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Demonstration of innovative forms of storage and their successful operation and integration into innovative energy system and grid architectures

AGISTIN

Advanced Grid Interfaces for innovative STorage INtegration

D7.2: Mid-term Communication, Dissemination and Exploitation Plan

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AGISTIN
Advanced Grid Interfaces for innovative STorage INtegration

Version history

VERSION	DATE	COMMENT
V0.1	*27-11-2024*	*FIRST DRAFT – EEU/EASE*
V0.2	*16-12-2024*	*REVIEWED VERSION*
V1.0	*18-12-2024*	*FINAL VERSION*

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EXECUTIVE SUMMARY

AGISTIN is a Horizon Europe project running from 2023 to 2026, Aiming at enabling industrial grid users to rapidly deploy renewables through advanced integration of innovative energy storage technologies at the interface with the grid. Rapid decarbonisation of industry through electrification, the growth of renewables, and the need for grid stability present a unique opportunity for new forms storage of storage and integration schemes to emerge. The main objectives in the project are to develop new forms of energy storage that meet grid needs for short-duration flexibility and stability, reduce the impact of new, large demand on the grid, and reduce costs for large grid users through innovative storage integration. The project will carry out two demonstrations and three test activities on renewable hydrogen electrolysis, irrigation pumping and fast electric vehicle charging.

The project is organized into seven work packages (WPs), with WP7 focusing on “Dissemination, Communication, and Exploitation.” WP7 is divided into two tasks: Task 7.1, which covers Dissemination and Communication Actions, and Task 7.2, which involves the Exploitation and Business Plan Rollout.

The D7.2 deliverable, titled ‘Mid-term Communication, Dissemination and Exploitation Plan’ is an update of D7.1 First Communication, Dissemination, and Exploitation Plan including project identity and website report, submitted in month 6 of the project (June 2023). This document highlights the progress made in the 18 months after D7.1 submission, and unveils the plans for the subsequent months, aiming to maximize the project’s impact.

This deliverable is structured into two main chapters: Communication & Dissemination; and Exploitation. The Communication and Dissemination chapter outlines the key activities undertaken and their impact, while also highlighting future plans, while the exploitation chapter sets up the initial framework for the Exploitation Plan and provides guidance on market intelligence, business modelling, outreach, and industry engagement for AGISTIN’s project execution.

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ABBREVIATIONS AND ACRONYMS

	Abbreviations and Acronyms
AGI	Advanced Grid Interface
BES	Battery Energy Storage
BoP	Balance of Plant
CAPEX	Capital Expenditure
C&D	Communication and Dissemination
CTR	Click Through Rate
DCE	Dissemination, Communication and Exploitation
DSO	Distribution System Operator
EC	European Commission
EMT	Electromagnetic Transient
ER	Exploitable Results
ES	Energy Storage
EU	European Union
HD EV	Heavy Duty Electric Vehicles
HiL	Hardware-in-the-Loop
IP	Intellectual Property
IPR	Intellectual Property Rights
KER	Key Exploitable Result
KPI	Key performance Indicators
LCA	Life Cycle Assessment
OPEX	Operational expenditure
PM	Person Month
PR	Press Release
PV	Photovoltaic
ROI	Return on Investment
SME	Small-Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
TRL	Technology Readiness Level
TSO	Transmission System Operator
VPC	Value Proposition Canvas
WP	Work Package

1 Introduction

WP7, titled "Dissemination, Communication, and Exploitation," supports the project in conveying its activities and results to the target audience (Technology providers, Industrial grid users, Grid operators, Policy makers and public bodies, Research & scientific communities, Media & journalists, Society at large), through various communication tools and channels, framed within advertising, direct marketing, digital marketing and public relations strategies. WP7 also facilitates the transfer of knowledge to society by setting the grounds for the utilisation of the developed tools and methodologies.

Its objectives are:

- Promote the dissemination and visibility of the results and findings to a wide range of stakeholders through presentations at webinars, technical conferences, publications, the website, social media and newsletter;
- Maximise the communication of project results and findings through exchanges with stakeholders that can be interested in implementing and utilising the project's findings, such as industry representatives, technology suppliers and regional, national and EU authorities;
- Achieve an optimum knowledge management of the project's findings, including appropriate IPR;
- Facilitate technology transfer and implementation of the project's results and findings to interested stakeholder in view of accelerating their exploitation;
- Engage proactively in Communication and Dissemination (C&D) activities with similar projects and initiatives to create synergies and collaborations between EU-funded programmes and other actions.

The WP 7 includes the following list of deliverables:

- D7.1 First Communication, Dissemination and Exploitation Plan including project identity and website report (Report, EPRI) (M06 – submitted on the 30 June 2023)
- D7.2 Mid-term Communication, Dissemination and Exploitation Plan (M24)
- D7.3 Final Exploitation Roadmap including Business Plan and IPR report (M42)
- D7.4 Final Communication and Dissemination Report (M48)
- D7.5 Collection of newsletters and dissemination activities (M48)
- D7.6 AGISTIN EU Positioning paper (M48)

As part of C&D Plan, the project has established effective communication channels and opportunities for regular engagement, creating optimal conditions for stakeholders—including industry representatives, technology suppliers, and regional, national, and EU authorities—to fully leverage the project's findings. This will enable them to integrate the newly developed tools and recommendations into their business models.

AGISTIN Exploitation Plan is a living document, to be upgraded along the project lifecycle, supporting RAGE partners in defining how the results of the project will be used both in commercial and non-commercial settings. The Exploitation Plan covers the entire process from the definition of the business case for the AGISTIN Ecosystem to the creation of the sustainability conditions for its real-world operation beyond the H2020 project co-funding period. The Exploitation Plan will be published in three incremental versions, due at months 6, 24 and 42 of the project lifetime. This early-stage version 1 of 3 is mainly devoted to:

I. Setting-up the structure and the initial building blocks to be populated and completed in the future editions of the Exploitation Plan and to
II. Providing additional guidance for market intelligence gathering, business modelling definition and validation, outreach and industry engagement and ultimately providing insights for the development, validation and evaluation of AGISTIN results across the project´s workplan execution.

These tasks will in turn render suitable inputs to enhance the two future editions of the Exploitation Plan.

2 Communication and Dissemination

2.1. Communication and Dissemination plan overview

WP7 is disseminating AGISTIN's results to a broad range of stakeholders using various marketing tactics and tools, including the project website, social media, public relations, newsletters, events, conferences, workshops, and webinars.

These actions have been employed since the project start to engage target audiences and achieve key performance indicators (KPIs). The targeted stakeholders include technology providers, industrial grid users, grid operators, policy makers and public bodies, research & scientific communities, media & journalists, society at large. A summary of the AGISTIN C&D plan is presented in Table 1, which highlights its objectives, target groups and channels and tools.

Table 1 AGISTIN C&D plan summary

Target Groups	Communication objectives	C&D Channels and Tools
Media & journalists	Fostering public awareness and engagement;	Communication materials: logo; website press releases; social media; videos
Society at large		
Technology providers	Promoting scientific excellence and innovation, addressing the scientific & technical sectors and the transfer to industry;	Videos, leaflets, technical fact sheets, webinars, newsletter
Research & scientific communities	Contributing to knowledge exchange and encouraging students and scientists to evolve in that sector through technology transfer;	Scientific publications, posters, webinars, conferences, workshops, social media, website
	Contribute to build Europe's reputation on R&D&I.	
Industrial grid users **Grid operators** **Policy makers and public bodies**	Creating market demand for the AGISTIN solutions as well as enhancing its exploitation potential;	Webinars, workshops, newsletter, website, social media; newsletters; leaflets
	Achieving optimum knowledge management, including appropriate handling of IPR; implementation and exploitation of the obtained results;	

Each stakeholder has been targeted with specific messages delivered through the most appropriate channels to maximize impact. Additionally, AGISTIN has been collaborating with other projects and initiatives towards leveraging its impact. By creating synergies and partnerships with EU-funded programs and Horizon Europe-supported actions, such as BRIDGE, the project aims to communicate the project's activities and results effectively, facilitating knowledge transfer to society.

2.1.1. C&D Milestones M24

Several landmarks have been crucial in achieving the WP7 objectives in the first 24 months, including:

- Development of Communication, Dissemination and Exploitation plan;
- Development of project visual identity;
- Identification of crucial key players, possible end users and stakeholders for the project and engage them with tailored set of messages and events, as outlined in the Communication, Dissemination and Exploitation Plan;
- Development of website and other communication channels such as social media and newsletter, continuously updated with project progress.
- Production and distribution of several communication materials including video, fact sheets, posters, leaflet, detailing project achievements or specificities.
- Engagement with more than 20 workshops, webinars, and events to disseminate the project with the target audience.
- Active participation in BRIDGE activities and Working Groups.
- Seek synergies with sister projects and other European initiatives.

2.1.1 2.1.2. Tailoring C&D to project outcomes

During the first two years of the project, the partners have achieved the following main outcomes:

- WP2: Study of the relevant regulatory framework and network codes, for the definition of the AGISTIN business models opportunities. Develop methodology to conduct LCA for energy storage integration via AGI by focus grid users
- WP3: Developed a set of generic open-source simulation models for the desired AGI topologies, based on the technical capabilities and requirements.
- WP4: Definition of the AGISTIN Use Cases, deriving technical requirements for testing infrastructure and HiL (hardware-in-the-loop) setup.
- WP5: Electromagnetic Transient (EMT) modelling of Green H_2 demo site and installation of demo components.
- WP6: Development of the long-term modelling and optimization tool for the irrigation system demo site.

In summary, these have been marked with several C&D activities, described in Table 2 with the goal of spreading awareness and engagement, leveraging its impact and optimizing the adoption of some results.

Table 2 C&D specific activities oriented to project outcomes

Project outcomes	C&D activities
Study of the relevant regulatory framework and network codes, for the definition of the AGISTIN business models opportunities	• Two webinars and two videos produced. • Materials disseminated on the website, social media and newsletter.
Developed a set of generic open-source simulation models for the desired AGI topologies, based on the technical capabilities and requirements.	• One video produced. • Materials uploaded on the website, social media and newsletter. • Conference paper
Definition of the AGISTIN Use Cases, deriving technical requirements for testing infrastructure and HiL setup.	• One video produced. • Materials updated on the website, social media and newsletter. • Two conference articles and one poster • One article published on online magazine • One Workshop • One Summer School
EMT modeling of Green H2 demo site and installation of demo components.	• Fact sheets produced about the demo site. • Updates on the lab and demo tests available on the website. • One article published in online magazine.
Development of the long-term modeling and optimization tool for the Irrigation system demo site.	• Fact sheets produced about the demo site. • Updates on the lab and demo tests available on the website. • Participation in ETIP HYDROPOWER webinar • Engagement sessions with local irrigation communities. • Three conference articles • News article submitted to online magazine • Press Release being developed • Video being planned
LCA methodological framework developed.	• One video produced • Deliverable available on social media, website and newsletter. • Webinar scheduled for the 29th January 2025.

Newsletter, website and social media updates are transversal to all outcomes.

2.2. Communication and Dissemination plan update

This section will provide a detailed description of the C&D activities developed until M24, the tools and channels used.

2.1.2 2.2.1. Clustering activities

As part of the project's dissemination approach, we've joined forces with the sister projects i-STENTORE, SINNOGENES and 2LIPP to launch a regular series of collaborative Energy Talks, poised to foster knowledge exchange and networking within the energy landscape. These Energy Talks aim to serve as hubs of innovation in the energy field, where participants can delve into pertinent topics, exchange best practices, and explore emerging trends. By partnering with sister projects i-STENTORE, SINNOGENES, and 2LIPP, the Energy Talks series can leverage the combined audiences and networks of all participating projects. This collaboration significantly amplifies the reach of each project's findings and activities, ensuring a wider dissemination of information to diverse stakeholders within the energy sector.

Furthermore, this series of webinars serve as networking hubs where stakeholders can connect and build relationships, leading to knowledge and best practices exchange and fostering collaboration. In addition, it contributes for project dissemination in a sustained and effective way, ensuring that the outcomes of the projects remain relevant and influential beyond their initial lifecycle. Figure 1 Energy Talks brand identity illustrates the visuals made support the promotion of this initiative.

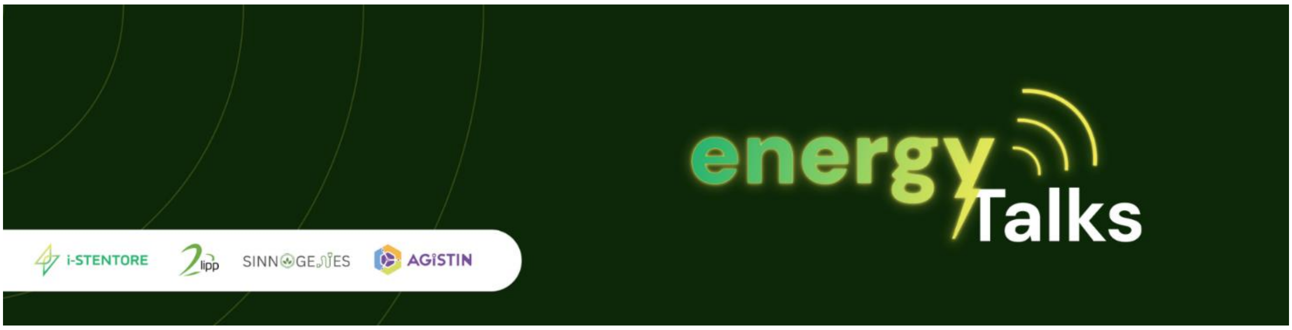


Figure 1 Energy Talks brand identity

To date, four energy talks have been organised. Details of the Energy Talks, including topic, title covered, audience, are in Table 3.

Table 3 List of energy Talks organised to date.

Energy Talk	Topic	Title	Date	KPIs
1	Generic, introduction to projects	Unlocking the potential of innovative energy storage solutions	8th May 2024	Total attendees: 65
2	Grid Connection	Innovative storage integration: bridging the gap between	29th May 2024	Total attendees:

	Codes	industrial needs and grid codes		46
3	Batteries	Advancing Energy Resilience: The Critical Role of Battery Storage in Modern Grids	26th June 2024	Total attendees: 52
4	Repurposing existing infrastructure for green energy	Transitioning to Green Technologies Using Existing Infrastructure	30th October 2024	Total attendees: 16
5	Environment/ Sustainability	Assessing the Environmental Impact of Energy Storage Systems: A Life cycle Perspective	29th January 2025	

Additional partnerships are being built with other projects and initiatives, namely iPlug project and ETIP Hydropower cluster, to cross-pollinate project updates. Under the partnership with ETIP Hydropower cluster, AGISTIN participated in the webinar **Hydropower Plant and Battery Coupling: Advantages and Challenges"** on December 12, where an in-depth look at the work conducted at the Irrigation site demo as part of AGISTIN was presented. More than 100 people attended the webinar. By exposing the project through different channels and raising its profile to diverse audiences, these partnerships ensure a broader dissemination, opening up new avenues for communication and engagement.

2.2.2. Events, Webinar, and Workshops

By M24, the project has been represented in 30 events, including webinars, workshops, conferences, exhibitions, listed below:

- EPRI European Workshop Week 2023
- BRIDGE General Assembly 2023
- Hydropower projects clustering
- TALENT project final event 2023
- SUPEHR23
- Workshop: Advanced laboratory testing methods for modern power systems 2023
- Enlit Europe 2023
- 2nd ILES workshop in Hamburg 2023
- EPRI European Workshop Week2024: Workshop Technology Innovation – Accelerating Innovation Through Collaboration
- EPRI European Workshop Week2024: Workshop: Challenges and Opportunities in the Large-Scale Development of the Hydrogen Economy
- Webinar: Perspectives on Grid Connection Networks for Energy Storage 2024
- EnergyTalks 1, 2024
- 8th Hybrid Power Plants & Systems Workshop on the Azores, 2024
- Energy Talks 2, 2024
- SINNOGENES General Meeting, 2024
- CIRED 2024
- Energy Talk 3 2024

- Workshop Optimising Grid Resilience: Exploring Hybrid Energy Storage And AI Solutions 2024
- I TRI - CIEMAT - CDTI meeting to discuss lines of research 2024
- Smart Grid Ireland Innovation Conference 2024
- Power Systems Computation Conference 2024
- CDC 2023
- Workshop Grid-forming controls, inverter development and P-HIL applications with OPAL-RT
- Summer School on Integration of Local Energy Systems 2024
- I *Congreso del Departamento de Energía del CIEMAT* 2024
- OSMSES 2024
- LOLABAT Final event 2024
- 23rd Wind & Solar Integration Workshop 2024
- ISGT Europe 2024
- Enlit 2024

Among these, several events are particularly noteworthy due to their significant impact and importance to the project. These events will be detailed next.

2.1.2.1 Webinar: Perspectives on Grid Connection Networks for Energy Storage

The first webinar held by the project addressed the main outcomes and results of WP2 T2.1 Task 2.1: Assessing and monitoring regulatory, network code & economic barriers of integrating storages at industrial sites, outlined in the deliverable D.2 Energy storage integration requirements, incentives & constraints, EU-wide analysis.

The webinar was hosted online on the 23rd of May 2024, under the title "Perspectives on Grid Connection Networks for Energy Storage". Project partners and invited speakers decoded the complexity of grid connection network amendments and address the implications of the network codes on grid connection networks for energy storage, making the bridge between the topic and the hydrogen tests and demo under Shell's partner development, following the below agenda:

- Welcome and AGISTIN project overview, Gianluca Lipari (EPRI Europe / AGISTIN Project Coordinator)
- Analysis of Connection Code Recommendations, Ellen Beckstedde (FSR)
- AGISTIN and GCN: Contributions, Enablers and Blockers, Francesca Di Gruttola (RINA) & Thibault Prevost (RTE), AGISTIN WP2
- Analyses of Grid Code Effects on Use Cases
    - AGISTIN project, Saran Ganesh, (SHELL / AGISTIN WP5)
    - i-Stentore project, Antonio Di Pasquale (UNINA)
- Q&A

Figure 2 illustrates the promotion banner designed for social media promotion of this webinar.

Figure 2 AGISTIN webinar promotion banner

The webinar was designed for energy storage developers and operators, electricity generators, grid operators, policymakers, regulators, and research institutions. A total of 46 participants attended the session, which was recorded and is now available on the project website (1).

2.1.2.2 Enlit Europe

The AGISTIN project has participated in two Enlit Europe editions so far. Enlit Europe is the European event gathering the Enlit community to meet and inspire each other and to develop their discussions and actions to take steps forward in the energy transition. It is the main showcase for European projects.

In the two latest editions (2023 Paris and 2024, Milan), AGISTIN was integrated into the EU Projects zone, along with other European projects. Aside from the presence in the exhibition area, the project also participated in two panel sessions, one per year. In the Paris edition of 2023 the project coordinator Gianluca Lipari introduced the project at the session "Large and Small scale storage technologies", sharing the stage with the projects: SINNOGENES, AGISTIN, ZHENIT, GR4FITE3, FLEXCHESS, i-STENTORE. Subsequently, in 2024, the project coordinator participated at the Storage Technologies session, focused on storage technologies that support the grid, alongside projects Hystore, i-STENTORE, AIR4NRG and ThumbsUp. Figure 3 AGISTIN representation in Enlit 2023 and 2024 editions exemplifies projects' representation in the two editions of the event.

