PANTERA
Pan European Technology Energy Research Approach

Work Package 7

Deliverable D7.2

Report on the promotion of key mid-term R&I priorities for smart grids

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Abbreviations

Acronym	Full name
CETPartnership	Clean Energy Transition Partnership
CORDIS	Community Research and Development Information Service
D	Deliverable
DG ENER	Directorate General for Energy (DG ENER)
EC	European Commission
EERA	European Energy Research Alliance
EIRIE	European Interconnection for Research Innovation & Entrepreneurship
ETIP SNET	European Technology and Innovation Platform for Smart Networks for Energy Transition
EU	European Union
EUSEW	EUropean Sustainable Energy Week
H2020	Horizon 2020
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
IPR	Intellectual Property Rights
JRC	Joint Research Center
MI	Mission Innovation
PANTERA	Pan European Technology Energy Research Approach
RD	Regional Desks
RDD	Requirements and Design Document
RD&D	Research, Development and Demonstration
RICAP	R&I status and Continuous gAP analysis
R&I	Research & Innovation
SET Plan	Strategic Energy Technology Plan
SES	Smart Energy Systems
SG+	Smart Grids Plus
SPRING	Service contract of DG Ener in support of ETIP SNET and BRIDGE and entrusted with taking over the EIRIE platform from PANTERA
SWOT	Strengths, Weaknesses, Opportunities and Threats
T	Task
TRL	Technology Readiness Levels
WG	Working Group
WP	Work Package
WT	Working Teams

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Executive Summary

The PANTERA project's Report on the promotion of key mid-term R&I priorities for smart grids, which can be found in Deliverable D7.2, consider the specifically needed R&I development of Smart Grid trajectories which are a key factor for enabling the Energy Transition.

Taking into account the results gained in WP3 and WP4 and considering the main conclusions obtained from the interactions with stakeholders in WP5 and WP6 this task fine tunes and encourages a detailed list of R&I recommendations, which stimulate, put forward and facilitate the innovations in Smart Grids at both local and pan-European level enabling the expanding all of the benefits of the massive utilization of smart grid technologies towards the transition to decarbonized energy system with active citizens, improved energy security and increased system resiliency.

Significant work on the Key R&I Priorities for Smart grids has been initiated and performed within the PANTERA project and which continuation is ongoing within the ETIP SNET, BRIDGE, JRC, DG ENER.

This deliverable, is focused on extracting summarizing, extending and showing the results of promoting this work to the stakeholders bringing real added value for the R&I community.

Key R&I Priorities for Smart grids Regional Desk 1: Latvia, Estonia and Lithuania

- education for workforce up skilling and attracting young talent in the energy transition;
- tailored call designs and pilot projects for improved national funding in R&I;
- alignment of policy and strategy across different domains for effective energy transition;
- promoting regional cooperation within the Baltic countries for increased visibility;
- collaboration and constructive communication between national policymakers and the EC;
- raising the motivation and enthusiasm among researchers to actively engage in Horizon projects.

Key R&I Priorities for Smart grids Regional Desk 2: Bulgaria, Romania and Greece

- Building a critical own Research Infrastructure which allows the regional Stakeholders to follow the R&I leaders and perform the main smart grid problems locally is a key priority which is required for the successful regional energy transition. Shrinking the significant gap between the level of the European R&I leaders and the regional stakeholders is a key for the successful operation of the interconnected European power system.
- The local needs of cutting-edge research infrastructure in short and mid-term can be successfully covered using the ERIGRID 2.0 free laboratory transnational access. The collaboration with the best laboratories of Europe is also supportive for the regional stakeholders in building their own critical infrastructure.
- TSO/DSO collaborations on grid codes, standardization and regulations is a main regional R&I priority after the unbundling process and the significant increase of the share of converter interfaced renewable generation.
- Participating in the Low Voltage DC (LVDC) expert groups of the European Commission and starting promptly the research on LVDC networks as well as the hybrid AC+DC networks is a new key priority in which the regional stakeholders have a chance not to lag and even be competitive in some specific subtopics.

- Voltage control of distribution networks with DER is a main priority which requires intensive research based on software, laboratory and real life experience combined with significant work on the provision of adequate standards, regulations and codes.
- The need of novel machine learning methods for PS forecasting and modeling is an important priority for the regional stakeholders which due to the well-developed IT sector in the region could offer competitive R&I products serving also some other European entities and stakeholders.
- The research needs on strengthening local incentives for Flexibility and Smart load control are another important R&I priority which has a significant potential. The low (reaching zero during the weekends) midday electricity prices in the region clearly outline the importance of this priority.
- The research of smart micro, mini and nanogrids allowing comparatively small network reinforcements which are costly and not always financially possible for the population in the region which is among the poorest in Europe is another important R&I priority.

Key R&I Priorities for Smart grids Regional Desk 3: Cyprus and Malta

- Evolution of the grid in meeting the requirements of the digitalized transformation of the interconnected grid to be ready to host 100% RES in a fully electrified society that includes mobility, heating, and cooling.
- Build the critical Research Infrastructure that will facilitate R&I community of the two countries to flourish and deliver what is expected by the local economy always in collaboration with strong EU partners to avoid duplication and unnecessary redundancies.
- Build stronger collaboration between the TSO/DSO (only one in Malta) capable of managing the evolving technologies that want distributed intelligence to flourish and achieve optimality at every level and achieving the strategic objectives of the zero-emissions energy grid.
- Frequency and Voltage control at all levels by maximizing the use of the emerging technologies and effective use of flexibility on the demand side.
- Develop the digitalized grid of tomorrow capable of being observable and responsive to the needs of the grid in an automated way, capable of maximizing the benefits to the end users.
- Facilitating the evolution of the Energy Communities that will maximize the use of local resources through effective use of flexibility at all levels.
- Smartening the grid at all levels to facilitate the evolution of the emerging technologies including E-Mobility and lay the foundation for achieving optimality at all levels including the benefits of Demand Response and available flexibility.

