimed.
- c. Explore AI and edge computing technologies for the PED. The operation of the PED is constrained by different external values given by the grid and imposed by the situation of the grid operation. In this sense, an automated learning algorithm can help to anticipate the operation setpoints and help to lower the reaction time of the system.

Furthermore, innovation activities are also foreseen:

- d. Elevate the TRL of the solution. The PED has been tested in a relevant environment, but for exploitation of the prototype, we need to elevate the TRL and industrialize for mass production of the prototype. Schemes like SME Instrument could be the vehicle to transfer the technology to interested SMEs and ask financing to implement the path to the market.

RESOLVD results are positively impacting UPC activities in terms of research, teaching, and training: 1 on-going PHD: PMU measurements and AI based grid planning (Antoinio Saldaña). Furthermore, a case study on LV smart grids and SGAM analysis in the degree subject: "Smart grids" (degree on Energy Engineering at the UPC).

### 7.6. SIN

SIN has strong expertise in business creation, as such future research will focus on developing business models for innovations.

SIN shall continue working to bridge the gap between innovation and market entry for innovation through its strong business development team.

SIN has a strong focus on the digitalization of the energy sector and will continue working with innovation happening in this area.

<p>The excellent scientific dissemination during the project period, resulting in 18 conference publications and 7 accepted and 6 queued journal publications, allows conclusions to be drawn about future publication trend. This, together with the extensive list of planned research activities at different TRL levels show the potential of the partners, which is partly based on the knowledge gained in RESOLVD, and will be distributed in future.</p>
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## 8. Conclusions

The goal of RESOLVD is to increase the observability and controllability of Low Voltage (LV) electricity distribution networks by the use of innovative ICT, power electronics and sensor infrastructures. This deliverable identified the following opportunities that can have an impact even beyond the end of the project:

- To fully exploit the potential of locally distributed renewable battery powered resources the capital expenditures (CAPEX) DSO remuneration should be changed to total expenditures (TOTEX) DSO remuneration. Traditionally, DSOs are making their investment decisions based on the investment for novel assets following national regulation that are using schemes to remunerate the Capital Expenditure of those investments. With the establishment of market-based procedures to use flexibility in distribution networks, it is needed to explore new hybrid approaches, also taking into account the Operational Expenditure (OPEX).
- For the DSO business of Estabanell, it has turned out that the impact on their business and digitalization efforts benefit a lot when they are participants of R&D projects such as RESOLVD. Furthermore, the creation of new companies and new business models are triggered to serve the DSO and aggregators sector.
- More than 90% of the Stakeholder and SIG members surveyed indicate that the RESOLVD solution has the potential for a large scale rollout in Europe. 38% of the surveyed respondents think that this is possible within 5 year and in particular, that regulatory restrictions could have a negative impact on this.
- The different partner skills favoring a future joint project applications, and in total 2 upcoming opportunities were all partners are interested in, were identified.
- Further dissemination and communication activities were identified ranging from a symposium, scientific dissemination, workshops and conferences up to the commitment to maintain the interaction with the SIG.
- An extensive list of planned research activities at different TRL levels shows the potential of the partners and their future ambitions.

The project plans to address the above mentioned opportunities in the following way:

- The partners will continue to promote a change of regulation to the TOTEX approach and therefore foresee future research activities in incorporating this. They will promote the need for a remuneration model change, organize seminars and workshops to disseminate the TOTEX approach and perform interactions with the regulators at the national level.
- Estabanell's newly founded companies will serve the DSO and aggregators sector with new business models.
- The RESOLVD partners will address the issue of a joint submission at the beginning of May after the Horizon Europe Work Programme is officially released.
- Six journal publications (submitted or under preparation) will create significant post project impact. Further dissemination and communication planning includes an annual symposium, planned participation in workshops and conferences as well as the maintained interaction with the SIG.
- Further ongoing or planned research activities will contribute to the sustainability of the results.



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## Annex I: Upcomming Horizon Europe Calls

The following Horizon Europe calls could be identified as suitable opportunity for a future collaboration. Due to the various draft programs available during the preparation of this report, no uniform notation was applicable. The call description are from drafted versions of Cluster 5 - *Horizon Europe - Work Programme 2021-2022 Climate, Energy and Mobility* and Cluster 3 - *Horizon Europe - Work Programme 2021-2022 Civil Security for Society*.

### Year 2021

***HORIZON-CL5-2021-D3-01-05: Increasing energy system flexibility based on sector-integration services to consumers (that benefits system management by DSOs and TSOs)***

Scope: The projects will test and develop further, already demonstrated solutions for data-driven energy services for consumers, in cooperation with various actors in the energy system (such as prosumers, aggregators, TSOs, DSOs, owners of assets that can provide flexibility like batteries, heating/cooling systems, charging point operators, gas systems)

***HORIZON-CL5-2021-D3-01-04: Energy Sector Integration: Integrating and combining energy systems to a cost-optimised and flexible energy system of systems***

Scope: Projects should demonstrate the benefits of the integration of different elements. This includes, in particular electricity and gas networks, district heating and cooling, and long term energy storage systems (for example, Hydrogen, power-to-X, thermal storage, hydro-storage).

***MISS-2021-CIT-01-01: Supporting national, regional and local authorities across Europe to prepare for the transition towards climate neutrality within cities***

Scope: Projects should contribute to the transition towards greater sustainability and should engage relevant actors to build a greener Europe and support the achievement of the Agenda 2030 on Sustainable Development Goals bringing together regions, local communities, civil society, industry and schools.