Figure 3 AGISTIN representation in Enlit 2023 and 2024 editions

2.1.2.3 AGISTIN/Fraunhofer IWES workshop

The AGISTIN project was presented at the 2nd Workshop on Integration of Local Energy Systems, on the 17th of November, at the Hamburg University of Applied Sciences.

Christoph Kaufmann (Fraunhofer IWES) introduced the challenges and the approaches of Work Package 5 (WP5) "Demonstration of AGI-integrated innovative storage for green H2 production", kicking off the discussions on how to integrate electrolyzers at large scale. After all the pitches, the attendees had a chance to look at the posters in detail, including the AGISTIN poster.

2.1.2.4 Summer school on Local Energy Systems Integration

The AGISTIN project's work on integrating hydrogen into local energy systems was a key component of the 3rd Summer School on Integration of Local Energy Systems, held from August 20th to 22nd 2024. The event offered a comprehensive and hands-on learning experience, where participants explored topics at the intersection of renewable energy, energy storage, electrolyzers, and advanced control systems. The students were introduced to AGISTIN the project converter-control design, modeling tasks, and electrolyzers.

Participants learned to build models of renewable energy plants, develop control systems, and implement them on real-time digital simulators. This deployment of models on real-time digital simulators allows for testing real hardware with those models, such as the rectifier of an electrolyzer, in a power hardware-in-the-loop setup using grid emulators like the Fraunhofer IWES' PQ4Wind. These activities aligned with AGISTIN's Work Package 5 (WP5), which focuses on demonstrating AGI-integrated innovative storage solutions for green hydrogen production, with the goal of enhancing electrolyzer electrical integration, efficiency, and lifetime.

2.1.2.5 EPRI European Workshop Week

AGISTIN participated in the last two editions of the EPRI European Workshop Week, a collaborative event primarily aimed at European utilities. This event fosters an environment for industry leaders and experts to converge and exchange insights. In 2023, AGISTIN showcased its project at an exhibition. In 2024, the project was featured in two different sessions: one highlighting its innovative aspects and the other addressing the grid integration challenges for large-scale electrolysis.

2.1.2.6 Workshop "Optimising Grid Resilience: Exploring Hybrid Energy Storage and AI Solutions"

The AGISTIN project participated in the online workshop "Optimising Grid Resilience: Exploring Hybrid Energy Storage and AI Solutions", on the 25th June 2024, promoted by StoRIES project. The workshop aimed at exploring the latest innovations and applications of hybrid energy storage systems, bringing together experts, researchers, and industry professionals to discuss key challenges, opportunities, and future directions in this rapidly evolving field.

2.2.3. Scientific articles

The scientific publications KPI aims for at least 8 high-impact publications on innovative storage integrated by the AGI in leading journals and conferences, with a target of 3 publications per year in scientific journals. As of month 24, the scientific contributions are summarized in Table 4.

Table 4 Scientific publications M1-M24

Number	Title of publication	Type
1	**The influence of grid-forming loads on transient stability**	Conference paper
2	**Beyond Blueprint: EPRI's Vision and Strategies of the Hybrid Energy Future in 2024**	Workshop paper
3	**Utilising the potential of demand side flexibility of an energy community for increasing the hosting capacity of distribution grids**	Conference paper
4	**MIMO Grid Impedance Identification of Three-Phase Power Systems: Parametric vs. Nonparametric Approaches**	Conference paper
5	**Optimal Dynamic Ancillary Services Provision Based on Local Power Grid Perception**	Other
6	**Dynamic Ancillary Services: From Grid Codes to Transfer Function-Based Converter Control**	Article in journal
7	**Redesign of Large-Scale Irrigation Systems for Flexible Energy Storage**	Conference paper
8	**Multi-physics operation and sizing optimisation in Pyomo: Application to large irrigation systems**	Conference paper
9	**Assessing compliance of power park modules with future grid-forming capability requirements**	Workshop paper

The project follows an open science-based approach, planning to make all publications accessible to the community through gold open access, which means they will be freely available without subscription or access fees. At a minimum, all publications will adhere to a green open-access strategy, where authors self-archive a version of their work in a repository, making it freely available after any embargo period.

2.2.4. Newsletters

The AGISTIN newsletter aims to keep stakeholders informed and engaged by regularly sharing updates, milestones, and insights from the project. It serves as a key communication tool to disseminate important information, foster collaboration, and highlight the project's progress and achievements. The newsletter usually follows the same structure:

1) A cover story, which is the main article and includes a photo, infographic, or video. This could be a significant milestone, an important outcome, or a major news piece.

2) Updates on past and upcoming events related to the project are included,
3) Recent communication pieces, like press releases and media coverage,
4) Resources such as deliverables, scientific publications, key project documents, and various communication materials.
5) Contact information, EU acknowledgment and an option to unsubscribe are provided to ensure transparency and accessibility.

Published biannually in June and December, the newsletter targets a diverse audience, including the scientific community, policymakers and industry professionals. Currently, it is constituted of 98 contacts . Figure 4 Partial screenshot of AGISTIN 3rd Newsletter illustrates the latest newsletter sent.

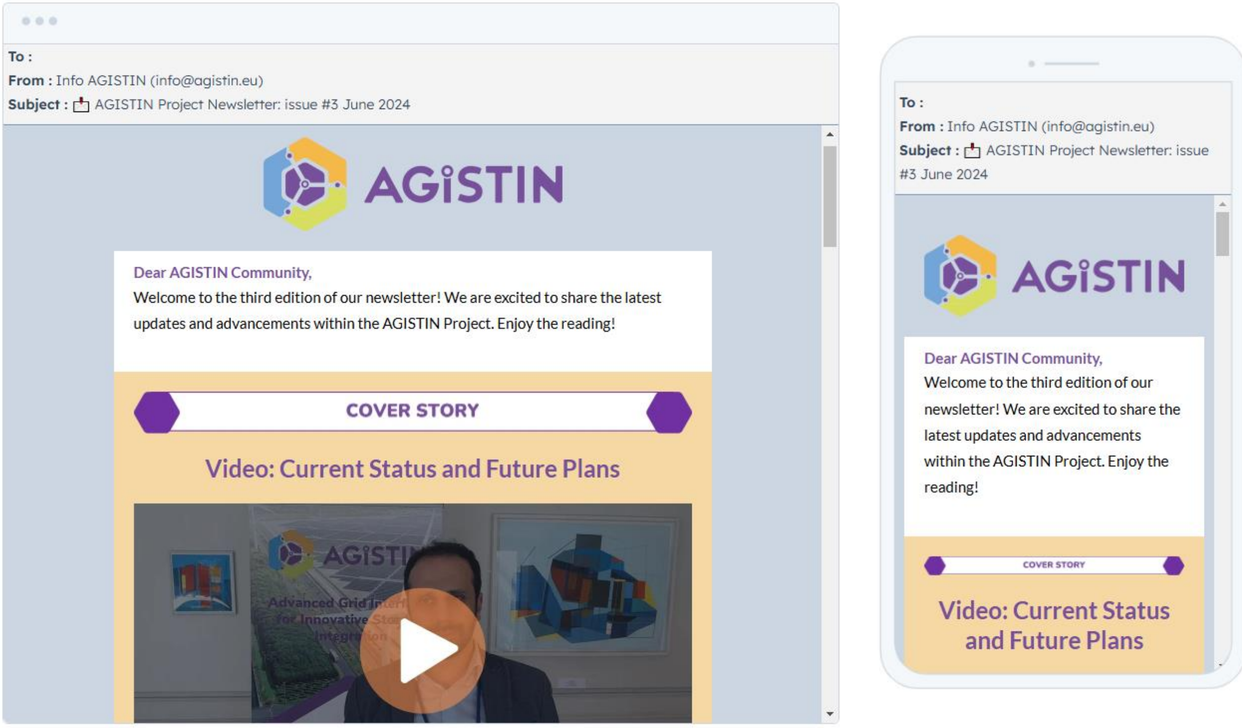


Figure 4 Partial screenshot of AGISTIN 3rd Newsletter

To prepare each issue, an email is sent one month in advance to WP7 contacts, requesting their contributions and afterwards is reviewed by the project leader to ensure accuracy and relevance before being sent to all project partners and email subscribers. It is also shared on social media platforms and the project website.

Key performance indicators for the newsletter include publishing more than two issues per year, achieving over 100 subscribers overall, and maintaining a click-through rate of more than 30% per issue. Table 5 provides the analytics related to the three issues sent.

Table 5 List of newsletters sent and respective analytics

Nb	Date of release	Size of mailing list	Open rate*	Click rate**	unsubscribers	link
#1	30/06/2023	94 contacts	**28.72%**	3.19%	1	http://epri-4296276.hs-sites.com/agistin-project-newsletter-1-june-2023
#2	14/12/2023	35	**31.43%**	11.43%	0	https://epri-4296276.hs-sites.com/agistin-project-newsletter-issue-2-december-2023
#3	02/07/2024	92	**20.22%**	6.74%	1	https://epri-4296276.hs-sites.com/%F0%9F%93%A9-agistin-project-newsletter-issue-3-june-2024

The fourth project newsletter will be sent in December 2024.

2.2.5. Fact sheets

The AGISTIN solutions are being tested in two field deployments. The Spanish demonstration pilot will illustrate the potential of using irrigation systems as an energy storage medium; while the Dutch pilot will exemplify the use of energy storage and advanced control to maximize the use of renewables in a renewable hydrogen generation facility.

To allow for a comprehensive understanding of what are the solutions being tested and the expected impact of those, a fact sheet for each one of the demos have been developed, following the project visual identity, and shared in the project main channels: website, social media and newsletter. Figure 5 provides a screenshot of the two factsheets, which are available on the website (2).

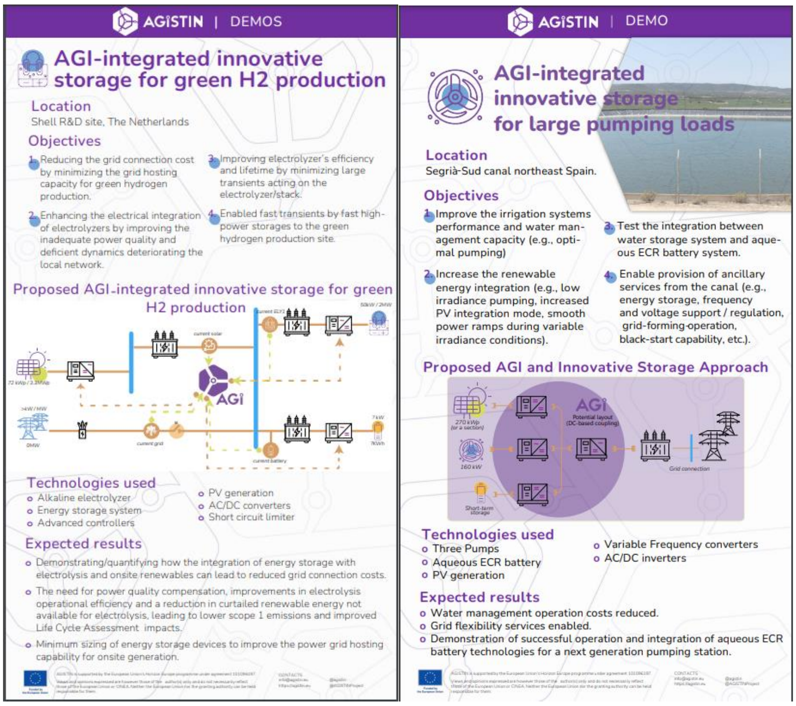


Figure 5 Project demo sites fact sheets

2.2.6. Videos

The project video has been delivered on M6. It's a motion graphics video highlighting project objectives and innovative aspects. The video was disseminated on social media, website, newsletter and events. In addition to this video, the project has created a series of one-minute videos, pitching project's public technical deliverables published to date, emphasizing the main outcomes and their contributions to the overall project objectives. The goal of these videos is to capture attention, increase downloads, and boost deliverables readership. The videos showcase the following deliverables:

- D2.1 Energy storage integration requirements, incentives and constraints: EU-wide analyses
- D3.1 Topologies for common AGI of identified combinations
- D4.1 Use case identification and test infrastructure set-up
- D2.2 LCA methodology for storage integrated in AGI

These videos are available on the website (2), were disseminated on social media and during the project exhibition at Enlit Europe 2024. Another video about the irrigation systems demo is being planned.

2.2.7. Website

The project website (3) went live in M2 of the project. It contains comprehensive information about the project and is continuously updated with progress, activities, and resources. To date, 24 news pieces and events have been added to the website. Additionally, nine deliverables and milestones are available for download, along with nine papers, posters, and fact sheets. Finally, broader communication materials are also accessible (2). Additionally, visitors can subscribe to the newsletter through the website. Figure 6 shows an overview of the site visitors and behaviour over time, since analytics became active in February 2023 until this deliverable was written in November 2024. While Figure 7 shows visitors' geography, allowing us to testify the widespread and reach of the project awareness.

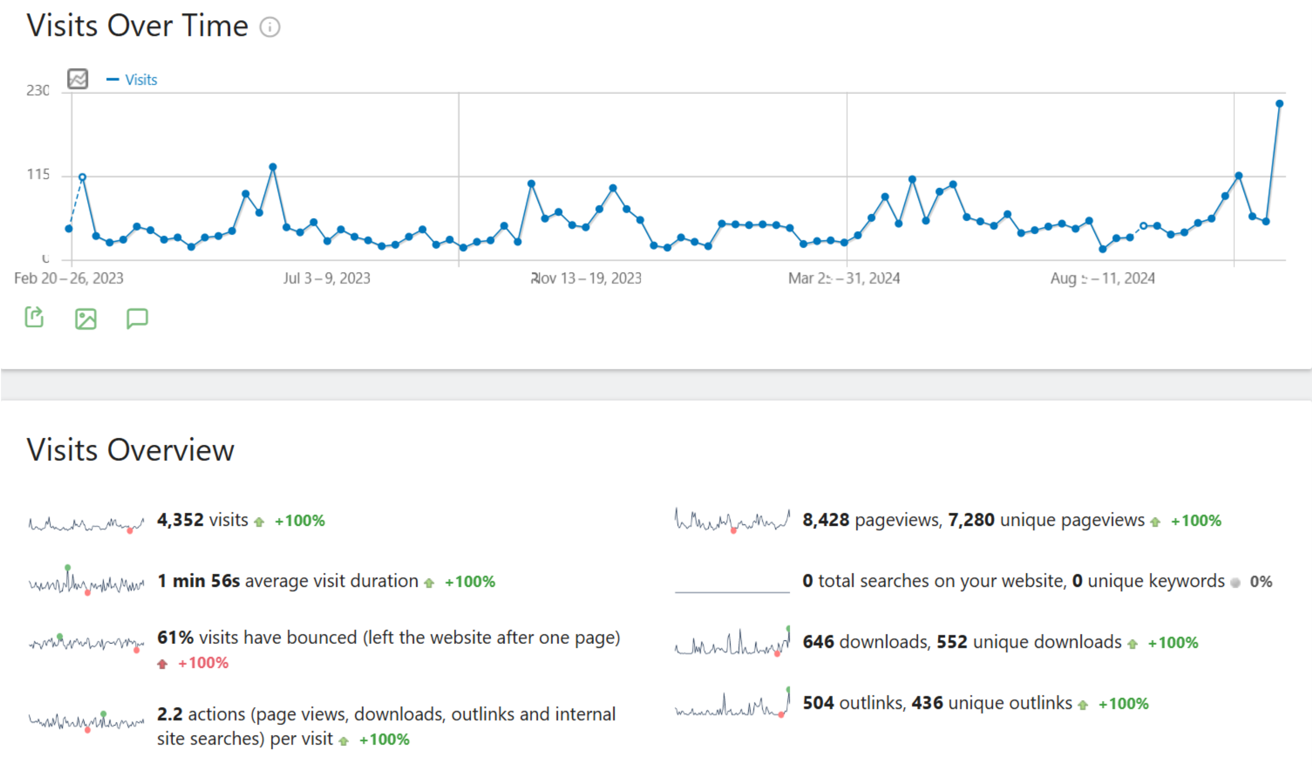
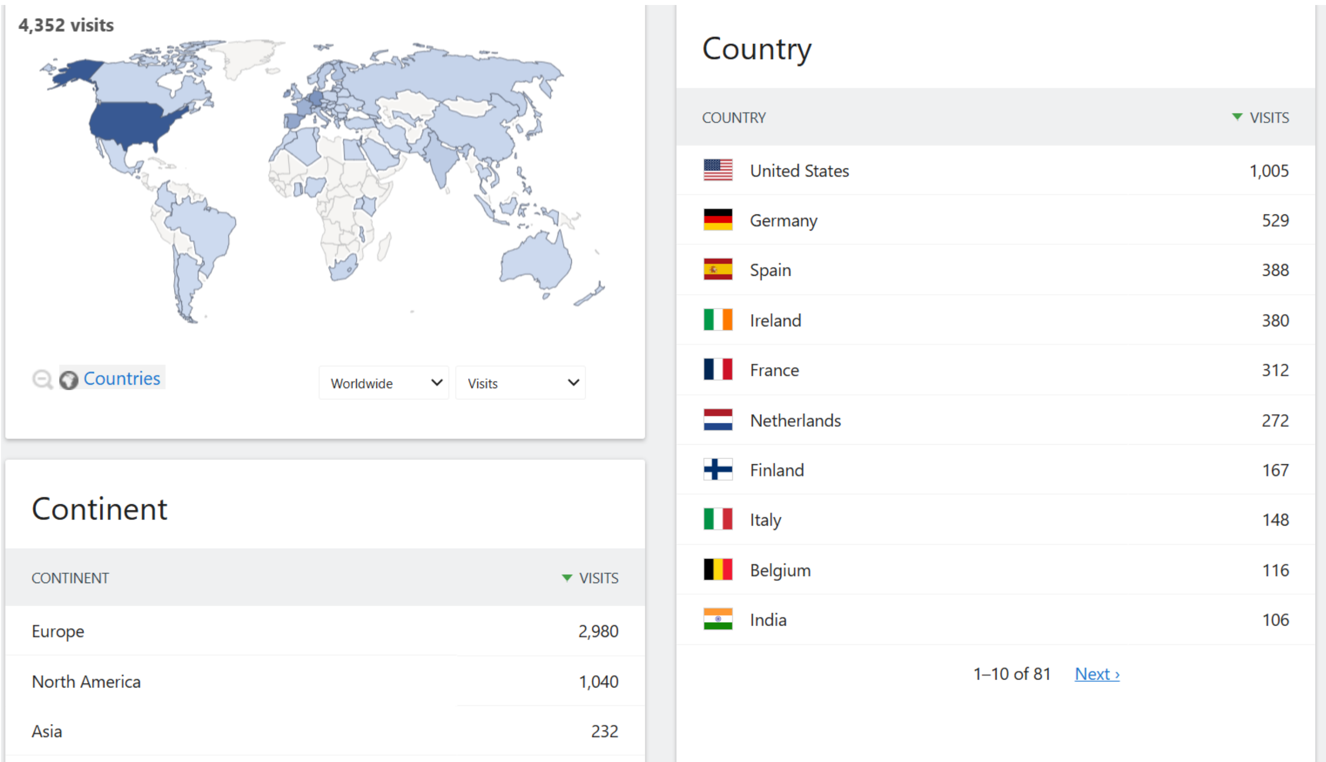


Figure 6 Website analytics summary overview



Continent

CONTINENT	VISITS
Europe	2,980
North America	1,040
Asia	232

Country

COUNTRY	VISITS
United States	1,005
Germany	529
Spain	388
Ireland	380
France	312
Netherlands	272
Finland	167
Italy	148
Belgium	116
India	106

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Figure 7 Website visitors geography

Figure 8 shows the most downloaded resources available on the website. This proves the high level of interest and engagement from the audience, highlighting the value and relevance of the materials the project provides.