Key R&I Priorities for Smart grids Regional Desk 4: Czech Republic, Poland and Slovakia

- The first step towards smart grids is Smart Metering. Then Observability is needed, and finally better use of flexible resources should be performed.
- An encouragement of national funding instruments for R&I activities for smart grid activities on short and mid-term is needed.
- Proper awareness and pilot systems demonstrating the smart grid solutions would be a significant and necessary step to bring everyone to the forefront of development.

- To deploy Smart Grid solutions, it is necessary to use public funding but ironically DSOs are less interested and reluctant to adapt to the current advancement in the power system.

Key R&I Priorities for Smart grids Regional Desk 5: Croatia, Hungary and Italy

- The relevance of energy communities and the need of their uptake have been regularly discussed. In particular during the workshop organized together with the EERA Joint Programme on Smart Grids at the MELECON 2022 conference in Palermo (Italy). It has been highlighted that there is a need for transferring the outcomes of the different pilot projects dealing with energy communities to regulatory bodies in order to update the regulatory framework to really allow the massive uptake of energy communities and foster the installation of local renewable energy sources.
- Need of proper sandboxes to test innovative approaches for energy communities and customer involvement. The importance of un updated regulatory framework in supporting clean energy innovation and the deployment of innovative solutions has been highlighted several times. In addition, it has been pointed out that to change the regulation the regulatory authorities need evidence that innovative approaches are effective and have system level benefits. To this effect projects and regulatory sandboxes are valuable instruments.
- Increasing the participation in SET-Plan implementing working groups have been identified in different occasions as a relevant opportunity to foster the involvement of less involved countries at EU level. Being part of the SET-Plan allow to bring at EU level specific countries R&I needs and helps in aligning the local policies to the overall EU ones.
- It has been highlighted that the bureaucratic process needed to participate in EU projects can be challenging for small organizations and this can hinder their participation. In this view the support of national agencies can be relevant.
- Effective international cooperation and knowledge sharing play a crucial role on changing and updating energy policies, national stakeholders should be keener to work together with partners from other countries in Europe.
- It has been also pointed out that that in some cases the presence of other funding opportunities such as cohesion funds (which are in some cases less competitive compared to the European Horizon funding opportunities) divert effort from EU project proposals.
- Regarding technical barriers, during the second workshop organized in Hungary, workshop participants coming from academia pointed out that widening the current deviation limit for the primary reserves full activation (e.g. from the present value of 200 mHz to 1 Hz) would facilitate PV plants integration in the electric system. Another measure to facilitate variable renewable uptake could be relaxing the time period for imbalance settlement (e.g. from the today figure period of 15 min to 1 hour). We need to note that this are proposals that need deeper technical investigation about their system level effects.
- It has been also pointed out that it is very relevant to coordinate at EU level decisions on energy strategies and national level ones. It has been highlighted that some decisions should be taken at European level considering and harmonizing all the needs of all the member countries.
- Finally, we need to report that recently the participation of Hungarian institutions to European funding is very limited calling for serious activation of corrective actions taking most of the above into consideration.

Key R&I Priorities for Smart grids Regional Desk 6: Ireland and Portugal

- Expedite the processes for constructing new Transmission and Distribution capacity that are extremely complicated, costly, long, and risky for a community energy project to connect into the Electricity Grid.
- Capture and promote the importance of data sharing and access that is a major concern at the moment. The lack of congruency between data sources makes it very difficult to collect and analyze data on a large scale. A more universal approach to data collection and open access to data needs to be adopted for smart grid technologies to be advanced and implemented at a substantial rate.
- Promote the potential for new services in the electrical field such as advancements in the area of EV's.
- Identify solutions to increase collaboration and data sharing mechanisms, compliance with open data requirements, and alignment with open platforms such as the EIRIE platform.
- Find ways of aligning National Energy and Climate Plans (NECPs) with R&I funding from industrial players. The primary focus should be on collaboration, access to infrastructure and validation cases, securing industry funding, and establishing connections with EU institutes.
- The slow development of research and development in renewable electricity and smart grids should be addressed identifying steps to enrich current approach and emphasize the technical requirements related to renewable energy integration, market aspects, and data access and validation.

1 Introduction

1.1 Scope of the Deliverable

Deliverable D7.2 of the PANTERA project details the promotion of key mid-term R&I priorities for smart grids among the R&I community and the stakeholders from the low activity countries which are targeted through the project.

1.2 Structure of the Deliverable

The deliverable comprises 4 chapters, each focusing on a specific aspect of the work done and the corresponding PANTERA project activities and EIRIE Platform reflections.

Chapter 1 introduces the main topics concerned.

Chapter 2 extracts and presents the R&I recommendations promoted to the R&I community providing both a summary of the Smart Grid Needs and priorities at EU level and the R&I needs coming specifically from the regional stakeholders. A special emphasis on the alignment of EU priorities with regional stakeholder needs is given, after which the main funding instruments where stakeholder needs are falling under are considered. Finally, the funding mechanisms investigated to guarantee the long-term sustainability of the EIRIE Platform are outlined covering all regional desks established.