***C5-D3-ESGS-16-2021: Reinforcing digitalisation related know how of local energy ecosystems***

Scope: The digitization of the future will not be created only by leading digital technologies but also by knowledge on and from the application areas of these technologies as well as a range of methods and strategic tools. The creation/reinforcement of local digitalisation-of-energy ecosystems as a way to support a competence cluster for digital energy concepts affecting operators, consumers/prosumers, and authorities, which enable them to be autonomous to react to local energy transition needs.

***C5-D3-ESGS-05-2021: Reliability and resilience of the grid: Measures for cybersecurity, vulnerabilities, failures, risks and privacy***

Scope: Projects should demonstrate the increased energy system reliability and resilience following disturbances, faults, cyberattacks, terrorism, etc., at all relevant levels. Therefore, advanced information technologies (e.g. probabilistic safety assessment, quantitative risk analysis) and digital technologies for ensuring operational data quality and demand patterns recognition for data access and information acquisition to maintenance operators should be used. The project should aim to create a shared knowledge about threats, vulnerabilities, and methods within Europe.

***C5-D2-CS-05-2021: Positive Energy Districts***

Scope: The project should address issues related to the effective and impactful transformation of cities and Positive Energy Districts, which are crucial elements of cities of the future. The concept of scales is essential to scale to city scale later and to meet the 2050 climate goals for which cities play a pivotal role.

***C5-D3-ESGS-08-2021: Demonstration of advanced Power Electronics for application in the energy sector***

Scope: Projects should intend to produce, test and validate Wide Bandgap-based (WBG-based) switching semiconductors such as Silicon Carbide (SiC) for converter station application which enables higher power density, operation voltages, temperatures, and frequencies while reducing heat dissipation of the PE.

***CL3-2021-INFRA-01-01: European infrastructures and their autonomy safeguarded against systemic risks***

Scope: Projects should address the interconnected infrastructure systems and focus on the systemic dimension and complexity of attacks and disruptions by cyber or physical means that need to be addressed.
<b>CL5-2021-D2-01-12: <i>Fostering a just transition in Europe</i></b>
Scope: Projects should enhance the understanding of the challenges of the “just transition” to climate-neutral and environmentally sustainable economies and societies, as envisaged in the European Green Deal and Next Generation EU
<b>CL5-2021-D3-01-11: <i>Establish the grounds for a common European energy data space</i></b>
Scope: Projects should develop, validate and demonstrate an Energy Data Space that enables access to and use of energy data, comparison with different solutions.
<b>CL5-2021-D4-01-03: <i>Advanced data-driven monitoring of building stock energy performance</i></b>
Scope: Projects should enhance the collection and quality of energy and related data for buildings through various sources such as manufacturers' data, BIM and digital twin models, surveys, digital logbooks, sensors, meters and interfaces.

Table 5: List of relevant Horizon Europe calls for 2021

## Year 2022

<b>C5-D2-CS-15-2022: <i>Positive Energy Districts</i></b>
Scope: The project should address issues related to the effective and impactful transformation of cities and Positive Energy Districts, which are a crucial element of cities of the future. The concept of scales is essential to scale to city scale later and to meet the 2050 climate goals for which cities play a pivotal role.
<b>C5-D3-ESGS-11-2022: <i>Interoperable solutions for flexibility services using distributed energy storage</i></b>
Scope: The objective is to develop interoperable distributed storage technology to enable the seamless utilization and monetization of storage flexibility within a real life environment.
<b>C5-D3-ESGS-13-2022: <i>Demonstration of innovative forms of storage and their successful operation and integration into innovative energy systems and grid architectures</i></b>
Scope: Demonstration of successful operation and integration of either standalone or combined innovative storage solutions (e.g. chemical, electrical, thermal, mechanical including e.g. compressed air/liquid, super-capacitors, innovative hydropower storage solutions) into innovative energy systems and grid architectures.
<b>C5-D3-ESGS-03-2022: <i>Supporting the action of consumers in the energy market and guide them to act as prosumers, communities and other active forms of active participation in the energy activities</i></b>
Scope: Projects should develop innovative tools and tailored solutions in order to fully enable a new type of interactions between citizens as consumers, prosumers and (members of) energy communities and foster participation in energy (in particular electricity) markets.
<b>HORIZON-CL5-2022-D3-01-10 <i>Interoperable solutions for flexibility services using distributed energy storage</i></b>
Scope: The objective is to develop interoperable distributed storage technology to enable the seamless utilization and monetization of storage flexibility within a real life environment.
<b>HORIZON-CL5-2022-D3-01-13: <i>Energy system modelling, optimisation and planning tools</i></b>
Scope: Advanced modelling tools to perform regional / cross-border and cross-energy vector system planning and optimisation on a long time horizon, where cross-sectoral disruptive innovations in industry, mobility and building sector can be included.
<b>CL3-2022-INFRA-01-02: <i>Autonomous systems used for infrastructure protection</i></b>
Scope: Projects should address pandemics such as the COVID-19 crisis and other health risks that have the potential to massively disrupt the functioning of infrastructures and vital societal functions. Therefore, targeted solutions to ensure continuity of operations of different services and supplies, which are also critical to allow for prevention, preparedness and response to pandemics, should be developed.
<b>CL3-2022-CS-01-01: <i>Improved monitoring of threats, intrusion detection and response in complex and heterogeneous digital systems and infrastructures</i></b>





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Scope: Project should guarantee at every moment the availability, controlled performance and reliability of digital infrastructures together with their connected devices, which are characterised by complex interdependencies involving various physical and logical layers and connecting a wide range of legacy IT solutions and innovative technologies.

Table 6: List of relevant Horizon Europe calls for 2022