DOWNLOAD URL	UNIQUE DOWNLOADS	DOWNLOADS
/wp-content/uploads/2023/02/SoA-Connection-Network-Codes.pdf	55	67
/wp-content/uploads/2023/10/AGISTIN-Demo-Irrigation-Canal.pdf	52	57
/wp-content/uploads/2023/12/Fact-Sheet-H2-Demo.pdf	37	44
/wp-content/uploads/2023/07/Ms2.2-Innovative-energy-storage-integration-requirements-incentives-and-constraints.pdf	36	40
/wp-content/uploads/2024/01/101096197_AGISTIN_D2.1_Energy_storage_integration_requirements_incentives_and_constraints_an_EU_wide_anal...	35	40
/wp-content/uploads/2023/06/101096197_AGISTIN_D1.1_Project_method_and_activity_plan_V1.pdf	33	39
/wp-content/uploads/2023/07/101096197_AGISTIN_D7.1_First-Communication_Dissemination_and_Exploitation_Plan_including_project_identity_...	33	38
/wp-content/uploads/2024/01/101096197_AGISTIN_D4.1_Use_case_identification_and_test_infrastructure_set_up.pdf	29	33
/wp-content/uploads/2023/12/Wiese_Karadag_Braun_The_Influence_of_Grid_Forming_Loads_on_Transient_Stability_WIW23-2.pdf	28	29
/wp-content/uploads/2023/06/AGISTIN-light.mp4	26	30
/wp-content/uploads/2024/04/101096197_AGISTIN_D3.1_Topologies_common_AGI_combinations.pdf	25	26
/wp-content/uploads/2023/02/Brand-Identity-guidelines_AGISTIN_.pdf	24	40
/wp-content/uploads/2023/06/AGISTIN-summary-Public-Presentation.pdf	24	27
/wp-content/uploads/2023/11/ILES-Workhop_IWES-AGISTIN-Poster_final.pdf	22	26
/wp-content/uploads/2023/06/AGISTIN-Brochure_.pdf	19	20

Figure 8 Download numbers of resources available on the project website

These figures and data allow us to measure the project impact and show how the project is resonating globally with its audience, as well as its relevance and influence. In addition to the project website, the public milestones and deliverables reports are being shared through Zenodo project account (4). This ensures that the findings and progress of the project are transparent and accessible to the public. Nine deliverables and milestones have been uploaded to Zenodo, with a total of 154 views and 164 downloads.

2.2.8. Social media

The project accounts on X (former Twitter) (5) and LinkedIn (6) were established from M1 to boost project awareness and outcomes. Changes in Twitter's management and scope have diminished its reputation, engagement, and efficiency. However, this has been offset by the project's strong performance on LinkedIn.

As of the submission of this deliverable, the project's LinkedIn account had 490 followers, and it averaged 3,700 impressions (users visiting the page) per month, with an engagement rate of 10% (percentage of viewers who engaged with the content). The LinkedIn page is updated weekly to ensure consistency, with an average of two posts per week, thereby driving reach and engagement. The number of followers and the volume of publications are significantly higher than other projects, particularly when benchmarked against AGISTIN sister projects.

Through LinkedIn embedded analytics, the project is also able to get to know the page visitor demographics (Figure 9 LinkedIn visitor demographics by industry). This helps to better understand the audience and measure the impact of the publications, determining if the project is resonating with its stakeholders.

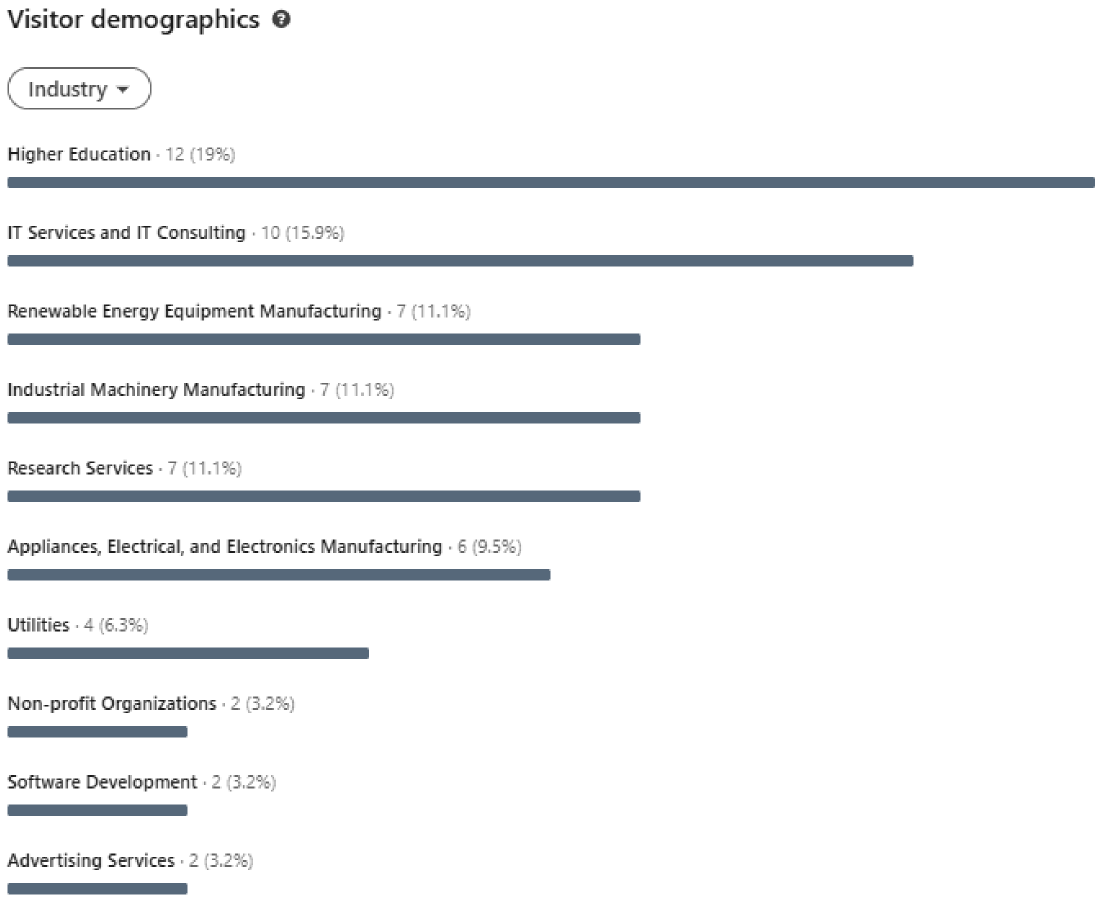

Figure 9 LinkedIn visitor demographics by industry

At the time of this deliverable submission, X account had 89 followers. Due to platform changes, embedded analytics are no longer available for basic accounts.

2.2.9. Press Releases and Online Publications

Media outlets are a key audience group for the project, significantly enhancing its credibility due to their perceived reliability. To leverage this, the project aims to disseminate at least two press releases. The first press release, announcing the project's start, was sent in Month 2.

There is also another press released being prepared on the Spanish demo objectives, initial results and foreseen impact, to be sent to regional media outlets in Q1 2025.

In addition to press releases, the publication in online media and non-media platforms also contribute to increasing the project's visibility and credibility.

The project has been featured twice in Enlit World' website and Newsletter:

- 27.11.2024 From the lab to the field: How AGISTIN is transforming energy storage

- 15.04.2024 Project AGISTIN: Accelerating industrial grid decarbonisation with advanced energy storage integration

It has also been highlighted twice in the BRIDGE newsletter:

- 02-06-2023 AGISTIN asks industrial users for feedback on innovative energy storage integration
- 18.07.2024 News from AGISTIN project

2.3. Communication and Dissemination plan – Impact and outreach results M24

Table 6 outlines the KPIs for each action and the results achieved up to M24. By continuously monitoring these metrics, the project is able to strengthen its strategies and implement corrective measures when actions do not meet expectations.

Table 6 C&D plan KPI and results M24

Task	Action	KPI	M24
Task 7.1: Dissemination and Communication Actions	**D7.1** First Communication, Dissemination and Exploitation Plan including project identity and website report	Submit M6	Submitted on time
	Logo, brochure, poster, roll-up banner	Number of downloads and prints downloads >200 prints	21 downloads 201 prints
	Video	Video views >200 video views	476 views
	Website	Webpage visits/year >5000/year Downloads/downloadable material >50 Website content updates> 12	2365 visits/year 310 downloads 25 content updates
	Social Media	Followers on social media >300/overall Impressions per 3 top posts/period >1000/post	574 followers 15 posts >1000 impressions/ post
	Newsletter	Published newsletters >2/year Subscriptions >100/overall Percentage of clicks >30%/issue	2/ year (total =3) 98 subscriptions 97% delivered; 20% open rate; CTR 33%
	Press Release	Number of press releases >2 PR Number of media clippings > 10 media clippings	2 PR 3 media clippings
	Events	Events attended (trainings, webcasts, workshops, round	15/year

		table, conference, webinars) >10/year	
	Webinars with topics defined by the consortium	3 webinars	2
	Webcasts reviewing the technical outcomes of the project (target: scientific community)	4	1
	Workshops and events to safeguard results are aligned with end-users needs and policy making in Europe	3 workshops 2 events	1
	Publication of scientific and technical results	8 High impact papers Papers in scientific journals >3/year Publication link visits on website >50/publication Participation to tech conferences >3/year	9 1 paper in scientific journal 30 downloads/publication 6 tech conferences
Task 7.1: Dissemination and Communication Actions	Cooperation with other activities	BRIDGE Sister projects Hydropower cluster	Representation in 3 BRIDGE WGs; Synergies with sister projects i-Stentore, SINNOGENES & 2LIPP; Participating in Hydropower cluster initiatives

2.4. Future activities

In the upcoming year of the project (M25 to M36), we will continue ongoing C&D activities to promote project findings and outcomes through the project main communication channels. At least two webinars will be organised in 2025, focusing on the findings and methodologies developed in WP2 (T2.4 Lifecycle Assessment) and WP3 (T3.3 AGI Tools and Methodologies). The first webinar will be part of the Energy Talks series, targeting technology providers, industrial grid users, and the research community.

The project partners also foresee participation in major events and initiatives to exchange knowledge and connect with policymakers, such as Enlit Europe, European Energy Sustainable Week, BRIDGE and key conferences like CIRED. To engage with irrigation communities to share results and information about the irrigation canal demonstration, the partners will plan through dedicated meetings, videos, a press release, and a demo site visit. An internal demo site visit to the ECTA demo site facilities is also on the schedule. Overall, as lab tests progress and transition to field tests, the communication efforts will mirror these advancements, ensuring that main public results and findings are shared with the public.

Leveraging D&C through Horizon Results Booster

The AGISTIN project, along with its three sister projects, has applied to the HRB to enhance stakeholder engagement. As a result, the HRB produced a report titled "D1.1 Portfolio of Research and Innovation Project Results of FutEUrEnergy". This report identifies the collective results of the Project Group to be disseminated, their characteristics, and the target stakeholders who can benefit from these results, ultimately forming the target audience for the Project Group's dissemination activities. The report provides positioning insights, recommendations on channels to approach the audience, and overall strategies on how to leverage project outcomes collectively. The sister projects will review the report and analyse the measures that can be implemented during 2025.

3 Exploitation Plan

The exploitation plan aims at defining a strategy to successfully harness the project's results. This second version presents a detailed explanation of each result along with information for their exploitability through the implementation of the tools described in the first plan. These tools aim to characterise and identify the best route leading to the most fruitful utilisation of the KERs. Similarly, the tools make it possible to trace the progress of the results and determine the approximate time to exploitation to define the actions guiding the future exploitation efforts to be presented in the last version of the plan.

The backbone of the exploitation framework is defined through the following concepts:

1. **Exploitation overview:** It provides the fundamental concepts to identify, characterize, and prioritize the key outputs of the project to determine their most sustainable and suitable exploitation route. The overview offers a classification method of each result by type and of when and where the result could be deployed.
2. **Exploitation routes definition:** It is used to identify whether the project results have the potential to be commercially exploited and presents a business model strategy. The commercial exploitation of a result will depend on the partner's willingness to marketize it.
3. **Future actions:** Identify future opportunities and efforts to be implemented to create a long-term exploitation pathway of the non-marketable results.

This version provides an overview of the KERs and serves as the main source to identify the best possible exploitation route. In consequence, results are divided between two main categories, commercially exploitable and non-commercially exploitable results. The KERs that are not marketable are exploited through extensive internal and external dissemination actions that aim to spread the knowledge developed during the project. Future actions are defined by each owner to ensure the long-term usability of these results and identify other potential uses. The final roadmap will contain an extensive description of the progress achieved by each key exploitable result and a business model plan for those results identified as marketable, it will elaborate a competitors' analysis and identify the main business opportunities and exploitation risks.

EASE, acting as the Exploitation Manager has been guiding the efforts to inform, collect and refine the information provided by AGISTIN consortium's participants. The Innovation Board has been established and is composed by those participants that act as KER owners (see Figure 10).

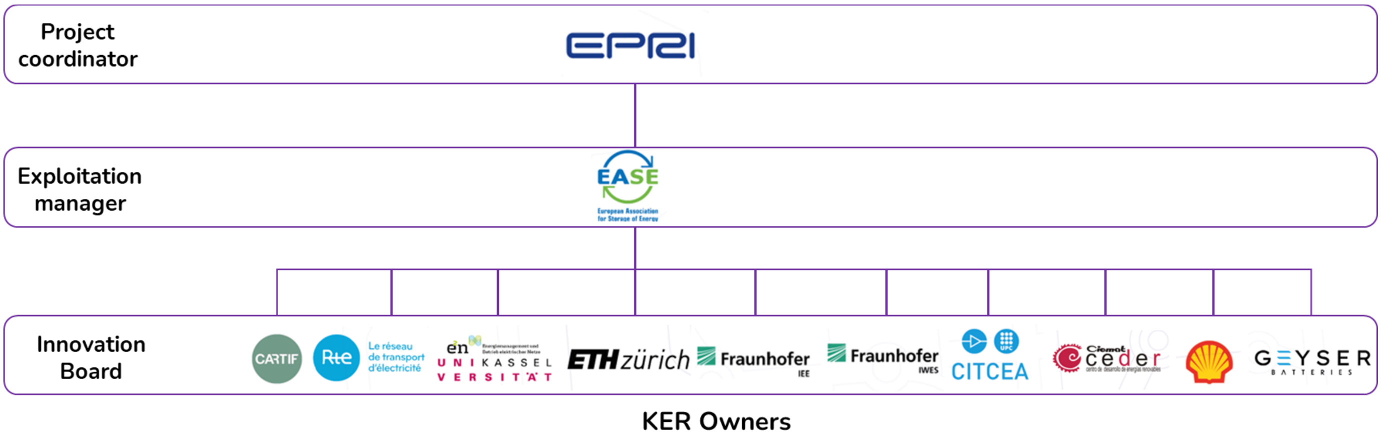

Figure 10. Innovation board structure

3.1 Key Exploitable Results

Table 7 shows those KERs that were initially defined by the consortium and identified in the Grant Agreement. EASE, in collaboration with the Innovation Board members, has been following the progress of the project's activities that will produce the main exploitable results. AGISTIN is in the process of producing 13 KERs that will not only generate benefits for the consortium's partners but will also be available to key stakeholders through the definition and implementation of dedicated exploitation plans. These plans are intended to directly target the expected impacts of the call. Moreover, as KERs' identification is progressive, AGISTIN partners have been able to identify additional KERs.

Table 7 Key Exploitable Results

WP	KER#	KER name	KER owner
2	KER1	LCA framework for industrial grid users, storage and renewables	CTF
2	KER2	Functional requirements for AGIs	RTE
3	KER3	AGI templates and selection tool	UniK
3	KER4	Open-source AGI control methods	ETH, UniK
4	KER5	Aqueous ECR battery system demonstration result	FHG-IEE, GSR
4	KER6	Validated models for industrial grid users providing grid forming capability	FHG-IEE
5	KER7	Operation of coupled electrolyser, storage and renewables	FHG-IWES
5	KER8	Determination of the impact of batteries on alkaline electrolyser degradation	FHG-IWES
6	KER9	Multi-level control system for irrigation canals to act as storage	UPC
6	KER10	Results of testing Al-ion battery	CDR
5	KER11	Determination of minimum economic grid connection for SHL renewable H2 demo	SHL
3, 4, 5, 6	KER12	Validated models of innovative storage behaviour	FHG-IWES, GSR
4, 6	KER13	Analysis of irrigation systems as innovative storage systems	UPC

New KERs resulting from the implementation of AGISTIN

The implementation of AGISTIN has successfully led to the emergence of an additional result, as members have identified further opportunities to be developed. Table 8 shows the new KER that will be analysed along with the previous outcomes.

Table 8 New KERs

WP	KER	KER name	KER owner
4	KER 14	RCP Inverter	FHG-IEE

The characterization and definition of the exploitation route of these new KERs is ongoing and will be reflected in the last version of the exploitation roadmap.

3.2 Exploitation overview

The purpose of this section is to present an overview of the results by providing a brief description, the main objective, and a preliminary high-level view of the scope and the main target groups. These features are key to determine the most suitable exploitation pathway based on a first categorisation of the type of results. Similarly, it makes possible to classify the results and define future actions according to the choice of exploitation route. This process is followed by a dedicated stakeholder analysis that allows for a more in detail definition of key groups of interest and how they might have an impact on the results.
A characterisation table tool was used to develop the first assessment of each result. KER owners and participants provided inputs.

Characterisation of results

KER owners were able to classify each result according to the definitions of the characterisation table These definitions intend to identify the partner's expectations and claims of the results and to characterize them to define the most suitable exploitation pathway. Each result was further defined according to the following features.

Identification of the problem/need - The nature of the problem that the result is trying to address.

- Technical: Need for higher performance, higher durability, different standards and features, etc.
- Financial: Need for lower CAPEX or OPEX, higher revenues, safer value chains, faster ROI, etc. Environmental: Need to reduce GHG emission, reduce pollutants, reduce impact on nature, etc.
- Social: Need to reduce impact on society, safer value chains, better work conditions, etc.

Actors involved - The considered segments of society manifesting the need.

- Private entities: Private companies, high education institutions, non-governmental institutions.
- Public entities: Governmental bodies, research centres, high education institutions.
- Industry: Group of companies that develop similar activities and make up a sector of the economy, i.e., energy, construction, chemical, transport and mobility, etc.

Type of project result - The outputs of the project may be classified using the following concepts:

- Methodology/Method: A method is a systematic sequence of steps aimed at solving a problem or executing an action. A methodology is the use of a method or methods in a particular field of study. Process: A group of methods used in the development stage of a product/service.