Chapter 3 presents the regulation barriers which need to be addressed in the mid- term providing the regulations and standards of EU and the anticipated directives that address afore mentioned barriers for the specific countries. Following that the work performed in PANTERA WT2 on linking regulations, standards and codes to technologies is noted, after which the corresponding supportive tools developed within the EIRIE platform are shortly presented.

The deliverable concludes in Chapter 4, which provides a summary of the information covered in this report.

2 R&I Recommendations

2.1 Review / Summary of Smart Grid Needs and priorities at EU level as documented in WP3 and ETIP SNET Roadmap and Implementation Plan

The main Smart Grid Needs and priorities at EU level have been determined and described in detail in PANTERA WP3, WP4 and in the ETIP SNET Roadmap and Implementation Plan. Here the most important R&I needs will be shortly extracted and summarized [1-8].

2.1.1 State of R&I, standardization, and regulation

Work Packages WP3 and 4 of the PANTERA project provide an assessment of the current state of research and innovation (R&I) activities in smart grids, storage, and local energy systems in EU member states. It analyzes the needs and priorities for future R&I to achieve a decarbonized European smart grid network in line with the EU's 2050 energy target. The project reviews national, EU, and global initiatives related to smart grid R&I [9-16]. It highlights the importance of the ETIP SNET roadmap, which provides a comprehensive plan for smart grid R&I activities in the EU. The project also considers National Energy and Climate Plans (NECPs) to identify R&I priorities at the national level. The aim is to align NECP priorities with the ETIP SNET roadmap and develop a universal methodology for R&I assessment. The findings contribute to a cohesive approach in achieving a decarbonized EU smart grid network. The main defined research areas (RA) according to ETIP SNET, related to smart grid research and innovation are the following:

- Consumer, Prosumer, and Citizen Energy Community:

  Focuses on empowering and engaging consumers, prosumers, and citizen energy communities.

- System Economics:

  Involves developing business models, market designs, and market governance strategies for the energy system.

- Digitalization:

  Addresses communication and data handling for the digitalization of energy systems, including data management, cybersecurity, and system security.

- Planning - Holistic Architectures and Assets:

  Encompasses energy system architectures, design, and planning, as well as technology solutions, asset management, and maintenance, with a focus on system stability and resilience.

- Flexibility Enablers and System Flexibility:

  Involves adapting all energy components to ensure flexibility to the system, including demand, generation, storage, energy conversion, and network transport.

- System Operation:

  Covers system supervision, monitoring, control, reliability, resilience, and automation, including state estimation, short-term, medium-term, and long-term control, and enhancing the skills of control room operators.

2.1.2 ETIP SNET Roadmap and Implementation Plan

ETIP SNET, with input from over 350 experts representing EU energy stakeholders, focuses on achieving intermediate goals by 2031 and preparing for further steps towards 2040 and 2050 [9]. The R&I Priority Projects Concepts (PPCs) in the ETIP SNET R&I Roadmap 2022-2031 are structured around nine High-Level Use Cases (HLUCs), each valid for the next 10 years. These HLUCs cover integration features of future European energy systems and include goals, challenges, and expected outcomes. The roadmap also highlights the relevant PPCs, which are further analyzed in the current and future ETIP SNET R&I Implementation Plans.

The ETIP SNET's roadmap outlines the R&I priorities and concepts for achieving the vision of a sustainable and integrated energy system, providing a framework for future advancements in the field. It outlines the necessary research and innovation goals to be achieved by 2031. It builds upon previous roadmaps, stakeholder input, and ongoing projects. The roadmap serves as input for funding programs at European, transnational, national, and regional levels. It recognizes the need for research, innovation, and demonstrations at different geographical locations and environments to address various challenges while emphasizing common solutions, interoperability, and knowledge sharing across Europe.

Next, each HLUC (High-Level Use Case) will be presented to summarize the main areas and crucial aspects that need to be addressed in smart grid research and innovation to ensure efficient and sustainable energy systems.

HLUC1

HLUC1, which focuses on achieving a carbon-neutral energy future through optimal cross-sector integration and grid-scale storage, aims to combine and optimize various energy system components to minimize costs. This involves integrating electricity generation, gas transport, heating and cooling, and transportation systems into a cohesive energy system. Advanced technologies like Power-to-X (P2X), X-to-P (X2P), and large-scale energy storage play a vital role in meeting carbon reduction targets effectively.

To accomplish this goal, automated management and control of flexible energy network resources are necessary to facilitate the seamless conversion between different energy sectors. Additionally, energy storage technologies need improvement and seamless integration with the grid to address decarbonization challenges. While some technologies are already mature, others are in early development stages and require further research and innovation to become economically viable in a carbon-neutral energy system.

Decarbonizing industries, transportation, and building-level energy demand requires intelligent coordination of interactions between energy sectors. This comprehensive approach considers the value and role of alternative technologies in energy production, transportation, storage, and demand sectors within a multi-vector energy system framework. Advancing sustainable environmental and social circular economy objectives can drive technological and business model advancements in this context.

Establishing technical and commercial frameworks that coordinate sector coupling, including electricity, gas, heat, and transport, is crucial. These frameworks enable efficient utilization of flexibility sources and maximize the benefits of coordinated operations. It is essential to explore the ability of cross-sector coupling flexibility to enhance the reliability and resilience of the energy system in a cost-effective manner, supporting effective energy sector planning and operation. These concepts can be implemented at various regional scales, ranging from individual buildings and microgrids to local distribution systems, national systems, and even Pan-European systems.

The primary objectives of HLUC1 encompass optimizing the operation and planning of integrated energy systems, providing empirical evidence on the significance of multi-vector energy coupling, developing market and regulatory frameworks for a low-emission, low-cost, secure, reliable, and resilient whole-energy system, and facilitating the development of appropriate energy storage and conversion technologies and infrastructure.

By 2031, the expected outcomes include the development of tools for operating and planning multi-energy systems, establishment of a real-time cross-sector control platform, formulation of new security and resilience standards for future multi-energy infrastructure, creation of regulatory and market frameworks for cross-sector integration (including data exchange standards and business model innovation based on circular economy practices), implementation of a governance model to optimize overall system performance while addressing the needs of each coupled sector, and integration of reliable and cost-effective energy storage and conversion technologies and infrastructure to enable efficient and resilient cross-sector integration.

HLUC2

HLUC2, also known as "Market-driven TSO-DSO-System User Interactions," emphasizes the importance of collaboration and coordination among electricity system operators, system users, and prosumers to tackle operational challenges and facilitate the integration of renewable energy sources. The growing digitalization of the electricity grid necessitates interactions with various stakeholders and devices, enabling flexibility, smart charging, and smart buildings.

Efficient planning, operational reliability, and risk reduction require cooperation among system operators. This involves exchanging coordinated balancing and congestion handling services between distributed energy resources (DERs), conventional power plants, and controlled loads. Sharing accurate forecasting information further enhances the efficiency and security of the energy system. Additionally, cross-border cooperation is encouraged to maximize the benefits of interregional collaboration.

Recent policies highlight the involvement of consumers and prosumers in the energy system, necessitating mechanisms for their interaction with system operators and participation in energy markets. The design of these mechanisms should be mutually beneficial, ensuring valuable outcomes for both prosumers and operators, while also benefiting the entire energy system. Innovative tools and solutions, including approaches from social sciences and humanities, are required to facilitate user-friendly interactions.

Efficient and transparent management of data, while upholding competition laws, confidentiality, and privacy, is crucial for market-driven interactions. These interactions should be designed with a cross-sectorial approach to enable the integration of an effective and efficient integrated energy system.

The high-level goals of HLUC2 align with the Green Deal and Fit for 55 policy documents and encompass increasing the penetration of renewable energy, enhancing consumer and local community participation, integrating distributed storage assets, leveraging the contribution of electric vehicles to renewable integration, optimizing system operation and planning, developing appropriate market models for TSO-DSO interaction, promoting demand-side participation and local energy communities, ensuring resilience contributions from DERs, leveraging digital technologies and data standards, exploring business models and cases, and utilizing advanced analytics for decision-making.

By 2031, the expected outcomes of HLUC2 include the development of a sophisticated virtual model of the European electricity grid, seamless coordination among system operators, increased integration and participation of DERs, demonstrated functionality of market models in

a cross-sector environment, understanding of cooperation levels between different system operators across multiple energy carriers, viable business models, reliable demand-side aggregation and forecasting, high adoption of smart meters and IoT+EMS devices, implementation of interoperability platforms and a common IT architecture, and the establishment of defined common IT interfaces.

HLUC3

HLUC3, referred to as "Pan European Wholesale Markets, Regional, and Local Markets," aims to develop a novel multi-energy market that encompasses cross-sector coupling and operates across various temporal and spatial scales. The objective is to facilitate a cost-effective transition to a low-carbon energy future by integrating renewable generation and decarbonizing demand sectors such as transportation, heating, cooling, and industry. This entails leveraging emerging flexibility technologies and advanced control systems across all energy sectors to achieve significant cost savings.

The goals of HLUC3 include designing a fundamentally new multi-energy market with appropriate temporal and spatial granularity, establishing cost-effective market mechanisms for allocating balancing services, network charging, and investments in conventional and low-carbon generation. It also focuses on demonstrating how the new market enables flexibility technologies and advanced system control concepts to access the benefits they offer. The development of fully decentralized energy markets that facilitate peer-to-peer trading and maximize service quality for end consumers is another key objective.

HLUC3 emphasizes evaluating the value of flexible distributed energy resources in providing grid flexibility and balancing services through aggregation. Additionally, it aims to enhance renewable power purchase agreements and guarantees of origin to promote consumer awareness and adoption of renewable energy. The provision of capacity market remuneration to traditional and emerging technologies, support for the development of an EU-wide capacity market, and the creation of market designs and regulatory frameworks that ensure cost-effective supply resilience are also important aspects.

The HLUC3 framework recognizes the option value of flexibility technologies in addressing uncertainties related to the future deployment of low-carbon technologies. It also focuses on developing advanced technologies, control concepts, and platform tools that facilitate multi-energy system markets, enable data exchange between different energy sectors, and manage uncertainties in balancing and ancillary services provision.

The technical challenges associated with HLUC3 include designing a cross-sector/multi-energy market based on real-time monitoring and data exchange, coordinating energy trading with real-time balancing markets, establishing fully decentralized energy markets, enabling regional markets and cross-border trading and collaboration, and developing monitoring and control capabilities for flexibility.