- Product: Tangible good derived from the combination of processes and methods intended to cover a need and with the potential to be commercialized.
- Service: Activities that benefit a group of people in a market, without providing tangible assets.
- Algorithms: A sequence of instructions or rules put together to produce a service or enable a computation action.
- Software: Operating system used by a digital equipment or program.
- Website: Virtual platform, containing a set of interconnected web pages, created to share information online.
- Scientific articles: Written publications containing research findings or theories supported by data and explained through a methodology.
- Product design: The process of creating a product that addresses a specific need in a given market. It involves research and development actions.
- Name of a product/service: A new name that identifies a new or existing product or service.
- Expertise: Skill or knowledge on a specific subject.
- Data base: Organized collection of data/information.

Exploitation level - The exploitation level of the project's results

- Not exploitable: It is not possible to exploit the results by the end of the project.
- Weakly exploitable: It is unlikely that the results will be exploitable by the end of the project.
- Moderately exploitable: There is an exploitation potential that will be furthered explored.
- Highly exploitable: There is a concrete possibility that these results can be exploited.

Time to exploitability - Different results can be exploited with different timings:

- More than 5 years;
- Between 3 and 5 years;
- Between 1 and 2 years;
- Less than 1 year;
- Immediately at the end of the project.

Exploitation route - Defined through the following areas:

- Scientific/Academic: Research; Thesis; Journal article; Knowledge transfer.
- Social: Social activity; Policy/regulation.
- Economic: Spin-off; Start-up, marketable product or service; Patent.
- Technological: Development and creation of new technology, design or manufacturing process.

Geographical scale - Geographical levels useful to identify the scalability of the project's results:

- Local: The exploitation of the result is only possible and significant in the area where it was developed or deployed. There are existing barriers for further exploitation beyond the local site.
- National: The exploitation is only significant at a national level. There are existing barriers for further exploitation.
- Global: The exploitation of the result is possible and significant at an international level.

Link to other KERs - KER owners will identify whether and how their results depend on other KERs to progress.

Stakeholder mapping and Value Proposition Canvas

Table 9 presents the main stakeholder groups of the AGISTIN project in general. Based on the initial assessment done to identify the stakeholders for the project, each KER owner made a deeper analysis to identify those groups that could either hold an interest in their specific result or have a direct influence on this.

Table 9 Dissemination, exploitation and communication (DEC) target groups of involved stakeholders

Stakeholder groups	Organisations, companies, individuals	Goal
Technology providers	Energy storage providers, power electronics (e.g., inverter) and integration controls providers, electrolysis providers, pump drive providers.	Mobilisation of the sector's interest. Recommendations for improvements of the project´s technology. Ensure collaborative market outreach.
Industrial grid users	Electrolysis operators, large pumping facilities, heavy duty EV charging operators, data centre operators.	Relate project findings from demonstrations, business case and LCA activities to inform future investment decisions.
Grid operators	Transmission and distribution system operators (TSOs and DSOs)	Develop guidance and recommendations for system operators that informs the development of network codes and qualification criteria for grid services.
Policy makers and public bodies	EU Institutions; National governments, Regional/local authorities/regulators	Influencing new regulations and policies for the innovative storage solution value chains at EU and national level. Adaptation of grid connection codes and incentives to optimally exploit the capabilities of combined grid coupling of storage, load and generation. Contributing to a sustainable EU future.
Research & scientific communities	Universities and research institutions; Research associations/networks	Mutual learning; Enhancement of R&D; Knowledge spill-over; Validation and improvement of results
Society at large	Citizens, NGOs, associations, civil society	

The stakeholders were divided into two categories, primary and secondary, depending on the impact they would have over each organisation. A level of influence and interest was assigned to each of them. The information was used in an influence vs interest table to better define the future interactive actions with the groups that will define and shape the exploitation route of each KER. Additionally, a VPC (Value Proposition Canvas) was implemented for each **key stakeholder** (high influence, high interest) to illustrate the main problem and the benefits that the results will offer to every group. This information is depicted for each KER in this section.

Primary stakeholders: Stakeholders that hold a direct interest in a business or organization and its dealings. Examples: shareholders, employees, customers, suppliers, vendors and business partners. This group will have a direct impact due to the company´s performance and is able to influence the company´s performance as well.

Secondary stakeholders: Do not hold direct interests in a business but can have a reasonable influence over a business´s dealings. An organization does not directly depend upon these stakeholders for survival of its immediate interests. Examples are business competitors, trade unions, pressure groups.

Key stakeholders: Those stakeholders identified as primary and have both high interest and influence over the result.

Value Proposition Canvas

Each KER owner used the following definitions to describe the key stakeholder profiles in terms of benefits, needs and barriers.

Benefits – What your result will bring to the stakeholders. They are the core of the value proposition.

Features – Functional attributes of the result.

Outcomes – Potential future uses and impact the result will generate.

Needs/Problems – What the stakeholders need to solve and the main challenges they face in the absence of the results.

Fears – Barriers that could prevent the stakeholders form using/implementing the result. How the KER is expected or can help to solve the customer's needs or problems identified in the previous segment.

Gains – What the stakeholder would acquire by using/implementing the result.

Exploitation potential

The exploitation route of each result is based on the type of outcome it will produce and the key stakeholders that are identified. The following categories were used to classify the innovation potential of the project's results.

- Commercial innovation potential
- Technology innovation potential
- Social/environmental innovation potential

Contribution to the expected impact assessment

As part of the Exploitation Plan, members are asked to monitor the contribution that their result will have, on the long-term, on the expected impact categories derived directly from the project's call. Each KER owner was asked to identify the relevant impact categories on which their result will have an effect and assign a level of contribution to it.

Exploitation aims

The expected ways in which partners will contribute to the exploitation of the results, including IPR intentions, are summarized in a BFMULO matrix. This tool is used to facilitate the assessment of the exploitation strategy of the KERs.

3.2.1 Exploitation plans and analysis for each KER

3.2.1.1 KER 1: LCA framework for industrial grid uses, storage and renewables

KER1	LCA framework for industrial grid uses, storage and renewables	WP2
KER Owner: CTF		Participants: RINA

Characterization of results

Result and objective: KER1 presents a framework for the application of the Life Cycle Assessment methodology to the demo cases developed in AGISTIN according to existing standards but adapted to the specifics of the project AGIs. The LCA will be used to assess the environmental impacts of the delivered electricity using AGIs, considering the different elements of the grid and the energy storage system. The framework will be applied to the AGISTIN demo sites, namely the green H_2 production site and the large pumping loads for irrigation systems. It will include the raw material extraction and supply chain, the manufacturing stage for all the components that integrate the energy storage system and the operation using the project's energy models. The main conclusions will be presented to the consortium members as a starting point for sustainability decision making.

Need: The need to reduce the environmental impact of electricity generation sources concerns not only the energy production but also the components themselves. Innovative storage components such as the aqueous battery developed by GSR is an example of a sustainable design capable of fulfilling grid requirements. The LCA will offer further insights on the components used in AGI to prove the sustainability of the solution.

Actors involved: This result is directed to the industrial partners that are involved in the design, development, procurement and operation of the novel energy storage technologies and systems being integrated in the AGIs.

Type of result: The LCA will act as a methodology on how to evaluate the environmental impact of AGI containing a specific set of energy storage and renewable assets.

Expl. Level: The framework will be focused on the LCA to be conducted in AGISTIN. It could be applicable to similar projects and technologies.

Time to exploitability: The result will be available for exploitation immediately after the completion of the project.

Expl. Route: CTF, as a non-profit organisation normally follows a **scientific** exploitation route, generating knowledge for application in new projects.

Scale: Dute to the nature of the result, the main outputs could be used at a global scale where production methods and operation are not largely influenced by geographical conditions.

<u>Link to other KERs:</u>

KER2: The functional requirements of the AGIs will be used to define the goal and scope of the study and the functions of the systems to be included in the assessment.

KER3: The results of the simulations will be used to model the environmental performance of the operation stage.

<u>Stakeholder analysis and exploitation potential</u>

According to the stakeholder analysis, energy storage providers and the consortium members are the primary stakeholders that have a high interest and influence over the framework, which means these groups are meant to be encouraged to exploit the result and can be influenced by the result itself. AGISTIN members are interested in the generated knowledge and the regulatory compliance of the obtained results, which could affect their technology selection and upscaling strategy. Similarly, the result would be influenced by them as they would actively shape the framework by providing data at the different stages of the technology's life cycle. This is highly relevant as the efforts from the authorities to have more transparent data are becoming stricter, not to mention that reduced carbon footprint has become a competitive advantage in the market. Thus, energy storage providers would be highly interested in complying with the requirements to meet environmental regulations targets through proven results and gain a competitive edge in markets driven by environmental performance (e.g., through EPDs). At the same time, they would be able to influence the result by providing accurate primary data.

Since the main outcome of KER 1 will be a methodology designed mainly to inform on the environmental impact of the project's technologies, the resulting knowledge will be exploited through internal dissemination actions to raise awareness among members and to facilitate the development and application of the framework. The main outcomes can also be used as benchmarks on which policymakers can elaborate further regulations. Table 10 shows the main stakeholders for KER 1, according to the definition of primary and secondary stakeholders provided in Section 3.2.2. Depending on the level of influence and interest that these stakeholders have on the result, an action plan should be followed.

Table 10. Influence vs interest levels of primary and secondary stakeholders for KER 1

Stakeholder	Influence/interest levels	Action
AGISTIN members	HIGH	Encourage & influence
Energy storage providers	HIGH	
Academia & scientific community	MEDIUM/HIGH	Keep informed/encourage
European institutions	MEDIUM/HIGH	
Circular economy companies	MEDIUM	Keep satisfied/informed/monitor/encourage
BES researchers	MEDIUM	
TSOs/DSOs	MEDIUM	
Electrolyser operators	MEDIUM	

Primary stakeholders
Secondary stakeholders
Key stakeholders

Key stakeholders were identified from the first mapping and different VPCs were developed to help each KER owner understand the main problem of each stakeholder group and the added value the result is aiming to provide.

VPC of Key stakeholders

Table 11 VPC for energy storage providers

LCA framework	Energy storage providers
Benefits: Improved sustainability insights Competitive edge in green credentials Optimized resource use	**Need:** Demonstrate sustainability Integration with existing systems Accurate impact assessment
Outcomes: Enhanced decision-making Better compliance with regulations	**Fears/Barriers:** High costs of implementing LCA Complexity of data collection Potential non-compliance issues
Features: Comprehensive LCA framework Detailed environmental impact metrics	**Gains:** Clear sustainability reports Improved market positioning Cost-effective LCA implementation

Table 12. VPC for AGISTIN's members

LCA framework	Consortium members
Benefits: Shared resources and knowledge Improved project impact	**Need:** Access to comprehensive LCA data Shared expertise
Outcomes: Reduced project risks Increased funding opportunities	**Fears/Barriers:** Complexity of the methodology Data sharing
Features: Holistic LCA framework Detailed metrics Comprehensive environmental analysis	**Gains:** Enhanced project impact and outcomes

Table 13. VPC for EU Institutions

LCA framework	EU institutions
Benefits: Support for policy development Promotion of sustainable practices Facilitation of green technology adoption	**Need:** Need for effective policy tools Support for green energy projects
Outcomes: Enhanced policy effectiveness Better compliance with regulations	**Fears/Barriers:** Inadequate data for policy-making Slow adoption of standards
Features: Comprehensive LCA framework Detailed environmental impact metrics Policy Impact analysis	**Gains:** Improved policy outcomes

Impact assessment

Table 14 offers a detailed explanation on how KER 1 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 14. KER1 Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Availability of disruptive energy technologies	Medium	Detailed assessment of environmental impacts may bring a competitive edge over other technology alternatives.
Enhance consumer satisfaction	Low	Providing environmental impact metrics may increase consumer acceptance and satisfaction over existing alternatives.
Improvement of European technological value chain and scientific basis	High	The application of the LCA framework will enable stakeholders in the energy sector to identify and mitigate environmental impacts across the value chain, support decision making and accelerating the deployment of new technologies.
Enhance sustainability considering social and economic aspects	High	The framework is used to address environmental aspects but could be later expanded to include socioeconomic issues.
Effective market uptake	Medium	The detailed environmental profile of energy storage solutions would support compliance with the EU regulations on green claims and sustainable products and improve market acceptance.

<u>**Exploitation activities**</u>

CTF has taken an active role in organizing an internal workshop to present the basics of the LCA study that will be conducted during the project and to raise awareness and share knowledge with the consortium members to facilitate the development and later application of the framework.

KER	Dissemination activity	Description	Date
KER1	Internal workshop: Introduction to LCA	CTF presented the basics of the LCA methodology to be used in the project	30/04/2024

3.2.1.2 KER 2: Functional requirements for AGIs

KER2	Functional requirements for AGIs	WP2
KER Owner: RTE	Participants: RINA, UniK, UPC, FGH-IWES, SHL	

<u>**Characterization of results**</u>

<u>Result and objective:</u> KER2 presents the functional requirements that are needed for AGI, in the form of guidelines for future connection network codes. The main conclusions will serve to inform on the unaddressed technical and regulatory gaps that could hinder the deployment of renewable energy and storage systems connected to the grid.

Need: The aim is to find and explain what the missing requirements are for present inverters connecting load/generation/storage to be transformed into AGI. It involves both technical problem identification and regulatory framework evolution.

Actors involved: The result will impact both public entities (i.e., system operators) to develop/adapt their products and private entities such as business developers aiming to provide energy/storage as a service.

Type of result: The functional requirements could be used as a recommendation for product design and technical requirement compliance, it might therefore influence the design of equipment and sizing methods.

Expl. Level: The result is highly impactful as it could be used as a base for the definition of future grid code requirements. Its exploitation would be defined by the willingness to adopt the recommendations and the progress of the grid connection policies.

Time to Expl: The result can be used for the next European grid code change that will occur in the 5 years' time frame (between 3-5 years). It can also be exploited sooner at national level if specific System Operator decides to use it (between 1-2 years).

Expl. Route: The exploitation route is mainly a regulatory route, both on national and European level. However, such recommendations could be used as the foundations upon which an energy storage product/service is designed, thus creating a potential commercial exploitation route by a third party.

Scale: The scale of use is targeted to be at European level; however, it is possible that it is used earlier at a national scale.

Link to other KERs:

KER 4: The functional requirement will have an impact on the open-source control methods that will be developed in KER 4 as the models will match the requirements. (or the guide on how to use the models will take into account how to use and build simulations out of these models)

KER 7/8/11/13: These KERs will help the requirements to be properly designed as the behaviour of the demo will have been assessed.

Stakeholder analysis and exploitation potential

The main stakeholders related to the determination of the functional requirements for AGI were identified to be the energy storage and power electronic providers, system operators and users such as EV charging, data centres, pumping facilities and electrolyser operators. Energy storage and power electronic providers could use the requirements as a guideline to develop new storage components. On the other hand, the development of new technologies with different characteristics and capacities could have a direct impact on the functional requirements. This would also apply to BESS researchers. Meanwhile, other stakeholders would act either as operators on the AC side or as providers on the DC side. All of them will have a high influence on the requirements as these need to consider the different constraints of both sides of the AGI. Similarly, the requirements will guide the overall behaviour of the AGI, making it a tool of high interest for these stakeholders. Other stakeholders might arise, from the implementation of these requirements, such as AGI operators. They would be highly interested in the result as their activities would be directly impacted by these requirements. Furthermore, policymakers will have an impact on the AGI requirements as they will be influenced by current AC connection requirements. On the other side, policymakers would be interested in the functional requirements as they will help designing future grid codes, especially for DC aggregated AGI. The main outcomes of KER 2 will be in the form of recommendations, that can inform energy storage providers interested in offering energy storage services to the grid, on the technical requirements they must fulfil to adapt accordingly and be able to leverage the business opportunities. This can be extended on a national and European scale to several energy storage service actors who seek to provide ancillary services to the grid. The result provides an in-depth analysis that can also be exploited by policy and decision makers.

Table 15. Influence vs interest levels of primary and secondary stakeholders for KER 2

Stakeholder	Influence/interest levels	Action
TSOs/DSOs	HIGH	Encourage & influence
ES & power electronic providers	HIGH	
AGISTIN members	HIGH	
Academia & scientific community	MEDIUM/HIGH	Keep informed/Encourage
BES researchers	MEDIUM/HIGH	
Policymakers	MEDIUM	Keep satisfied/informed/monitor/encourage
National governments	LOW/MEDIUM	Monitor/Keep informed

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 16. VPC for Energy storage providers, Power electronic providers, Heavy duty EV charging, Data centres, Pumping facilities, Electrolyser operators

Functional requirements for AGIs	**Energy storage & Power electronic providers, EV charging, Data centres, Pumping facilities, Electrolyser operators**
Benefits: The requirement will ease product development, and integration in the future AGI	**Need:** Users need a standardized solution to prepare their product to be connected to such AGI.
Outcomes: Requirement for both AGI hardware and controls for AC and potentially DC side, guideline for connection codes.	**Fears/Barriers:** Having heterogeneous requirements that would prevent to develop a fit for purpose product.
Features: Harmonised technical solution that would both help electrical system, fasten storage installation and provide service for DC connected users.	**Gains:** For PE developers, a view of the requirement for PE. A gain in time for future grid code development. A guideline for storage **developers** and inverter-based users for product development.

Table 17. VPC for system operators and policy makers

Functional requirements for AGIs	TSO/DSO/Policy maker
Benefits: Functional requirement might be used as rough draft for grid codes	**Need:** Allow for AGI to be connected to the grid in a secure and fair manner.
Outcomes: Updated version of the connection codes.	**Fears/Barriers:** AGI topologies not covered by connection code, leading to discrepancy throughout Europe or even impossibility to connect.
Features: A set of requirements for AGI hardware, and for connection to the AC grid.	**Gains:** Easier consultation process with stakeholders as requirement would already embed some of stakeholders needs/constraints.

Impact assessment

Table 18 offers a detailed description on how KER 2 will trigger and enable future regulatory, commercial and scientific endeavours based on the following assumption: The functional requirement will be taken into account for future grid code development. This KER is mainly a regulatory one, therefore, as the Code is being revised presently, the next revision will probably be around 5years after EoP. The level of the impact of the result will depend on the early national adoption of the requirements.

Table 18. KER2 Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	5 years after EoP, there will be limited amount of AGI connected to the grid, therefore limited impact on energy system flexibility and resilience.
Availability of disruptive energy technologies	Medium	Some disruptive technologies (as Geysers' one) might benefit of the functional requirement as they will have a better view on potential market opportunities and adapt their development accordingly.
Effective grid-integration	Medium	National law might take benefit from these requirements even before European code implementation leading to a fastened AGI development.
Reduced cost and improved efficiency of energy technologies	Low	Having functional requirements in advance to grid code implementation will leave time to prepare for it and would end up with better technological solution.
Enhance consumer satisfaction	Low	No direct impact, but having a system that integrate more storage, while being more stable and cost effective would limit energy price increase.
Improvement of European technological value chain and scientific basis	Medium	The functional requirement will help European companies and scientist to develop product that will match grid codes when they will be enforced.

Exploitation activities

RTE has conducted a survey targeting industrial users to provide feedback on their needs and constraints regarding the integration of innovative energy storage system to the grid. The outcome of the survey will be used in the development of the project's tools for storage sizing and inverter controls. This information was presented during a webinar where a summary of new requirements in the European code was introduced.

KER	Dissemination activity	Description	Date
KER2	Webinar: Perspectives on Grid Connection Networks for Energy Storage	New requirement in the European code that will impact AGISTIN.	23/05/2024
KER2	ENERGY Talks #2 Innovative Storage Integration: Bridging the Gap Between Industrial Needs and Grid Codes	Discussion on how aggregation should be done for multiple types of users.	29/05/2024

3.2.1.3 KER3: AGI templates and selection tool

KER3	AGI templates and selection tool	WP3
KER Owner: UniK	Participants: ETH, UPC, FGH-IWES, GSR	

Characterization of results

Result and objective: KER 3 involves a common set of AGI designs (including loads, energy storage systems, distributed generation systems and power electronics), simulation models and an accessible tool developed and released to support design and evaluation of AGI solutions. The aim is to provide relatively-easy-to-use templates and generic component models along with design guidelines to facilitate the implementation and simulation testing of AGI for future applications.

Need: The design of AGI (in contrast to individually and independently connected components) can be challenging. Setting up adequate topologies along with simulation models for every individual project might be inefficient. The templates and selection guidelines provided by AGISTIN aim to help parties willing to adopt an AGI scheme by providing a generic framework that can (and must) be customized only with respect to particularities of the respective project.

Actors involved: Public or private operators of facilities that can be connected via AGI and the respective grid operators in charge of the grid connection.

Type of result: The result consists of simulation models (algorithms & computational models) along with documentation (reports) describing their scope and application. Scientific articles showcasing the main features and outcomes of the result are foreseen.

Expl level: Exploitation hinges on the willingness and ability of the relevant actors involved to assess the challenges and opportunities that go along with AGI implementation.

Time to expl: Exploitation starts with the publication of the respective parts (design rules, models) which will happen over the project duration (the most relevant part – the publication of AGI model templates - is linked to deliverable 3.2 which is due in June 2025). The results will be made available for exploitation during the project through open-source publications via git-hub.

Expl. route: The most suitable exploitations route for this type of result is scientific through the publication of scientific articles, dissemination of the knowledge via workshops, and publication of open-source models.

Scale: The results are not tied to specific geographical conditions, thus can be used at a global scale.

Link to other KERs:

KER4: The AGI control methods shall be applicable to the models and model templates. Ideally, selection guidelines are also in line with the potential identified in T3.5.

KER6: The validation of the grid forming models will make the templates and generic models more accurate and provide guidance to users.

KER12: The validation of the storage models will make the templates and generic models more accurate and provide guidance to users.

Stakeholder analysis and exploitation potential

The academia and scientific community as well as the consortium members have the highest impact on and from the development of the AGI templates and selection tool. The academia and scientific community will use the open-source models as they facilitate reproducibility and reusability of simulation models, which is highly relevant for scientific work, while making the research process more efficient. This is also the case for AGISTIN members who work with simulation models. While, these stakeholders are key for engagement and data collection, there are other stakeholders that are of interest for the uptake of the outcomes, such as BES researchers and power electronic providers as they would be interested in understanding the utilisation features of the battery (duration, magnitude etc.) in AGI applications since it is important for design of battery and converter systems. Energy storage providers would be mainly interested in the public available AGI simulation models to address potential new customers who might augment their facilities with battery systems. Since the main outcome of KER 3 will be a computational model designed mainly to simulate the response of an integrated system, the resulting knowledge will be exploited through dissemination actions among the scientific and research community through open-source models and scientific articles. Whereas the models are not yet finished, and no open-source content is available at the time, the creation and investigation of components for individual AGI elements (such as loads operating under grid forming control schemes) already yields results with respect to their impact on power system stability.

Table 19. Influence vs interest levels of primary and secondary stakeholders for KER 3

Stakeholder	Influence/interest levels	Action
AGISTIN members	HIGH	Encourage & influence
Academia & scientific community	HIGH	
ES & power electronic providers	MEDIUM	Keep satisfied/informed/monitor/encourage
BES researchers	MEDIUM	
TSOs	MEDIUM	
DSOs	MEDIUM	Monitor/Keep informed

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 20. VPC for academia, scientific community & consortium members

AGI templates and selection tool	Academia, Scientific community & Consortium members
Benefits: Open-source models offer improved reproducibility of results and reusability of code/models	**Need:** Simulation models are needed to assess the adequacy of storage integration and to optimize solutions. Preferably, models and results are comparable across different technologies and topologies.
Outcomes: Different options of storage integration with load and generation are easily benchmarked and therefore their value can be assed rather quickly for new combinations.	**Fears/Barriers:** Without publicly available models, dedicated models need to be built for each investigation which goes along with additional effort and hampers reproducibility and comparability among results achieved by different parties
Features: Public availability, transparency and comparability.	**Gains:** Reduced effort in building own models and more reliable results using validated and well-known models.

Impact assessment

Table 21 depicts a detailed description of how KER 3 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 21. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	Medium	Understanding and adaptation of AGI uses improves by model and template availability
Availability of disruptive energy technologies	Medium	Before building actual hardware for new technologies, simulations studies are necessary. This is made easier by making models available.
Reduced cost and improved efficiency of energy technologies	Medium	Understanding and adaptation of AGI uses improves by model and template availability
Improvement of European technological value chain and scientific basis	Medium	By making models of their own components available in a form that can integrated with the models and simulation framework provided by AGISTIN, manufacturers can more easily integrate the latest scientific results with respect to the efficient integration and operation of their components in larger AGI systems.
Effective market uptake	Medium	The free availability of simulation models makes it easier (and cheaper) to evaluate the benefit from AGI solutions and therefore reduced the entry barriers for stakeholders.

Exploitation activities

UniK has participated in the 22nd version of the Wind & Solar Integration Workshop with the presentation of a scientific paper on the influence of grid-forming loads on stability.

KER	Dissemination activity	Description	Date
KER3	22nd Wind & Solar Integration Workshop	Scientific paper: The influence of grid-forming loads on transient stability	04/12/2023

3.2.1.4 KER4: Open-source AGI control methods

KER4	Open-source AGI control methods	WP3
KER Owner: ETH, UniK		Participants: UPC, FGH-IWES

Characterization of results

Result and objective: KER 4 involves open-source control methods for real-time operation of the AGI, providing flexible grid-forming ancillary services to the grid and internal energy balancing under varying ambient grid conditions as well as internal variable generation and demand. This result provides a transparent control scheme and verifiable behaviour available to inspect and incorporate into projects.

Need: The operation of AGI aims to maintain energy balancing and provide flexible grid-forming services, which may involve different types of devices with different dynamics and has to respect the inherent limitations of different devices. In the operation of AGI connecting load, generation and storage, there are numerous degrees of freedom that can be exploited to optimize for goals such as revenue from system services, component's life, local power quality, reliability etc. Furthermore, the coordination of the AGI participants must ensure that the limits of the components (including the grid connection) are respected under all foreseeable operating conditions and contingencies. The control scheme will provide a way to reliably and efficiently coordinate the components while keeping complexity and hardware requirements as low as possible.

Actors involved: Main actors include relevant private entities, which have individual devices that are connected to the main utility via the AGI, public entities such as grid operators, and power electronics converter manufacturers.

Type: The project results include control methods and optimization algorithms that will be disseminated through scientific publications.

Expl. Level: High.

Time to expl. The control methods will be ready before M40 or earlier, as they will be used in the demonstrations. Once validated by the demonstrations, the exploitation of the control methods will be possible.

Expl. Route: Researchers and engineers will use the developed open-source control methods to develop and validate new control algorithms, enabling reproducibility and fostering collaboration in scientific and technological communities. The methods will also serve as reliable benchmarks for comparative studies to illustrate the advantages of different control methods.

<u>Scale:</u> Grid-forming grid interface control is a common problem being studied by global countries. This exploitation occurs globally, enabling researchers and engineers worldwide to access, implement, and build upon open-source control methods, fostering international exploitation.

<u>Link to other KERs.</u>

KER2: The functional requirements that are needed from AGI, e.g., network codes, will be based on the results of KER2.

KER3: The control methods of AGI will be validated on the model templates provided by the results of KER3. The AGI control methods shall be applicable to the models and model templates.

KER9: The control methods of AGI will serve as a basic referential solution for the operation of the irrigation canal system.

<u>Stakeholder analysis and exploitation potential</u>

The development and effective utilisation of AGI control methods is of high interest for members among academia and scientific community as these methods provide a new control solution for academia to further investigate and improve. The main stakeholders include researchers in the power electronics and power systems communities such as IEEE PELS and PES societies. On the other hand, the sizing and types of power converters, manufactured by power electronic providers such as ABB and Siemens, influence the control parameters and interface of AGIs. At the same time, the AGI algorithm provides control inputs for power electronic converters. Moreover, the control and operation of AGI accepts the scheduling and satisfies grid code specifications from DSOs, making the result interesting for them. DSOs can also be influenced by this result as the response of AGI affects the operation of grid systems. The main stakeholders include RTE, Swiss Grid, EirGrid, etc. Other primary stakeholders include battery energy storage researchers and energy storage providers as the characteristics of different types of energy storage technologies are relevant to the AGI control performance and improve the operation of energy storage systems. Since the main outcome of KER 4 will be a set of control algorithms, the resulting knowledge will be exploited through dissemination actions among the scientific and research community through open-source content and scientific articles.

Table 22. Influence vs interest levels of primary and secondary stakeholders for KER 4

Stakeholder	Influence/interest levels	Action
DSOs	HIGH	Encourage & influence
Power electronic providers	HIGH	
Academia & scientific community	HIGH	
AGISTIN members	HIGH/MEDIUM	Keep satisfied/Encourage
BES researchers & ES providers	MEDIUM	Keep satisfied/informed/monitor/encourage
Associations	MEDIUM	
TSOs	LOW/LOW	Monitor

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 23. VPC for academia and scientific community

Open-source AGI control methods	Academia & Scientific community
Benefits: Open-source control methods enable the academic community to advance research in real-time AGI control and flexible grid-forming ancillary services. By providing a reproducible and adaptable platform, they support benchmarking, collaboration, and the development of innovative control strategies and educational tools.	**Need:** Need typical and reproducible control methods to advance research, validate innovative algorithms, and address the challenges of dynamic operation in real-time AGI systems.
Outcomes: The control methods are widely reproduced and considered by academia as a typical and promising solution.	**Fears/Barriers:** Some academia & scientific people may have limited technical expertise, fear integration challenges with their existing systems, lack of infrastructure for real-time testing, and concerns about scalability and reliability.
Features: Open-source, reproducible	**Gains:** The stakeholders acquire advanced control methods for real-time AGI operation and understand the difference between various control strategies.

Table 24. VPC for power electronic providers

Open-source AGI control methods	Power electronic providers
Benefits: Open-source control methods for real-time operation of the AGI, providing flexible grid-forming ancillary services to the grid and internal energy balancing under varying ambient grid conditions as well as internal variable generation and demand.	**Need:** Need of effective and open-source control methods to provide desired (grid code compliant and device capability limited) grid-forming services, particularly when involving heterogeneous DC devices/users with different dynamic characteristics.
Outcomes: The control methods are applied in the future scenarios of AGIs and improve the performance and efficiency of their operation.	**Fears/Barriers:** The providers need to invest economic costs in exploring, upgrading, and testing these new control algorithms.
Features: Grid-forming operation, desired dynamic response, grid dynamic ancillary services, optimal performance.	**Gains:** Effective compliance of future grid-forming grid code requirements, high-performance dynamic response, rewards for grid-forming services, better utilization of reenable energy resources.

Table 25. VPC for DSOs

Open-source AGI control methods	DSOs
Benefits: The control methods enable AGIs to provide enhanced grid stability through advanced grid-forming ancillary services and improved flexibility to adapt to varying grid and demand conditions. Additionally, these methods	**Need:** The integration of AGIs accepts the grid dispatch, satisfies grid code requirements, and provides grid-forming ancillary services.

enable better integration of local renewable energy sources and reduce grid supply pressure.	
Outcomes: AGIs pass the grid code compliance test, are widely deployed in distribution grids, and successfully provide grid ancillary services.	**Fears/Barriers:** The stakeholders must invest time and resources to develop grid codes and testing requirements for grid-forming assets such as AGIs.
Features: Grid-forming operation, grid-code compliance	Gains: Accommodate more research energy generation and enhanced grid stability and flexibility.

Impact assessment

Table 26 describes how KER 4 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 26. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	The control algorithms provide new and flexible technical solutions for coordinating a set of heterogeneous energy generation/storage/usage systems.
Effective grid-integration	High	Grid-forming-type integration is effectively enabled by the developed control algorithms.
Reduced cost and improved efficiency of energy technologies	Medium	The developed control algorithms allow different control objectives aimed at reducing costs or improving efficiency.
Enhance consumer satisfaction	Medium	The developed control algorithms satisfy different control objectives or requirements of consumers.
Improvement of European technological value chain and scientific basis	Medium	The developed control algorithms represent a new technology development route.
Enhance sustainability considering social and economic aspects	Medium	The developed control methods make better utilization of renewables and enhance grid stability.

Exploitation activities

ETH presented a scientific paper during the Power Systems Computation Conference. The scientific paper presents a control algorithm, which translates grid code requirements into control objectives of an AGI central inverter. The algorithm achieves grid code specifications by the control of the AGI inverter and serves as a good basis for further investigation of the coordination of the AGI inverter and DC components.

KER	Dissemination activity	Description	Date
KER4	Power Systems Computation Conference 2024	Scientific paper presentation: Dynamic ancillary services: From grid codes to transfer function-based converter control	05/06/2024

3.2.1.5 KER5: Aqueous ECR battery system demonstration result

KER5	Aqueous ECR battery system demonstration result	WP4
KER Owner: FHG-IEE		Participants: GSR

Characterization of results

Result and objective: KER 5 seeks to understand the operational advantages of using an aqueous ECR battery and to explore the potential use cases for using a battery storage system made with innovative materials and possessing innovative properties.

Need: The charge/discharge cycles of a battery lead to the degradation of the battery ‘s life. This is not observed with the aqueous battery developed by GSR. The innovative aqueous ECR technology prevents significant degradation of the battery even with rapid high-power charge/discharge cycles. Additionally, the usage of non-organic solvents in the battery significantly reduces the material toxicity and fire hazard risk which is a common risk associated with conventional lithium-ion and lead-acid batteries. Moreover, the use of net-zero carbon materials in the battery's electrodes, reduces the environmental impact of the technology, making it a safer and more sustainable option.

Actors involved: In order to popularise the use of such an innovative battery, public entities such as research institutions would work together with Aqueous ECR battery manufactures to demonstrate use cases for its implementation. Private entities that are interested in implementing their products together with manufacturers of aqueous ECR batteries can also contribute to exploiting the results of this product.

Type: (Methodology) The project result will entail the description of how use cases for the Aqueous ECR battery were chosen based on its existing properties. (Processes) Furthermore, the setup and the laboratory tests conducted with the battery will be described, and areas for improvement will be identified. Based on the final outcome of this KER, it could potentially be used to guide product design efforts from Geyser.

Expl. Level: The current exploitation level of the KER is moderate as the concrete exploitation potential is under exploration. However, if the aqueous ECR battery technology proves to be cost efficient for a grid forming use case it might be highly exploitable.

Time to expl.: Depending on the evolution and progress of the ongoing activities, it could be estimated that the result would be exploitable between 1 and 2 years.

Expl. route: The results of the tests can be used to explore other avenues/use cases for this battery technology from the perspective of which characteristics of the battery will benefit which use cases. This could be further exploited through a commercial path by identifying marketable opportunities for this technology. Furthermore, there will be potential for researching this innovative battery and improving on the technology.

Scale: As the technology does not have any geographical constrains, it is foreseen that the exploitation could be achieved at a global level.

Link to other KERs:

KER 12: The result from KER 5 will be used as input for KER 12.

Stakeholder analysis and exploitation potential

While monitoring and engaging with primary stakeholders is important, some secondary stakeholders could be as relevant as they could represent either a direct competitor or a possible collaborator. This is the case for energy storage providers, as they could become a collaborator for GSR, depending on the type of energy storage they focus on. Similarly, power electronic providers could provide either GSR or GSR clients with appropriate solutions. Also, associations like EASE, BEPA etc. can support the energy storage community and facilitate the R&I work as well as assist in removing regulatory bottlenecks. Hence the KER will benefit from the exposure. Since the main outcome of KER 5 will be the demonstration of the aqueous ECR battery technology, this will result in two possible exploitation routes scientific and commercial. The resulting knowledge will be exploited through dissemination actions among the scientific community, power electronic providers and associations through scientific articles and informative talks. The commercial route to exploitation will be possible based on the feasibility of the technology to become a market-ready product.

Table 27. Influence vs interest levels of primary and secondary stakeholders for KER 5

Stakeholder	Influence/interest levels	Action
Electrolyser operators	HIGH	Encourage & influence
Pumping facilities	HIGH	
AGISTIN members	HIGH/MEDIUM	Keep satisfied/Encourage
Policymakers	HIGH/MEDIUM	
DSOs	MEDIUM/HIGH	Keep informed/Encourage
HD EV charging	MEDIUM/HIGH	
Data centres	MEDIUM/HIGH	
Associations	MEDIUM	Keep satisfied/informed/monitor/encourage
ES & power electronic providers	MEDIUM	
TSOs	MEDIUM	
Academia & scientific community	LOW/MEDIUM	Keep informed/Monitor

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 28. VPC for pumping facilities and electrolyser operators

Aqueous ECR battery system demonstration	Pumping facilities and electrolyser operators
Benefits: Cost-effective and sustainable fast-acting energy storage solution answering the needs.	**Need:** Hydropower or electrolysers cannot activate fast enough and need a power buffer to cover the first few seconds or minutes of operation.
Outcomes: Efficient grid integration and use in frequency regulation use-cases	**Fears/Barriers:** GSR Batteries and need to reach final design validation on their commercial packs through follow on development.
Features:	**Gains:**

Low cost, sustainability, safety	Reliable operation at low cost and increased renewables uptake

Table 29. VPC for heavy duty EV charging

Aqueous ECR battery system demonstration	Heavy duty EV charging
Benefits: Cost-effective and sustainable fast-acting energy storage solution answering the needs.	**Need:** High-power batteries, which will be both safe and long-lasting.
Outcomes: Use in charging station to reduce the load on the grid (for heavy-duty vehicles).	**Fears/Barriers:** GSR Batteries and need to reach final design validation on their commercial packs through follow on development.
Features: Low cost, sustainability, high-power, safety, long cyclic life	**Gains:** Reliable operation at low cost.

Impact assessment

Table 30 describes how KER 5 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 30. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	ECRs can cover the critical minutes-long gap before electrolysers/ hydropower/other LDES can ramp up their operation, hence ensuring uninterrupted and reliable operation of renewables-based power grid.
Availability of disruptive energy technologies	High	After reaching a required level of maturity, GSR's aqueous battery technology will become available for industrial users needing fast energy storage.
Reduced cost and improved efficiency of energy technologies	High	ECRs is 80% lower cost than the cost of conventional supercapacitors. In addition, ECRs' usable energy is up to 5 times higher than supercapacitors.
Enhance consumer satisfaction	High	Unlike the alternative energy storage solutions today (li-ion and supercapacitors), ECRs are fire-safe and have 80% lower cost than the cost of conventional supercapacitors today with the goal for further reduction in the long-run. Thus, offering a better and cheaper solution to the customers.
Improvement of European technological value chain and scientific basis	Medium	EU-based technology with the supply chain mainly based in Europe.
Enhance sustainability considering social and economic aspects	Medium	EU-based technology with the supply chain mainly based in Europe.
Effective market uptake	Medium	Tests leading to this KER will allow for more reference cases for the customers.