By 2031, HLUC3 aims to achieve outcomes such as the implementation of dynamic market-time intervals, dynamic price zones, and grid constraints. It also seeks to integrate Power-to-X (PtX) and X-to-Power (XtP) technologies, incorporate market designs that consider integrated energy systems, and make strategic investments to support the objectives of the multi-energy market.

HLUC4

HLUC4 focuses on the ambitious goal of achieving widespread integration of renewable energy sources (RES) into the transmission and distribution grid. To address this challenge, various technical aspects need to be considered, including ensuring grid stability, enhancing forecasting capabilities, and implementing advanced control systems. Market dynamics and designs must

also be adapted to accommodate RES participation while minimizing risks and ensuring a reliable energy system. Additionally, the integration of multiple energy vectors and storage solutions requires revisiting system scenarios and behaviors.

The overarching goals of HLUC4, in alignment with the European Commission's directives, include establishing a cost-effective, secure, and reliable energy system with increased RES penetration. This involves facilitating cross-sector RES participation, mitigating system risks associated with fluctuating generation, and creating market access and incentives for RES investments. The development of advanced network technologies and efficient control systems for distributed energy resources is also emphasized.

By 2031, the expected outcomes encompass reliable and efficient management of the energy system with RES integration, particularly in offshore wind energy through high-voltage direct current connections. Planning and operational methods will be refined to support increased RES participation, while resilience assessment and targets will be integrated into grid planning. The seamless integration of renewable sources from heating and cooling networks, buildings, industry, and various energy vectors, along with the participation of distributed renewable sources in the energy market, will be realized. Furthermore, the integration of renewable generation with storage systems across different energy sectors will be achieved, resulting in a more sustainable and resilient energy landscape.

HLUC5

HLUC5 focuses on empowering consumers and citizens to actively participate in the energy market and promote the adoption of new energy services and technologies. Consumers, including prosumers, play a vital role in accelerating the transition to decarbonized energy systems. The design of cross-sector energy infrastructure is influenced by the increasing electrification of various sectors, such as heat pumps, electric vehicle charging, and green hydrogen applications.

Consumer education and training are crucial, ensuring informed decision-making and understanding of integrated energy systems. However, consumers should not be burdened with excessive technical knowledge. IT solutions are needed to provide consumer access to energy data and advanced services while abstracting market-specific complexities. Integration of the energy system into the broader data economy enables cross-domain applications beyond energy.

The high-level goals of HLUC5 include granting consumers access to energy data and advanced services, achieving Fit for 55 indicators, increasing renewable energy penetration, ensuring system flexibility, promoting electric vehicle adoption and heat pump use, and establishing a secure and transparent digital ecosystem for data sharing.

By achieving these goals, HLUC5 aims to empower consumers and citizens through digital technologies, enabling their active participation in the energy system and contributing to the EU's renewable energy and climate targets.

HLUC6

The HLUC6 initiative focuses on ensuring the secure operation of power electronics devices throughout the power system. There is a need to understand the impact of these devices as their presence in the grid increases and actively involves them in various grid aspects.

At the transmission system level, the development of multi-terminal, multi-vendor meshed DC grids, including onshore and medium voltage applications, needs consideration. This involves researching grid-forming converters, exploring the transition between operation modes, and integrating power electronics in traditional substations with smart power routing devices.

The high-level goals of HLUC6 include developing simulation tools and controls for power electronics devices, evolving substations to intelligent nodes with a high adoption of power electronics, enabling high renewable energy penetration, increasing grid security through power electronics flexibility, and addressing stability challenges arising from power electronics integration and changing power generation dynamics.

Expected outcomes by 2031 include a deep understanding of power grids with power electronics devices, implementation of simulation tools, advanced grid-connected inverters, grid operation principles for HVDC and MVDC networks, principles for hybrid AC/DC networks at different voltage levels, electronic substations with active power flow control, and standardization processes for compatibility and interoperability.

By achieving these outcomes, HLUC6 aims to ensure secure and efficient power electronics operation, facilitate renewable energy integration, enhance grid flexibility, and support a sustainable and reliable power infrastructure transition.

HLUC7

The HLUC7 initiative focuses on improving system supervision and control, with a specific emphasis on cybersecurity, to accommodate the growing use of renewable energy and decentralization in power generation. It aims to reinforce and optimize electricity networks by integrating centralized and decentralized elements and promoting the allocation of renewable energy sources. Through pervasive network digitalization and secure communication networks, decentralized monitoring and control will be enabled, ensuring transparency for market participants.

In terms of control room concepts, HLUC7 envisions a complete reconsideration, with intelligence being more distributed, particularly at the edge of distribution grids. This transition requires careful planning, verification, and secure implementation, considering existing infrastructure. Workforce implications include the development of new Human-Machine Interfaces (HMIs) and training programs.

The high-level goals of HLUC7 are to increase the dominance of electricity as an energy carrier through greater renewable energy adoption and improved network efficiency, resiliency, and reliability. Flexibility in energy systems will be achieved by real-time supervision and control of Distributed Energy Resources (DERs), supporting electric transport through smart charging, and facilitating carbon-neutral heat supply in industries.

The main technical challenges identified by HLUC7 include evolving control centers to adapt to the complex cyber-physical infrastructure, enabling distributed control while maintaining an overarching concept of supervision, and enhancing observability at all voltage levels with real-time monitoring and accurate weather predictions. Automation, integration of IT systems, long-term workforce education, and addressing cybersecurity threats throughout the energy system are also key areas of focus.