Exploitation activities and future actions

GSR has taken an active role in participating in dissemination efforts organised by sister projects to broadcast the innovative energy storage technology and its role in modern grids.

KER	Dissemination activity	Description	Date
KER5	ENERGY Talks #3	Advancing Energy Resilience: The critical Role of Battery Storage in Modern Grids	26/06/2024

The commercial potential of this result will be explored in depth along with GSR in the upcoming months. An initial business plan draft to analyse the market size and identify strategic objectives as well as possible competitors and future funding requirements will be implemented as part of the exploration efforts.

3.2.1.6 KER6: Validated models for industrial grid users providing grid forming capability

KER6	Validated models for industrial grid users providing grid forming capability	WP4
KER Owner: FHG-IEE	Participants: UniK, GSR	

Characterization of results

Result and objective: KER 6 objective involves testing models for storage integration using an AGI with the grid for providing grid forming services. Future applications of the...

Need: There is a need for validated models for industry manufacturers of grid forming converters and connected products (battery storage systems). These models can be used by industry for verifying the behaviour of developed products and matching them against validated models.

Actors involved: Power electronics and storage developers will use AGI control development to inform their own control development processes. Public entities such as system operators can use findings from models to determine the suitability of grid services provided by AGI enabled users.

Type: The project result will entail validated models with integrated AGI which can be used by industry in their validation process for their own product development. It will also provide a basis for further technological development of interfaces for storage and renewable energy sources, connected to the grid, that will be providing grid forming capability.

Expl. Level: This result will be highly exploitable as it will foster the integration of renewables and energy storage systems with the grid, while facilitating the uptake of grid forming ancillary services.

Time to expl: The grid forming capabilities with AGI will be demonstrated during the project as part of WP4 and will be ready for exploitation immediately by the end of the project.

Expl. route: The created models will be used as a basis for further AGI based model development. The improvements in the technology storage and converter side (which will be integrated with AGI interfaces) will be part of the technological exploitation route.

Scale: Based on grid service requirements in the country/ or region, the models can be validated by various actors such as industry and system operators and can be used at a local, national and global scales.

Link to other KERs:

KER3: The AGI templates from KER3 will be used for this KER.

Stakeholder analysis and exploitation potential

This KER is under further exploration by the involved industrial partner (Geyser), who will be able to provide further details regarding the target exploitation audience in the following months of the project. Up until now, some stakeholders with high influence on the result has been determined. The added value of the result and the determination of the specific need manifested by the target segments identified is being studied.

Table 31. Influence vs interest levels of primary and secondary stakeholders for KER 6

Stakeholder	Influence/interest levels	Action
HD EV charging	HIGH	Encourage & influence
Power electronic providers	HIGH	
Academia & scientific community	HIGH	
DSOs	HIGH/MEDIUM	Keep satisfied/Encourage

Primary stakeholders
Secondary stakeholders
Key stakeholders

3.2.1.7 KER7: Operation of coupled electrolyser, storage and renewables

KER7	Operation of coupled electrolyser, storage and renewables	WP5
KER Owner: FHG-IWES		Participants: SHL

Characterization of results

Result and objective: The objective of KER 7 is to understand what the operational requirements of a green hydrogen production site with an onsite generation are, what are the important design options and considerations, which storage technology is most suitable and how it should be integrated.

Need: Little experience exists in the production of green hydrogen at large-scale and how the components, e.g., a PV plant and a battery energy storage, should interact with the electrolyser. Besides common integration practices of each device via a common AC bus, the AGI provides an alternative that could offer a more efficient solution.

Actors involved: Public research institutions developing new methodologies work together with industry partners, such as Shell, developing advanced control methodologies for coupled operation of electrolyser with renewables. This enables electrolyser operators to test the limits of electrolyser operation in weak grid/islanded conditions and understand latest GFM technology that will be used within the storage system to stabilize the hybrid network.

Type: The outcomes of the demonstration and simulative studies will be the knowledge about the operation of green hydrogen plants in a hybrid layout and the special considerations during the design phase, for example, the size of the battery and converter control design. The learnings will be shared in deliverable D5.3 and through scientific articles during and after the project period.

Expl. Level: Moderate. The learnings made during the project will impact future designs of industry partners, such as Shell. Scientific articles will ensure that the learnings are shared with industry, this will impact other future projects.

Time to expl. It is difficult to provide an accurate estimation as the electrolyser market is facing challenges in the scale-up of production, which in turn impacts future projects. Since the participating partners are involved in future follow-up projects, the result may be exploitable in 3 to 5 years.

Expl. Route: The exploitation route is along scientific articles and future technological designs that can be applied on field and could have a potential commercial exploitation.

Scale: It will impact the global hydrogen market.

Link to other KERs.

KER8: As the electrolyzer is exposed to weak grid conditions, the support from the storage devices would be higher. The reliability on the storage devices based on duration (short term/long term) could provide information on the efficiency and lifetime of the electrolyser.

Stakeholder analysis and exploitation potential

The key stakeholders for the operation of coupled electrolyser along storage and renewables are indeed electrolyser operators who are interested in getting to know the control capabilities of the electrolyser when coupled with solar generation and energy storage systems. At the same time, the coupled operation of energy storage devices with renewables and electrolysers can provide new solutions to address the intermittency issues. Different types of energy storage devices can be further explored to support the system. This will be of high interest for energy storage providers and DSOs, who will be keen to understand the operation of the hybrid system in weak grid conditions. For this reason, also battery energy storage researchers could be key in the study of how different types of energy storage technologies can have various impacts in terms of grid support. In the same way, the outcomes of using grid forming converters in weak grid and islanding modes are of keen interest to power electronic providers, who could quickly adopt this technology over the conventional thyristor-based converters used in electrolyser applications. Similarly, TSOs are interested in the hybrid system behaviour for different testing conditions based on new grid codes being developed. In large scale projects with higher voltage networks, the hybrid system can provide various grid services and can support the grid. On the other hand, other key stakeholders might have a more evident influence on the result and its future applications. National governments can further support large scale on site green hydrogen production to accelerate the energy transition, while understanding the challenges of operating electrolysers at extreme conditions will facilitate the support from regulators to formulate new grid codes. Academia, the scientific community and the consortium members can impact the results by developing and testing models involving grid forming and grid supporting technologies used for the AGI. Understanding the advantages provided by grid forming technologies and their impact on supporting the grid would give place to diverse exploitation plans spanning from knowledge transferring, technology enabling and commercial opportunities of new products and services.

Table 32. Influence vs interest levels of primary and secondary stakeholders for KER 7

Stakeholder	Influence/interest levels	Action
Electrolyser operators	HIGH	Encourage & influence
ES & power electronic providers	HIGH	
BES researchers	HIGH	
Policymakers	HIGH	
TSOs/DSOs	HIGH	
Academia & scientific community	HIGH	
National governments	HIGH	
AGISTIN members	HIGH	
EU institutions	MEDIUM/HIGH	Keep informed/Encourage

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 33. VPC for electrolyser operators, energy storage & power electronic providers, BES researchers

Operation of coupled electrolyser, storage and renewables	Electrolyser operators, energy storage & power electronic providers, BES researchers
Benefits: Optimal operation of electrolyser with on-site solar generation in weak grid conditions Contribution of an energy storage System equipped with a grid-forming inverter in strengthening the resilience of the hybrid system Testing of the hybrid system for various scenarios to understand the coordination between the power electronic converters present in the system	**Need:** Insufficient knowledge of electrolyser plant operation with renewables in weak grid conditions Test scenarios to be performed for such hybrid layouts considering weak grid and different types of technologies (grid following and grid forming) are still in the early stages of formulation
Outcomes: Moving to large scale on-site production of green hydrogen by integrating electrolysers with various renewable sources and energy storage systems at higher voltage ratings	**Fears/Barriers:** Technical capabilities of electrolyser operation with intermittent PV generation Concerns about the electrolyser's operation in islanded conditions with solar generation and energy storage.
Features: Optimal sizing of energy storage system for coordinated operation of electrolyser with solar generation in weak grid conditions. Advanced control developed for green hydrogen production from solar generation.	**Gains:** Performance of hybrid system in weak grid conditions. Role of energy storage system in stabilizing the hybrid system and support during weak grid conditions.

VPC for DSOs and policymakers

Operation of coupled electrolyser, storage and renewables	DSOs and policymakers
Benefits: Optimal operation of electrolyser with on-site solar generation.	**Need:** The technical challenges associated with operating electrolysers in conjunction with renewables and storage are not yet fully understood, and the concept remains in its initial stages.
Outcomes: The learning will help in understanding the on-site production of green hydrogen by integrating electrolysers with various renewable sources and energy storage systems at higher voltage ratings for large scale systems.	**Fears/Barriers:** The role of storage system to better the poor power quality and dynamics of the electrolyser that can deteriorate the local network.
Features: Optimal sizing of energy storage system for coordinated operation of electrolyser with solar generation in weak grid conditions. Advanced control developed for green hydrogen production from solar generation.	**Gains:** Better understanding of the technical challenges in integrating electrolyzers with renewables. This will help in developing new grid codes for P2G keeping the challenges in mind.

Impact assessment

Table 34 depicts a detailed description of how KER 7 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 34. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	Optimal sizing of energy storage system and enhanced operation of electrolysers at various operating/grid conditions
Availability of disruptive energy technologies	High	Islanded operation of electrolysers with solar power and energy storage system with grid forming technology
Effective grid-integration	High	Integration of renewable energy sources like solar with electrolyser, energy storage system and with or without external grid connection
Reduced cost and improved efficiency of energy technologies	High	Reduces the grid connection fees and improves electrolyser efficiency and lifetime
Enhance consumer satisfaction	Medium	Reduction in levelized cost of hydrogen and the operational cost of electrolyser plants
Improvement of European technological value chain and scientific basis	High	Promoting electrolyser operation at various conditions can provide opportunities to utilize co-location of renewables and electrolysers in various scales
Enhance sustainability considering social and economic aspects	Medium	Mix of renewables and energy storage optimizes to reduce costs and provision of cleaner energy
Effective market uptake	High	Being in the initial stages of the concept, the influence on market penetration, customer adoption and technological integration can gradually increase

Exploitation activities

SHL has successfully participated in dissemination activities to showcase the progress of partial results obtained during the implementation of its activities. The operation of the alkaline electrolyser together with solar power in weak grid conditions was addressed at the Fraunhofer IWES workshop. The webinar provided insights on the challenges with respect to the upcoming grid codes for electrolyser operation.

KER	Dissemination activity	Description	Date
KER7	2nd Workshop on integration of Local Energy Systems	Scientific paper: The influence of grid-forming loads on transient stability	17/11/2023
KER7	Webinar	Perspectives on Grid Connection Networks for Energy Storage	23/05/2024

3.2.1.8 KER8: Determination of the impact of storage systems on alkaline electrolyser degradation

KER8	Determination of the impact of storage systems on alkaline electrolyser degradation	WP5
KER Owner: FHG-IWES	Participants: SHL	

Characterization of results

Result and objective: The objective of KER 8 is to understand how the co-location of storage systems can help in reducing the stress of grid disturbances on alkaline electrolysers and how it can help in reducing the degradation caused by sudden transients.

Need: Little experience exists in the operation of electrolysers at large dimensions. The scale of grid-connected electrolysers at the scale of tenths to hundreds of gigawatts capacity requires for the electrolyser to be operated in a dynamic manner. However, little information exists on what is the possible impact of a dynamic operation on the cell and the lifetime of electrolysers, such as alkaline electrolysers.

Actors involved: The research will be carried out by FHG-IWES in discussion with industry partners, such as Shell.

Type: The learnings will be shared in scientific articles, conferences, and entries in global electrolysis databases.

Expl. Level: There is interest from the industry on this subject, however, the willingness to allow a more dynamic operations and changing security measures is unknown. Key actors will be addressed by adequate conferences.

Time to expl: It is expected that the outcomes of this results will impact future projects in 3 to 5 years depending on the market situation.

Expl. Route: Results are made available via international databases on electrolysis reliability and learnings will be shared through scientific articles addressing academia as well as the industry.

Link to other KERs:

KER 7: Provides the plant configuration on which KER 8 is being investigated.

KER 12: Thanks to the tests set to be carried out with the storage system and the data obtained from its real operating procedure, it will be possible to validate the model with real data and thus achieve an optimisation of the model.

Stakeholder analysis and exploitation potential

Battery energy storage researchers would be interested in the result as they can provide potential solutions to electrolyser manufacturers and operators as well as to power electronic and energy storage providers. Similarly, the result is of high interest to energy storage providers if the result can prove that the degradation of the electrolyser could be improved using energy storage solutions (supercapacitors or any high-power, low-capacity storage manufacturer). This could create a new market opportunity. On the other hand, academia and the scientific community were identified as secondary stakeholders that have a high interest in developing new solutions to reduce the electrolysers' degradation (or electrochemical components like batteries, fuel cell, etc. in general). However, they won't not influence the business profitability. They would influence the result by finding new solutions to increase the cell's lifespan. Reducing the degradation of electrolysers might allow for a more dynamic and flexible mode of operation that TSOs and DSOs will require in the future. Consortium members like SHL, that are operators, have an interest in the result as it might influence their future business opportunities. KER 8 will all ow for a deeper understanding of the impact that the energy storage components have on the electrolyser operation and the performance of the hybrid system. Thus, the route to exploitation will be scientific, informing mainly the battery energy storage researchers and providers and electrolyser manufacturers, who will potentially use this information during the design phase and to provide operational instructions. Moreover, the results will offer knowledge, that can be used by industrial electrolyser operators, in the commercial exploitation of grid-connected electrolyser systems.

Table 35. Influence vs interest levels of primary and secondary stakeholders for KER 8

Stakeholder	Influence/interest levels	Action
Electrolyser manufacturers & operators	HIGH	Encourage & influence
BES researchers	HIGH	
Energy storage providers	HIGH	
Power electronic providers	HIGH/MEDIUM	Keep satisfied/Encourage
Academia & scientific community	MEDIUM/HIGH	Keep informed/Encourage
AGISTIN members	MEDIUM/HIGH	
TSOs	MEDIUM	Keep satisfied/informed/monitor/encourage
Policymakers	MEDIUM	
DSOs	LOW/MEDIUM	Monitor

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 36. VPC for electrolyser manufacturers and operators, BESS researchers and ESS providers.

Impact of storage systems on alkaline electrolyser	Electrolyser manufacturers and operators, BESS researchers and ESS providers.
Benefits: Less maintenance cost of the electrolyser	**Need:** Achieve cost-effective green hydrogen production.
Outcomes: More cost-effective hydrogen production	**Fears/Barriers:** Additional costs of storage units are larger than the replacement cost of the electrolyser stack.
Features: Possibly reduce the aging of the electrolyser stack, lowering investment costs due to less frequent exchange of stacks	**Gains:** Offer longer lasting electrolyser stack operation, which in turn, could reduce the cost of hydrogen

Impact assessment

Table 37 depicts a detailed description of how KER 8 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 37. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	Medium	Reduced degradation could allow for a more flexible operation, which could improve the system stability because electrolysers could change their setpoints more quickly, or also support in reactive power provision.
Effective grid-integration	Medium	Reduced degradation could help in operating the electrolyser more flexible which would allow for a better integration into the electricity grid
Reduced cost and improved efficiency of energy technologies	High	Reducing the degradation of electrolyser stacks could help in making it more cost-competitive.
Enhance sustainability considering social and economic aspects	Low	more green hydrogen would allow for a more sustainable energy system if other sectors switch to hydrogen usage, e.g., furnaces, mobility sector, etc.
Effective market uptake	Medium	If a cost reduction of hydrogen could be achieved, then this could impact the effective market uptake of electrolysers

Exploitation activities

FHG-IWES presented the activities developed in relation to this KER in the 2nd Workshop on Integration of Local Energy Systems. Researchers (academia / scientific community) in the electrolyser field contributed to raise awareness about the topic. Also, a scientific paper was presented during the Power Systems Computation Conference.

KER	Dissemination activity	Description	Date
KER8	2nd Workshop on Integration of Local Energy Systems	Fraunhofer IWES Workshop	17/11/2023

3.2.1.9 KER9: Multi-level control system for irrigation canals to act as storage

KER9	Multi-level control system for irrigation canals to act as storage	WP6
KER Owner: UPC	Participants: ICAT, teknoCEA	

Characterization of results

Result and objective: The multi-level control system aims to create a two-layered tool for operating (high-level) and controlling (low-level) an innovative irrigation canal-based energy storage system, customized to meet field requirements. Initially, a real-time operation tool (high-level) will be designed to guide various devices within the irrigation system, optimizing the energy storage system based on diverse criteria such as cost reduction, irrigation priority, water consumption, and maximum water storage. This tool will generate optimal operation plans considering current and future system states, weather forecasts, and flexibility services. At a lower level, control design for individual elements of the energy storage system, including AGIs, will be developed to align with optimal setpoints. Control specifications, operation modes, and system models will be defined, ensuring accurate tracking of setpoints while respecting system limitations and device capabilities. This comprehensive approach ensures efficient operation and optimal performance of the energy storage system within the irrigation context.

Need: The tool will follow a techno-economic approach at the high level (optimization) and a pure technical approach at the lower level (control).

Actors involved: The result is aimed to different stakeholders in the private and public sectors.

- Irrigation community (private)
- ICAT (public)
- Distribution network operator (private)
- Transmission network operator (public/private)
- Exploitation and maintenance services(private)

Type: The low-level control tool will be reported and the high-level operation tool and controller examples will be compiled and published on github following an open-source-based approach. The **algorithms** will be made available for the general public and they will also be published and detailed in journal and **conference papers**. In addition, developing a potential **product** for both tools will be considered.

Expl. Level: The tool will be ready to be deployed in the field, given the demo tests that will be conducted throughout the project.

Time to expl: In two years, the optimization tool will be ready to be moved to an exploitation phase.

Expl. Route: First, the tool will follow a **scientific route** to later on be possibly used in **techno-economic** (operation) and purely **technical** (control) calculations.

Scale: Irrigation canals are being used at a global scale; therefore, it is considered that such tools can be applicable in any option.

Link to other KERs:

KER13: The technology output will provide upgraded design of the irrigation canals to act as energy storage. It will be linked to KER13, when this system starts its operational phase.

Stakeholder analysis and exploitation potential

The main stakeholders for this result will be energy storage providers, who have the ability to provide energy storage services to the distribution grid while the irrigation system works and the irrigation communities who will be directly benefited from the result as the tool reduces the operation costs. Similarly, as pumps are an essential part of the system, different pumping facilities are considered in the tool (e.g. as reversible pumps or banks of pumps). At the same time, the tool evaluates the possibility of integrating an EV charging station, although it is not the primary use. The tool also considers the possibility to provide ancillary services to the grid, thus DSOs are regarded as key stakeholders. On the other hand, despite being connected to the distribution network, large-scale irrigation systems can provide energy storage related services to the TSOs. Aggregation of different systems is possible. Power electronic providers would be highly interested in the result as the multi-level control that optimizes the irrigation system commands the power electronics assets (enabling technology). Associations are also identified as key stakeholders since the tool offers an optimal operation of the irrigation systems that would raise the interest of irrigation communities. Finally, the academia and scientific community would be among the most interested parties with high influence in the open-source optimisation tool that provides an innovative manner to control irrigation plants and optimizes other systems. The main outcomes of KER 9 will result in new knowledge that can inform energy storage providers and operators who are interested in offering energy storage services to the grid, while supporting the operation of irrigation systems to act as energy storage. Similarly, the resulting control system is proven by the Segrià Sud irrigation community who will leverage the tool in the operation of its pumping facilities, allowing for cost reduction and optimisation. This can be extended to several other irrigation communities and pumping facilities who seek to provide ancillary services to the grid, even at large-scale. The tool also allows for the aggregation of different systems. Additionally, the tool considers its application in an EV charging station, although it is not the primary use. The result provides an open-source optimisation tool that can be also exploited by the scientific and academic communities.

Table 38. Influence vs interest levels of primary and secondary stakeholders for KER 9

Stakeholder	Influence/interest levels	Action
Power electronic providers	HIGH	Encourage & influence
DSOs	HIGH	
TSOs	HIGH	
Pumping facilities	HIGH	
Energy storage providers	HIGH	
Associations	HIGH	
Academia & scientific community	HIGH	
Irrigation communities	HIGH	
Policymakers	MEDIUM	Keep satisfied/informed/monitor/encourage
HD EV charging	MEDIUM	

BES researchers	LOW/MEDIUM	Keep informed/Monitor
Civil society	MEDIUM/LOW	Keep satisfied/Monitor
Government & financial institutions	MEDIUM/LOW	

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 39. VPC for irrigation communities

Multi-level control systems for irrigation canals	Irrigation communities, pumping facilities, associations
Benefits: The tool helps to reduce the operational costs of the irrigation plants and enable energy storage services from large-scale irrigation systems. The tool is also supported by a sizing tool to redesign the system for improved capabilities.	**Need:** Due to electricity prices, high demand and non-optimal operational planning, the irrigations plants suffer extremely expensive operational costs. They are currently not prepared to act as storage systems.
Outcomes: Considering the irrigation system assets, inputs as weather forecast and electricity prices, and the state of the plant, the tool returns an optimal operational trajectory. It also integrates the capacity of providing network services.	**Fears/Barriers:** Lack of confidence in an automatic and optimized operation of the plant by the local operators of the irrigation plant. Current state of the irrigation canals does not enable the full operational capacity of the system.
Features: Optimal and reliable planner for irrigation plants operation. The sizing tool outputs the new/modified assets to be installed in existing plants.	**Gains:** Reducing the operating costs of the irrigation system. Reliable irrigation plant. Internal and external services to be provided.

Provision of storage services	Irrigation communities, academia and scientific community, energy storage providers, DSO/TSO
Benefits: The tool allows to consider pumping systems and irrigation communities' facilities as providers of innovative energy storage services.	**Need:** Irrigation communities are currently not prepared to act as storage systems. Few literature on these kind of systems as network services providers.
Outcomes: The tool integrates the capability of providing network services. Utilising the pumping systems as energy storage, considering turbines and pumps working as turbines.	**Fears/Barriers:** Lack of confidence in an automatic and optimized operation of the plant by the local operators of the irrigation plant. Current state of the irrigation canals does not enable the full operational capacity of the system. Few literature on these kind of systems as network services providers.
Features: Optimal and reliable planner for irrigation plants operation.	**Gains:** Reducing the operating costs of the irrigation systems. Reliable irrigation plant. Internal and external services to be

The sizing tool outputs the new/modified assets to be installed in existing plants.	provided. New and innovative energy storage services that will require little new infrastructure. New challenges and solutions on optimisation techniques of these systems.

Impact assessment

Table 40 depicts a detailed description of how KER 9 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 40. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	The multi-level optimization tool considers the flexibility of the irrigation plant to provide grid services, as demand control.
Availability of disruptive energy technologies	Medium	The tool considers existing technology, but it might open the door to innovative technologies (e.g. innovative pump design)
Effective grid-integration	High	The tool ensures the proper grid integration by respecting grid codes.
Reduced cost and improved efficiency of energy technologies	Medium	By reducing the operational costs of the irrigation plant.
Enhance consumer satisfaction	High	The reduction costs of operations have an might have an impact on the consumer community,
Improvement of European technological value chain and scientific basis	Medium	The tool opens the potential paths for research
Enhance sustainability considering social and economic aspects	High	The optimisation considers the main role of the irrigation system, while contributing to reduce operation costs and improve network resilience and flexibility for the vicinity towns.
Effective market uptake	Medium	Result profitable to irrigation communities and grid operators.

Exploitation activities

UPC has started the scientific exploitation of the result by presenting scientific conference papers in the OSMSES conference and ISGT Europe this year.

KER	Dissemination activity	Description	Date
KER9	Open-Source Modelling and Simulation of Energy Systems (OSMSES 2024) conference presentation.	Scientific paper: Multi-physics operation and sizing optimisation in Pyomo: Application to large irrigation systems. Description of the tool and simulation of an irrigation system.	03/09/2024

3.2.1.10 KER10: Results of testing Redox-flow battery

KER10	Results of testing Redox-flow battery	WP6
KER Owner: CDR		Participants: UPC

Characterization of results

Result and objective: The main objective of KER 10 is to test a commercial, yet less familiar and explored storage system. This KER will generate further knowledge on the operation of the storage system through different profiles or consumption cases.

Need: Lack of test trials to anchor the technology.

Actors involved: The company developing the battery system is involved, and CIEMAT is involved as a testing entity.

Type: The result involves the product itself and the experience of using it.

Expl. Level: These tests would involve an important aspect of getting to know the system better and then exploiting the results obtained.

Link to other KERs:

KER 12: Thanks to the tests set to be carried out with the storage system and the data obtained from its real operating procedure, it will be possible to validate the model with real data and thus achieve an optimisation of the model.

Stakeholder analysis and exploitation potential

As it is a new storage system and not as widely tested as other storage technologies, the results would be of high interest for researchers in the field of battery storage. Everything involved in this system, from its materials, operation, etc. can help to extrapolate relevant conclusions that can provide information in the field of storage systems. For both, energy storage providers and power electronic providers, the real operating data of a storage system that is not widely used and is currently being tested and defined will help to bring greater maturity to the technology and provide it with higher reliability and proof in order to gain a position in the market and new customers for this type of storage. On the other hand, the result could prove to be interesting to pumping facilities, which are normally used without the support of storage systems. This not-so-common approach can be interesting for the operation of pumping facilities from a different perspective in the future. Lastly, consortium members, in particular UPC, would have a high interest in the result as they use real operating data to optimise the digital model. The main outcome of KER 10 will be the results of testing the VRF battery technology in the pumping application. The results will be used to inform energy storage and power electronic providers, who will exploit this information by improving the knowledge about the technology and potentially boosting the performance, which could result in increased opportunities for energy storage grid-connected services.

Table 41. Influence vs interest levels of primary and secondary stakeholders for KER 10

Stakeholder	Influence/interest levels	Action
ES & Power electronic providers	HIGH	Encourage & influence
European institutions	MEDIUM/HIGH	Keep informed/Encourage
BES researchers	MEDIUM/HIGH	
Policymakers	MEDIUM	Keep satisfied/informed/monitor/encourage
Associations	MEDIUM	
AGISTIN members	MEDIUM	
Pumping facilities	LOW/MEDIUM	Monitor

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 42. VPC for energy storage and power electronic providers

Pilot – Use of VRFB in irrigation systems	Energy storage and power electronic providers
Benefits: Real data acquisition of a micro-grid consisting of generation, storage and load systems. Increased knowledge of how the equipment works in a real equipment operation. Increased knowledge of the operation of the storage system	**Need:** Energy input from the distribution network for the operation of turbines/pumps thus assuming a non-zero balance in terms of energy consumed vs. input.
Outcomes: Open the doors to a new way of operating hydraulic systems with the union of renewable generation systems and storage systems, to address their mode of operation from a more renewable point of view.	**Fears/Barriers:** Referring to the storage system. New, untested technology and potential for problems during operation hitherto unknown.
Features: Joint operation with different types of systems in the renewable sector	**Gains:** Increased knowledge of the operation of the storage system. Operational knowledge of a microgrid consisting of hydro, photovoltaic and storage systems with the objective of optimised overall operation.

Impact assessment

Table 43 depicts a detailed description of how KER 10 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 43. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	Medium	With the actual data collected in this microgrid serves as a study to see how energy systems are influenced by these two aspects

Availability of disruptive energy technologies	Medium	If the performance tested in this project is satisfactory, it could be considered as a new reliable and suitable technology for future installations with storage systems, offering the possibility to diversify from the different types of batteries.
Effective market uptake	High	The impact on the battery storage system can be high as it is an unproven technology with a wide range of possibilities if it is well operated.

Exploitation activities:

Several visits to the pilot site have been organised, in which different consortium members have participated to show the purpose of their activities as well as of the project's. Other attendees have expressed their interest in the performance of the equipment being tested and the integration of them working together as a system.

KER	Exploitation activity	Description	Date
KER10	Pilot to demonstrate the potential of using irrigation systems as an energy storage medium.	Testing of redox flow battery and advance grid interface in pumping applications	19/06/2024

3.2.1.11 KER11: Determination of minimum economic grid connection for SHL renewable H2 demo

KER11	Determination of minimum economic grid connection for SHL renewable H2 demo	WP5
KER Owner: SHL	Participants: RINA, FHG-IWES	

Characterization of results

Result and objective: Increasing grid connection fees and the need for affordable hydrogen requires for an economic design of a green hydrogen site consisting of a renewable power supply, an electrolyser, and an energy storage system. The objective of KER 11 is to find design considerations that lead to an economically attractive solution.

Need: The need for cost reduction in green hydrogen production opens the possibility of having a reduced grid connection compared to the total hybrid generation load site capacity, to reduce the grid connection fees. A reduced grid connection will also help integrating more renewables and hybrid sites, as less capacity is required, utilizing the limited network capacity for more sites.

Actors involved: Key actors are plant operators such as Shell, developers and designers, such as FHG-IWES, and research institutions/ consultancies such as CARTIF and RINA for the economic assessment. Grid operators (DSOs/TSOs) will be mandated to provide only a reduced grid connection. Developers could benefit from the lower grid connection fees associated with this smaller connection.

Type: The result will be the **expertise** obtained during the demonstration and simulative studies, that will lead to **publications**, new **design practices**, etc.

Expl. Level: The learnings will impact future projects and plant designs. Since there is a need for cost reduction, it is expected that project developers and plant designers will try to implement the results as soon as possible.

Time to expl: The subject is of interest, and it is expected that it will impact future projects in 3 to 5 years depending on the market situation, which is currently very volatile.

Expl. Route: **Scientific** articles about the findings, and new design procedures will be the main outcomes for an economic impact due to reduced cost.

Link to other KERs:

KER 3: Possibility to model the network based on the available tools and models in this KER.

KER 7: The coupled operation of electrolyser, storage and renewables provide clarity on the intermittency of the electrolysers and by bettering the poor power quality deteriorating the local network. Equipping the electrolyser with storage to provide grid supporting functionalities to support integration in weak grids.

KER 8: Improving the efficiency of the electrolyser and lifetime by minimizing any large transients acting on the electrolyser. Advanced technologies like GFM converter with storage allow the electrolyser to operate in weaker grid conditions thus supporting in determination of the minimum required grid connection.

Stakeholder analysis and exploitation potential

Among the key stakeholders identified for KER 11 are electrolyser operators since the result could impact the operation schedule of the electrolyser (specifically the BoP) plus energy storage on the grid connection requirement. At the same time, battery energy storage researches would have a high interest in the result to study the impact of different storage technologies to maximise the green hydrogen production during continuous operation. Additionally, energy storage and power electronic providers would use the optimal sizing of short-term storage to provide stable operation of electrolysers under weak grid conditions and integrate this into the design of converts as they key components and constitute an important part of the hybrid system. The tool would also result helpful for TSOs, especially in large scale projects involving high voltages where the sizing of energy storage and operation schedule of electrolysers can significantly determine the grid connection sizing. On the other hand, DSOs would be interested in the challenges and impacts of providing a lower grid connection for a large hybrid power plant consisting of on-site generation and load. Finally, the result could be of high interest for EU institutions, policymakers and national governments who could use it to promote new regulations supporting power-to-gas connections, hydrogen production and the development of new green hydrogen infrastructure, such as production facilities and distribution networks.

Table 44. Influence vs interest levels of primary and secondary stakeholders for KER 11

Stakeholder	Influence/interest levels	Action
Electrolyser operators	HIGH	Encourage & influence
DSOs	HIGH	
TSOs	HIGH	

BES researchers	HIGH	
ES & Power electronic providers	HIGH	
AGISTIN members	HIGH	
EU institutions & policymakers	HIGH	
Academia & scientific community	MEDIUM	Keep satisfied/informed/monitor/encourage
HD EV charging	MEDIUM	
Data centres	MEDIUM	
Associations	MEDIUM	

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 45. VPC for electrolyser operators, energy storage & power electronic providers, BES researchers and consortium members

Determination of minimum economic grid connection for SHL renewable H2 demo	Electrolyser operators, energy storage & power electronic providers, BES researchers and consortium members
Benefits: Sustainable operation of electrolysers with solar power generation. A lower grid connection requirement compared to a significantly larger on-site generation and demand system. New design characteristics to improve electrolyser operation and hence have an economic impact	Need: Infrastructure reinforcements supportive to integrate large scale renewables. The high grid connection fee for green hydrogen and the time delay in getting the grid access for large scale green hydrogen projects.
Outcomes: Self-sustaining hybrid system in weak grid and islanded conditions by addition of energy storage. Calculation of the minimum size of storage required for the green hydrogen production system in weak grid conditions.	**Fears/Barriers:** The effect on the BoP in the electrolyser plant during operation under weak grid conditions. Ability of storage components to support during fast transients in the network.
Features: Optimal operation of green hydrogen production that can further be elevated to a larger scale. Impact of energy storage in stabilizing the hybrid system.	**Gains:** Advanced control architecture developed to support the stabilized operation of electrolyser and renewables during weak grid and islanded conditions.

Table 46. VPC for DSOs, TSOs, EU institutions, policymakers and national governments

Determination of minimum economic grid connection for SHL renewable H2 demo	DSOs, TSOs, EU institutions, policymakers and national governments
Benefits: A lower grid connection requirement compared to a significantly larger on-site generation and demand system.	**Need:** Possibilities to provide more grid connections for such hybrid systems that require only a small sizing of grid connection for a sufficiently large generation/load connected.
Outcomes: Determination of the minimum required grid connection for stable operation of electrolysers with renewables and storage	**Fears/Barriers:** Provision of grid services must be addressed The new grid codes (e.g. DCC 2.0) for P2G must consider the technical competency of the electrolyser operation
Features: Capability of coordinated operation of electrolysers with renewables and storage which could also provide grid services.	**Gains:** The necessity of only a small grid connection for optimal operation of significantly larger green hydrogen production with renewable energy and energy storage.

Impact assessment

Table 47 depicts a detailed description of how KER 11 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 47. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	High	Understanding the capability of energy storage system to maintain the stability of the hybrid system in weak and islanded conditions
Availability of disruptive energy technologies	High	Understanding the integration of renewable generation with green hydrogen production and its success can lead to increased deployment of electrolysers, thereby reducing their cost.
Effective grid-integration	High	As the grid becomes weaker in the future, the solution for operating green hydrogen plants in such conditions becomes vital
Reduced cost and improved efficiency of energy technologies	High	Deployment in large scale can significantly reduce the CAPEX and OPEX
Enhance consumer satisfaction	Medium	Increase in the production of green hydrogen can lead to lowering the price and can be economic friendly for consumer
Improvement of European technological value chain and scientific basis	High	The immediate necessity for grid infrastructure reinforcement can be lowered and new combinations of renewable generation and load can open new trajectories for research
Enhance sustainability considering social and economic aspects	High	Combining renewables with energy storage optimizes cost reduction and provides cleaner energy. The lower the grid connection required can also significantly reduce the cost
Effective market uptake	Medium	As the concept is in its early stages, its impact on market penetration, customer adoption, and technological integration can gradually grow.

Exploitation activities

SHL has successfully participated in dissemination activities to showcase the progress of partial results obtained during the implementation of its activities. The operation of the alkaline electrolyser together with solar power in weak grid conditions was addressed at the Fraunhofer IWES workshop. The webinar provided insights on the challenges with respect to the upcoming grid codes for electrolyser operation.

KER	Dissemination activity	Description	Date
KER7	2nd Workshop on integration of Local Energy Systems	Scientific paper: The influence of grid-forming loads on transient stability	17/11/2023
KER7	Webinar	Perspectives on Grid Connection Networks for Energy Storage	23/05/2024

3.2.1.12 KER12: Validated models of innovative storage behaviour

KER12	Validated models of innovative storage behaviour	WP 3,4,5,6
KER Owner: FHG-IWES, GSR	Participants: FHG-IEE, UPC, CDR	

Characterization of results

Result and objective: The goal of KER 12 is to understand the dynamic properties of innovative storages technologies, such as the aqueous ECR battery system, to help identifying suitable use-cases for the respective technology. This will help R&D and product developers to design suitable dynamic responses of the storage systems, e.g., to provide marketable system services, and to help developing solutions for the integrations of generators and loads based on the AGI-concept.

Need: There is little information about the dynamic behaviour of innovative storage technologies, such as the aqueous ECR battery system from GSR, or the vanadium redox flow battery. Therefore, some test results are needed to identify their potential for the AGI.

Actors involved: The target group are storage manufacturers and storage solution providers. For this KER, industry partners, such as GSR, work together with public research entities, e.g., FHG-IEE, FHG-IWES, or UPC, and other industry partners, like Shell, to assess their potential in their demonstration case.

Type: The project result will be mainly the **expertise** about the dynamic behaviour of the tested storage systems and their potential use-cases. Depending on the availability of public data sets, **scientific articles** may be produced.

Expl. Level: The results will be utilized in developments shared in scientific articles impacting the development of use cases of storage systems. The results can be used to inform storage providers by contributing to the roadmap of storage integration and their use cases.

Time to expl: After the test results and the integration of those in the AGI-development, KER owners forecast that results could be exploited in 1-2 years.

Expl. route: The results will be exploited in developments shown in **scientific articles** and in the **product** developments of GSR.

Scale: The learnings will be provided in deliverables, and scientific articles, that are available and applicable on a global scale.

Link to other KERs:

KER3: Will be using the model in the implementation of the result.

KER5 & KER10: Will be providing inputs for the development of the models.

Stakeholder analysis and exploitation potential

Battery energy storage researchers and energy storage providers were identified as key stakeholders because of the high interest these parties have in validated models to be able to offer credible information about the dynamic behaviour of their products. Moreover, researchers can use the models to test different types of energy storage systems. The result is also relevant for consortium members like FHG, who is working in the development of the models, while operators like SHL, or manufacturers like TeknoCEA are interested in the models' applications. Similarly, the result could be useful for EV charging and pumping facilities, and data centres who are interested in exploring and adopting new and validated energy storage technologies. TSOs would be more inclined to use the outcome of the models to study the dynamic behaviour of new technologies that could be integrated into the utility network. The exploitation potential of KER 12 is based on the utilisation of the validated models by interested parties such as consortium members, BESS researchers and energy storage providers. The result can also be extended to different BESS researchers, who will use the models to test future innovative energy storage systems. Thus, enabling new technology to be validated and potentially scaled.