By 2031, the expected outcomes of HLUC7 include the development of next-generation control rooms for Transmission System Operators (TSOs) and Distribution System Operators (DSOs), integrated planning and operation in a fully digitalized grid, and the integration of new control concepts and data management strategies. Furthermore, a network code for cybersecurity in cross-border electricity flows will be established, and gas and hydrogen networks will be adapted to address cybersecurity risks.

In summary, HLUC7 aims to establish advanced control rooms, enhance grid supervision, and control, and ensure cybersecurity in the energy system. Its goals are to create a more efficient, secure, and resilient electricity network with increased integration of renewable energy sources.

HLUC8

HLUC8 is an initiative that focuses on integrating sustainable transport to achieve sustainability in the sector. It emphasizes an integrated system approach that encompasses vehicle efficiency, promotion of low- and zero-emission vehicles, and transitioning to a low- and zero-carbon electricity system. The objective is to shift towards more sustainable modes of transport through multi-modal integration.

The initiative addresses various transport sectors, including road, railway, waterborne, and airborne transport. The challenge is to make electric vehicles charging an active component of the integrated grid, utilizing on-board batteries to optimize solutions and improve the carbon footprint of e-mobility. Smart charging plays a crucial role by enabling dynamic load management and efficient energy flow management.

By 2031, HLUC8 aims to assess alternative decarbonization strategies for the transport sector, develop supportive policy and market frameworks, and evaluate the role of electric vehicles in providing energy control services. The impact of rapid-charging infrastructure, the system value of smart electro mobility, and the feasibility of offshore charging facilities will also be assessed. Additionally, the initiative aims to enhance security and resilience through V2X concepts, establish interoperability between energy and transport sectors, and consider the benefits of second-life EV batteries.

The expected outcomes of HLUC8 include the development of decarbonization strategies, integration of the transport sector with the whole energy system and leveraging the flexibility of the transport sector for effective utilization of renewable energy. The initiative will demonstrate the impact of advanced charging technologies in various environments and develop effective decarbonization strategies for all transport sectors. The goal is to connect energy sector decarbonization strategies with the crucial role of EVs in achieving a decarbonized economy.

HLUC9

HLUC9 focuses on promoting flexibility in buildings, districts, and industrial processes within the context of clean energy legislation and the efficient utilization of renewable energy. It emphasizes the integration and deployment of renewable energy at different levels and highlights the effective use of waste heat and cold in urban infrastructure. The initiative aims to renovate and develop energy infrastructure, expand the focus to wider communities, and address issues related to smart grid connectivity, market participation, and resilience preservation.

HLUC9 recognizes the limited integration of the heating and cooling sector with the integrated grid and emphasizes the need for effective market participation, control mechanisms, and data management to enhance the smartness and resilience of interconnected resources. The high-level goals include achieving carbon-neutral buildings, integrating building flexibility into distribution networks, and incorporating microgrid efficiencies. The initiative also aims to support system operators, integrate virtual power plants, and improve flexibility assessment and forecasting through the use of artificial intelligence and digital twins.

By 2031, HLUC9 aims to achieve robust forecasting techniques, inclusive market design, and effective participation of multi-sector buildings and communities in the energy system. The initiative seeks to drive advancements in flexibility provision, market design, and sector integration, ultimately contributing to a sustainable and efficient energy system.

2.1.3 Conclusion

In conclusion, there is strong emphasis on the importance of High-Level Use Cases (HLUCs) in driving the transition to a sustainable and integrated energy system. These strategic objectives

provide a roadmap for achieving a carbon-neutral future by addressing key challenges and opportunities across various energy sectors. By focusing on clean, secure, and efficient energy sources, energy system integration, customer-centric approaches, digitalization, social and economic dimensions, research and innovation, integrated planning and policy instruments, sustainable transportation, and flexible energy provision, stakeholders can collectively shape a balanced and inclusive energy system. By working together and committing to clean and efficient energy solutions, a sustainable energy future that ensures environmental sustainability, energy security, affordability, and social inclusivity can be created.

2.2 R&I needs of regional stakeholders as extracted from workshops and the collaboration area of the PANTERA/ EIRIE platform

2.2.1 Introduction

To identify R&I needs of the regional stakeholders an intensive collaborative interaction using regional and pan- European workshops, nano- workshops and webinars has been performed through the course of the project [1]. These activities have been further strengthened by performing interviews, individually dedicated meetings and other online and offline communication which were specifically adapted to the local needs and specificities.

Additionally, the PANTERA regional collaboration area of the EIRIE platform using Confluence turned out to be very supportive and well responsive to the R&I needs of regional stakeholders towards generating knowledge in the desired topics. Thus, some of the most important R&I needs and priorities originating from the regional corner of the EIRIE will be shortly presented.

It has been identified that in many cases the regional stakeholders R&I needs could be strictly specific for the specific region, country or even stakeholder. At the same time some other EU R&I needs were noted to be common for all stakeholders as for example the need of linking technologies to standards, regulations and codes. The main outcomes of this process have been extracted and will be shortly presented below. A more detailed description has been included in previous deliverables.

2.2.2 Regional Desk 1

Regional Desk 1 represents well established geographical region, i.e., Baltic States. From energy system perspective, synchronization with the continental European network, planned by 2025, is an essential political priority for the whole region. As for smart metering, a key enabler of Smart Grids, progress towards a wide roll-out of smart meters differs among three countries. While Estonia has completed a roll-out of smart meters and developed a data hub to ensure the efficient handling of data in retail energy markets, Lithuania has no significant progress in this field except a plan to establish a mass roll-out of smart metering in two stages: 1st stage until 2026 - applicable to consumers who consume more than 1,000 kWh per year, 2nd stage until 2037 - applicable to consumers who consume less. As for Latvia, in 2020 the amount of smart electricity meters covered almost 98% of the total number of electricity meters of customers of Sadales tīkls AS (Latvian DSO).

As described in D4.4 the following R&I needs were mentioned by stakeholders during the interviews:

- digitalization, control solutions and effectiveness;
- data protection;
- tools for ensuring system stability, reliability and adequacy;
- automatization of the grid and data management.

Another important non-technical issue mentioned is end-user acceptance and need to change customers mindset.

Furthermore, PANTERA workshops in Riga and Vilnius focused on organizational aspects of R&I rather than technical aspects of Smart Grids. Discussions took place around two main headlines: collaboration opportunities for increasing participation in R&I activities and experience and benefits from the participation in the energy international networks, including the SET plan.

The following important needs were identified:

- education for workforce up skilling and attracting young talent in the energy transition;
- tailored call designs and pilot projects for improved national funding in R&I;
- alignment of policy and strategy across different domains for effective energy transition;
- promoting regional cooperation within the Baltic countries for increased visibility;
- collaboration and constructive communication between national policymakers and the EC;
- raising the motivation and enthusiasm among researchers to actively engage in Horizon projects.

2.2.3 Regional Desk 2

Through the course of the PANTERA project Regional Desk 2 performed extensive work dedicated to the R&I needs of the regional stakeholders from Bulgaria, Romania and Greece. The main event orientated stakeholder interaction activities were performed by organizing workshops, nano- workshops, webinars, dedicated working meetings and interviews on which the main mid-term R&I priorities for smart grids were promoted.

Figure 1 : Collaborative stakeholder interactions using workshops

Targeting 2 planned events in the beginning of the project RD2 found significantly higher regional demand and stakeholder interest than initially expected. Following that an efficient collaborative approach was found and implemented which allowed the performance of the following 9 events:

- PAN European Research and Innovation Activities for Smart Grids, Energy Storage and Local Energy Systems, 02 July 2019, Sofia, Bulgaria
- Nano Workshop “Smart Grids Research and Innovation Status in Bulgaria: gap analysis, opportunities and needs”, BULEF conference, 13.09.2019, Varna, Bulgaria
- Regional Workshop Green Islands as a driver for the Energy Transition – Going Renewable and Smart 13th of February 2020, Athens, Greece
- PANTERA VIRTUAL WORKSHOP, “Energy transition through optimal use of the rich Renewable Energy Resources, of the Mediterranean basin”, MedPower 2020, 10.11.2020