Table 48. Influence vs interest levels of primary and secondary stakeholders for KER 12

Stakeholder	Influence/interest levels	Action
BES researchers	HIGH	Encourage & influence
Energy storage providers	HIGH	
HD EV charging	MEDIUM/HIGH	Keep informed/Encourage
Academia & scientific community	MEDIUM	Keep satisfied/informed/monitor/encourage
AGISTIN members	MEDIUM	
Power electronic providers	MEDIUM	
TSOs/DSOs	LOW/MEDIUM	Keep informed/Monitor
Pumping facilities & electrolyser operators	LOW/MEDIUM	

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 49. VPC for BESS researchers, ESS & power electronic providers

Validated models of innovative storage behaviour	BESS researchers, ESS & power electronic providers
Benefits: Better understanding of the dynamic behaviour of	**Need:** innovative storage technologies need to compete with

innovative storages	well-established, cost-effective technologies that offer lower risk to the costumer
Outcomes: Effective usage of innovative storages in different applications and better designs	**Fears/Barriers:** New innovative storage technologies might not be utilized because of lack of validated models, missing experiences, and the resultingly lower market uptake
Features: Validated models	**Gains:** Validated models allow for easier, faster, and more cost-effective product development of new solutions (e.g., converters) that utilize the storage technologies

Impact assessment

Table 50 depicts a detailed description of how KER 12 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 50. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact
Increased flexibility and resilience of energy systems	Medium	Better grid-integration through better knowledge of the dynamic behaviour
Availability of disruptive energy technologies	High	Validated models can help in the credibility of a new technology resulting in a better market uptake
Effective grid-integration	Medium	Better grid-integration through better knowledge of the dynamic behaviour
Enhance consumer satisfaction	Medium	Consumers have a better understanding of the dynamic performance
Improvement of European technological value chain and scientific basis	Medium	Better knowledge of innovative storage technologies
Effective market uptake	High	Validated models can help in the credibility of a new technology resulting in a better market uptake

Exploitation activities

Future plans include sharing the resulting knowledge through workshops and conference papers. It is expected that the models are further used by GSR to perform dynamic behaviour tests of their battery technology.

3.2.1.13 KER13: Analysis of irrigation systems as innovative storage systems

KER13	Analysis of irrigation systems as innovative storage systems	WP 4.6
KER Owner: UPC		Participants: ICAT, EPRI

Characterization of results

Result and objective: The developed tool represents an important advancement in optimizing irrigation systems, especially through its integration with solar PV generation and the exploration of additional applications, such as functioning as an energy storage system. At its core, it embodies a long-term optimization framework aimed at converting conventional irrigation facilities into active participants within the electrical grid. Its versatility extends beyond its initial application in the Segrià-Sud irrigation system, with strategies and methodologies designed to be scalable and adaptable for various irrigation communities. The aim of KER 13 is the on-site demonstration of the tool's capabilities that will serve to underscore its practical effectiveness and feasibility, providing tangible evidence of its potential impact. Overall, the developed tool represents a significant advancement in the pursuit of more efficient, sustainable, and resilient irrigation systems, poised to deliver tangible benefits for communities worldwide.

Need: The optimization tool addresses the challenge of improving the situation of the irrigation communities today, with an impact across different sectors, including:

- Technical: proper selection of the modernization assets
- Financial: optimization of the system costs
- Environmental: maximize the integration of renewable energy and optimization of the water management
- Social: impact in the irrigation community

Actors involved: The result is aimed to different stakeholders in the private and public sectors.

- Irrigation community (private)
- ICAT (public)
- Distribution network operator (private)
- Transmission network operator (public/private)
- Exploitation and maintenance services (private)

Type: The optimization tool will be compiled and published on github following an open-source-based approach. The **algorithms** will be made available for the general public and they will also be published and detailed in journal and **conference papers**. In addition, developing a potential **product** will be considered.

Expl. Level: The tool will be available to perform studies for any irrigation community given its modular structure. However, at this stage, studies have to be conducted by an optimization/Python expert.

Time to expl: It is estimated that in two years, the optimization tool will be ready to be moved to an exploitation phase.

Expl. Route: First, the tool will follow a **scientific route** to later on be possibly used in **techno-economic** calculations for decision-making.

Scale: Irrigation canals are being used at a global scale; therefore, it is considered that such tools can be applicable in any option.

Link to other KERs:

KER9: will be key to deploy the new developed technology to transform the irrigation facilities into innovative storage systems. Stakeholder analysis and exploitation potential

Stakeholder analysis and exploitation potential

The development and effective utilisation of AGISTIN's open-source AGI control methods is of high interest for energy storage and power electronic providers. They have the ability to provide energy storage services to the network (distribution/transmission), through the transformation of irrigation systems and the technology required to control renewable energy systems, pumps and potential supporting storage assets. In this way, irrigation communities and its associations are in the best interest to be main participants on this topic, while pumping facilities are key players to enable the operation of irrigation canals as energy storage systems. Support from regulators and policymakers to enable the full potential from the demand side would be required to enable the irrigation systems to act as storage systems service providers. On the other hand, the interdisciplinarity of the topic (electrical, hydro, social, agriculture etc.) and relevant topics involved (energy storage, climate change adaptability, grid stability, renewable energy etc.) make the result interesting to the academia and scientific community, who could conduct interdisciplinary applied research to improve the irrigation systems. Lastly, improving the network operation (providing grid services) to support the energy transition will have a positive impact in the civil society.

The main outcome of KER 13 will be the results of demonstrating the operation of an irrigation canals as an innovative storage system, interconnecting the existing PV system and water pumps to a VRF battery. Therefore, this result will allow for multiple exploitation paths as to fostering the multidisciplinary research to allow for the continuous improvement of the irrigations systems and enabling different energy storage providers to supply storage services to the grid. Similarly, social advantages are foreseen from this result as a community will benefit from a more efficient and sustainable operation. The resulting knowledge will be exploited through dissemination actions, among the academic and scientific community. A potential commercial exploitation route will be explored through the implementation of possible business models of the irrigation systems acting as energy storage service providers to the grid.

Table 51. Influence vs interest levels of primary and secondary stakeholders for KER 13

Stakeholder	Influence/interest levels	Action
TSOs/DSOs	HIGH	Encourage & influence
Irrigation communities	HIGH	
Policymakers	HIGH	
ES & Power electronic providers	HIGH	
Pumping facilities	HIGH	
Civil society	HIGH	
National governments	HIGH/MEDIUM	Keep satisfied/Encourage
European institutions	HIGH/MEDIUM	
Academia & scientific community	MEDIUM/HIGH	Keep informed/Encourage
Associations	MEDIUM/HIGH	
Power electronic providers	MEDIUM	Keep satisfied/informed/monitor/encourage
AGISITN members	MEDIUM	
BES researchers	LOW/MEDIUM	Keep informed/Monitor

Primary stakeholders
Secondary stakeholders
Key stakeholders

VPC of Key stakeholders

Table 52. VPC for pumping facilities and irrigation communities

Analysis of irrigation systems as innovative storage systems	Pumping facilities, irrigation communities, associations, civil society
Benefits: Improving capacity factor of irrigation systems, underutilised during low demand cold seasons. Providing energy storage and other grid services from already built and working infrastructure. Economic and technical benefits from grid services provision.	**Need:** Underutilisation of facilities during low irrigation demand. Huge power demand for pumping. Pumps operate at night (low price) or connected to a PV plant (even in off-grid mode).
Outcomes: Large-scale irrigation systems capable of operating optimally, providing network services.	**Fears/Barriers:** Extra maintenance costs should be addressed. Current and future legislation may affect the feasibility of the redesign and the operation
Features: Optimal operation (and sizing) of large-scale irrigation systems enabling internal and external (grid) services provision. - Energy storage and related grid services provision to the distribution and transmission grid.	**Gains:** Economic and technical rewards from providing grid services, both for the irrigation canal and for network operators.

Actual implementation and operation of irrigation systems as ESS	ES and power electronics providers, academia
Benefits: New ESS concepts that might be more integrated and sustainable	**Need:** Specialised assets to operate irrigation systems as energy storage providers in terms of power electronics.
Outcomes: Large-scale irrigation systems capable of operating optimally, providing network services.	**Fears/Barriers:** New technology applied on high power requirement systems
Features: Energy storage and related grid services provision to the distribution and transmission grid.	**Gains:** Groundbreaking power electronics technologies emerging from and for the energy storage concept.

Impact assessment

Table 53 depicts a detailed description of how KER 13 will trigger and enable future regulatory, commercial and scientific endeavours.

Table 53. Contribution to expected impact

Expected impact	Level of contribution	Contribution to the expected impact

Increased flexibility and resilience of energy systems	High	Operation optimisation and sizing considers energy storage and load flexibility, as well as other possible grid services.
Availability of disruptive energy technologies	Medium	The analysis considers already existing technologies, but with a different approach. Potential innovative research on new pumps design to enable bidirectional operation is possible.
Effective grid-integration	High	Integrates renewable resources as energy storage (hydro storage), as well as other renewable resources as energy sources (photovoltaic).
Reduced cost and improved efficiency of energy technologies	High	Reduces cost of operating the pumping system and enable new revenue streams (storage operation)
Enhance consumer satisfaction	Medium	Reduces cost of operating the pumping system, which may have an impact on irrigation community consumers.
Improvement of European technological value chain and scientific basis	Medium	New paths open for research and extract the most value from existing infrastructure.
Enhance sustainability considering social and economic aspects	High	The optimisation considers the main role of the irrigation system, while contributing to reduce operation costs and improve network resilience and flexibility for the vicinity towns.
Effective market uptake	Medium	Irrigation communities have already stated they are interested in energy optimisation of their facilities and are open for assets' renovation.

Exploitation activities

UPC has started the scientific exploitation by presenting the results of applying the optimisation tool in an irrigation community close to Segriá-Sud. Future exploitation actions include the outreach to stakeholders with high levels of interest and influence to disseminate the outcomes and explore possible commercial uptakes. A business model will be drafted in conjunction with the KER owner and future actions to enhance the commercial and technical maturity of the result will be outlined.

KER	Dissemination activity	Description	Date
KER13	IEEE PES Innovative Smart Grid Technologies (ISGT 2024)	Scientific conference: Redesign of Large-Scale Irrigation Systems for Flexible Energy Storage	15/10/2024

3.2.2 Characterisation table - summary

After a preliminary classification of the results through the characterisation table, it could be observed that, in general, AGISTIN's outcomes are moderately to highly exploitable, meaning that the benefits of these results could have an immediate impact either during or before the end of the project or in the mid-term future. The impact and the exploitation potential are under constant analysis, based on the evolution of the project's activities, to be able to define the most suitable exploitation pathway. Through the implementation of the characterisation analysis, it has been possible to identify starting exploitation routes for each result that span from scientific and technological to regulatory and commercial. This initial mapping establishes the interdependence and links among the project's results, which is useful to determine whether some results could be merged with the aim of simplifying the exploitation activities. At the same time, the characterisation tool allows for an initial identification of the segments of the society that each KER is aiming at. Table 54 offers a summary of the characterisation of each key exploitable result.

Table 54. Characterisation summary table of AGISTIN's KERs

KER	TRL	Need	Actors involved	Type	Expl. level	Dev. phase	Time	Expl. route	Scale	Other KERs
KER1	4	Environmental	Private & Public entities	Methodology	High	Under development	EoP	Scientific/Academic; Regulatory	Global; European	2, 3
KER2	n.a	Technical; Regulatory	Industry, Private & Public entities	Methodology; Product design	Moderate	Under development	1-5 years	Regulatory;	European, national	4, 7, 8, 11,13
KER3	...	Technical	Industry, Private & Public entities	Algorithm; Software; Scientific articles	High	Under development	EoP	Scientific/Academic; Technological	Global	4, 6, 12
KER4	...	Technical	Industry, Private & Public entities	Algorithm; Software; Scientific articles; Methodology	High	Under development	EoP	Scientific/Academic; Technological	Global	2, 3, 9
KER5	...	Technical; Environmental	Industry, Private & Public entities	Methodology; Process; Product design	Moderate	Under development	1-2 years	Scientific/Academic; Technological; Commercial	Global	12
KER6	...	Technical	Industry, Public entities	Product	High	Under development	EoP	Scientific/Academic; Technological	Global	3
KER7	...	Technical	Industry, Public entities	Expertise, Scientific articles; Methodology	Moderate	Under development	3-5 years	Scientific/Academic; Technological Commercial	Global	8
KER8	...	Technical; Financial	Industry, Public entities	Expertise, Scientific articles;	Moderate	Under development	3-5 years	Scientific/Academic; Technological	Global	7, 12
KER9	4	Technical; Environmental	Private & Public entities	Scientific articles; Methodology; Product; Service; Algorithms; Software	Moderate	Under development	1-2 years	Scientific/Academic; Technological; Commercial	Global	13
KER10	4	Technical	Private & Public entities	Product; Expertise	Moderate	Dev. Not exploited	1-2 years	Technological; Commercial	Global	12
KER11	n.a	Technical; Financial	Industry, Private & Public entities	Expertise, Scientific articles; Methodology (design practices)	Moderate	Under development	3-5 years	Scientific/Academic; Technological	Global	3, 7, 8
KER12	...	Technical	Industry, Public entities	Expertise, Database; scientific articles	Moderate	Under development	1-2 years	Scientific/Academic; Technological	Global	3, 5, 10
KER13	3	Technical; Financial; Environmental; Social	Private & Public entities	Scientific articles; Product; Algorithms; Software	Moderate	Under development	1-2 years	Scientific/Academic; Technological; Commercial	Global	2, 3, 9

3.2.3 Exploitation potential - summary

Having defined the initial target segments, an in-depth analysis was carried out through the implementation of a stakeholder mapping and value proposition canvas. Through the combination of the results obtained from these tools, it was possible to classify each KER into specific exploitation routes (see Table 55) based on the problem they are aiming to solve, the type of actors involved and the innovation potential.

Table 55. Exploitation potential classification

KERs	Comm.	Tech.	Soc.	Reg.
KER1 LCA framework for industrial grid uses, storage and renewables				
KER2 Functional requirements for AGIs				
KER3 AGI templates and selection tool				
KER4 Open-source AGI control methods				
KER5 Aqueous ECR battery system demonstration result				
KER6 Validated models for industrial grid users providing grid forming capability				
KER7 Operation of coupled electrolyser, storage and renewables				
KER8 Determination of the impact of batteries on alkaline electrolyser degradation				
KER9 Multi-level control system for irrigation canals to act as storage				
KER10 Results of testing VRF batteries in irrigation systems				
KER11 Minimum economic grid connection for SHL renewable H2 demo				
KER12 Validated models of innovative storage behaviour				
KER13 Analysis of irrigation systems as innovative storage systems				

Comm.: Commercial; **Tech.:** Technological/Scientific; **Soc.:** Social/Environmental; **Reg.:** Regulatory

3.2.4 Exploitation aims

Members were able to identify their interests in each result through the following definitions:

B: IPRs on background information

F: IPRs on foreground information. All types of exploitable results generated during the project. To mark the result with an F, partners should be involved in a task(s) related to the result itself.

M: Manufacturing the products;

U: Using the result to develop further products/processes;

L: Licensing the result;

O: Other exploitation (Consultancy, provide services, etc).

The exploitation aims expressed by each partner are summarised in **Errore. L'origine riferimento non è stata trovata.**. These inputs will be used to assess the IPR intentions and define a management plan.

Table 56. BFMULO matrix

	UniK	CTF	RTE	UniK	GSR	ETH	FHG-IEE	FHG-IWES	IRDE	SHL	UPC	CDR	ICAT	RINA	TKC
LCA framework for industrial grid users, storage and renewables	B	O	B	B	B	B	B	B	B	B	B	B	B	O	B
Functional requirements for AGIs			U/O							U					U
AGI templates and selection tool			U												
Open-source AGI control methods			U												
Aqueous ECR battery system demonstration result					B/M						U		U		U
Validated models for industrial grid users providing grid forming capability				U			U	U			U				
Operation of coupled electrolyser, storage and renewables								U		L/U/O					
Determination of the impact of batteries on alkaline electrolyser degradation								U		U/O					
Determination of minimum economic grid connection for SHL renewable H2 demo										B/U					
Multi-level control system for irrigation canals to act as storage											U/O		U/O		
Results of testing VRF battery											U	U			
Validated models of innovative storage behaviour				U	B/U			U							
Analysis of irrigation systems as innovative storage systems							U					U			

3.3 Future exploitation actions

Project's results that are classified as commercially exploitable will be further analysed through tools that allow for a better understanding of their market potential. Non-commercially exploitable results will be further exploited through dissemination and stakeholder engagement actions to ensure their usability.

Future exploitation actions include the following activities:

- Narrowing down the initial KERs list to strengthen the exploitation process by focusing on those KERs that will provide the highest impact
- In-depth analysis of new KERs
- Definition of short-term outreach actions to maximise the engagement of key stakeholders
- Implementing a high-level market analysis to further explore the market potential of those KERs identified as commercially exploitable
- Implementation of the 2nd Exploitation Workshop
- Work together with RINA to develop the business plan of the commercially exploitable results as part of subtask 7.2.
- IPR identification and management strategy
- Identification of possible competitors
- SWOT analysis
- Determine long-term actions to ensure the exploitation of the results after the end of the project

The outcomes deriving from these activities will be summarised and described in the Final Exploitation Roadmap deliverable (M42).

4 Conclusions

Over the first 24 months of the project, several C&D actions have been implemented, significantly contributing to the goals of WP7. These actions have provided visibility to the project's outcomes and facilitated updating certain results. The activities were strategically adapted to align with project milestones and outcomes and tailored to each stakeholder group to maximize impact. The project has successfully met C&D KPIs. Some KERs that are ready for dissemination have already been shared through these activities. These efforts have been further enhanced through engagement and synergies with other initiatives, such as BRIDGE, ETIP Hydropower, and sister projects.

The next 24 months will be crucial for cementing the project's main results, with a series of initiatives already planned for months 25 to 30 (January to June 2025). Efforts for the second half of the project will be analysed in the two final C&D deliverables: D7.4 Final Communication and Dissemination Report (M48), which will provide a comprehensive overview of all C&D activities carried out throughout the project, evaluating their impact and effectiveness; and D7.5 Collection of Newsletters and Dissemination Activities (M48), which will compile all newsletters and dissemination activities conducted during the project, serving as a detailed record of the outreach efforts and stakeholder engagement.

Finally, the exploitation actions will continue to further explore the most suitable initiatives that will propel the usability of the results. Future activities have been defined and will be implemented throughout the following year. These actions will always be tailored according to the progress and potential impact of each KER. EASE, as exploitation manager, along with RINA have applied to the Horizon Result Booster initiative to receive guidance on the coming exploitation efforts. Two mentors have been assigned and a couple of meetings have been conducted to understand the tools provided by this service. Exploitation and business model experts from the initiative will continue to inform the upcoming activities starting from January 2025. The Final Exploitation Roadmap will be created by the end of the project, containing a well-defined commercial strategy (including business models) and an IPR management plan, as well as the succeeding efforts to guarantee the exploitability of the outcomes after the end of the project.

5 References

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