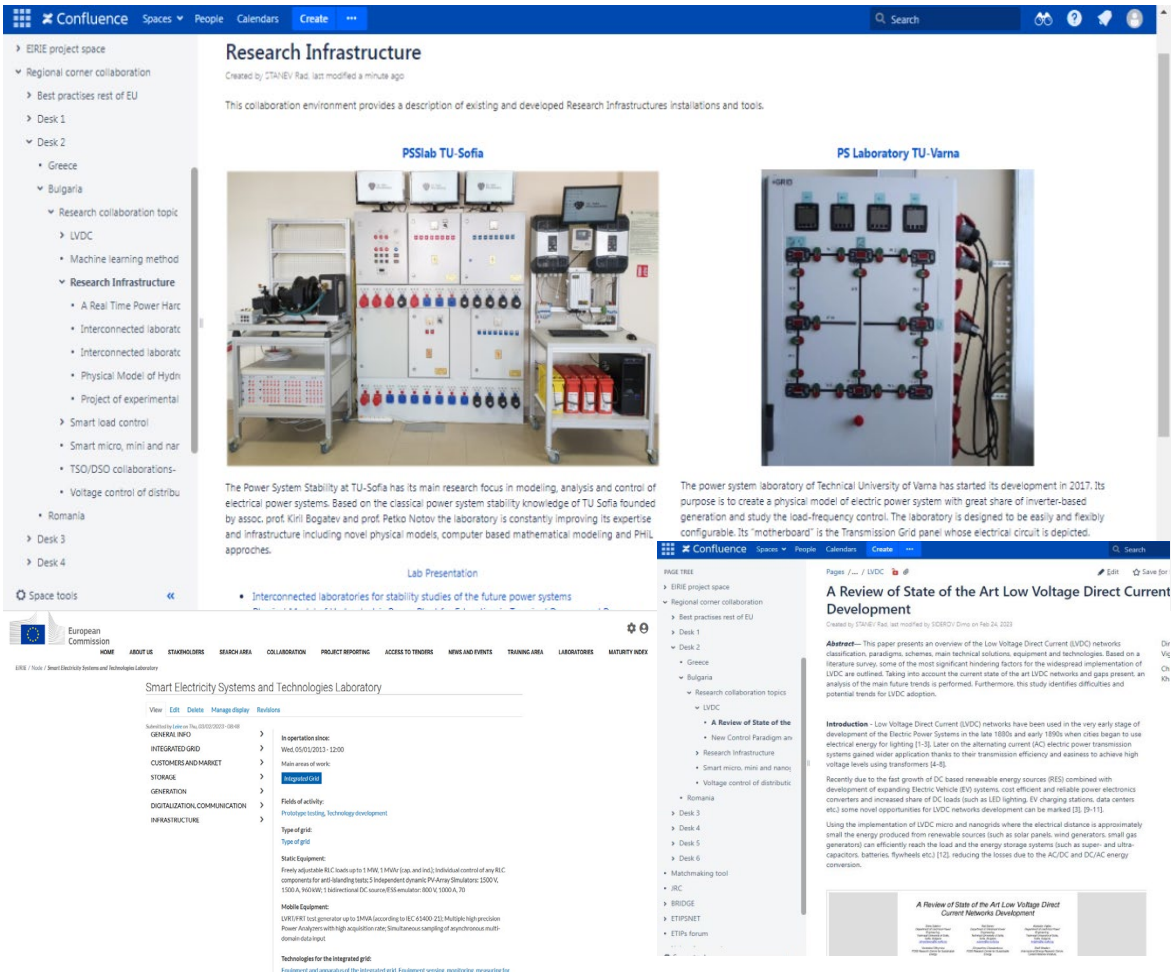

Figure 2: EIRIE/ confluence regional collaborations

- Workshop in Cretan Energy Conferences, “The key role of the R&I unified approach across EU for boosting smart grids, investments: The EIRIE platform”, 9th July, 2021
- Nano Workshop Regional Research and Innovation activities for Smart Grids, Energy Storage and Local Energy Systems, 03 August 2021, Varna, Bulgaria

- International research collaboration opportunities fostering EU Clean Energy transition in Bulgaria – SUPEERA/ PANTERA joint workshop, 25.05.2022, Sofia, Bulgaria
- PANTERA Session, Boosting the R&I activity on Smart Grid Technologies, Empowering the R&I community to actively contribute to the Energy Transition, Country: Greece, Thessaloniki, SyNERGY MED 2022, 18.10.2022
- International research collaboration opportunities fostering EU Clean Energy transition in Romania PANTERA / SUPEERA joint workshop, 23.03.2023, Bucharest.

The results from the events realized showed that the most efficient way for promotion of R&I priorities for smart grids relies on work in small groups, implementing interactive dialogue and respecting the local stakeholder and country specificities with individual approach.

Significant added value was also achieved using the intensive post event collaboration mainly using the EIRIE Platform and the dedicated Regional Corner serving the connected local stakeholders.

The key mid-term R&I priorities and needs of regional stakeholders as extracted from workshops and the collaboration area of the EIRIE platform for smart grids promoted were already noted in detail in the previous deliverables documenting the workshops and EIRIE platform as well as the workshop outcomes of each individual event. However, a special emphasis on the following R&I need and priorities will be shortly given:

- Building a critical own Research Infrastructure which allows the regional Stakeholders to follow the R&I leaders and perform the main smart grid problems locally is a key priority which is required for the successful regional energy transition. Shrinking the significant gap between the level of the European R&I leaders and the regional stakeholders is a key for the successful operation of the interconnected European power system.
- The local needs of cutting-edge research infrastructure in short and mid-term can be successfully covered using the ERIGRID 2.0 free laboratory transnational access. The collaboration with the best laboratories of Europe is also supportive for the regional stakeholders in building their own critical infrastructure.
- TSO/DSO collaborations on grid codes, standardization and regulations is a main regional R&I priority after the unbundling process and the significant increase of the share of converter interfaced renewable generation.
- Participating in the Low Voltage DC (LVDC) expert groups of the European Commission and starting promptly the research on LVDC networks as well as the hybrid AC+DC networks is a new key priority in which the regional stakeholders have a chance not to lag and even be competitive in some specific subtopics.
- Voltage control of distribution networks with DER is a main priority which requires intensive research based on software, laboratory and real life experience combined with significant work on the provision of adequate standards, regulations and codes.
- The need of novel machine learning methods for PS forecasting and modeling is an important priority for the regional stakeholders which due to the well-developed IT sector in the region could offer competitive R&I products serving also some other European entities and stakeholders.
- The research needs on strengthening local incentives for Flexibility and Smart load control are another important R&I priority which has a significant potential. The low

(reaching zero during the weekends) midday electricity prices in the region clearly outline the importance of this priority.

- The research of smart micro, mini and nanogrids allowing comparatively small network reinforcements which are costly and not always financially possible for the population in the region which is among the poorest in Europe is another important R&I priority.

The collaborative interaction with the PANTERA RD2 stakeholders focused on these priorities generating knowledge and content on EIRIE/Confluence. The key mid-term R&I priorities for smart grids which were outlined here were successfully promoted trough the PANTERA events, the EIRIE platform and the other interaction means which were already mentioned in the previous deliverables.

2.2.4 Regional Desk 3

PANTERA Desk 3 includes Cyprus and Malta islands that were supported by activities guided by PANTERA coordinator University of Cyprus/FOSS. Both are Mediterranean countries-islands and Member States of EU that share to a certain extent the same challenges for availability of energy resources and sufficiency with a high potential of solar capacity. Both islands share membership in The Smart Islands Initiative. This initiative is based on bottom-up approach and it builds on years of collaboration between European islands and seeks to communicate the significant potential of islands to function as laboratories for technological, social, environmental, economic and political innovation related to the smart grids. From Malta side, the Local Councils Association is a coordinator member whereas from Cyprus side, the Cyprus Energy Agency (CEA) is the coordinator of the regional initiative. This forms a local network that PANTERA has exploited to build rewarding working relations among stakeholders of the two countries.

The technical needs that are co-shaped by the consortium aimed Malta's and Cyprus' national energy goals: As the deployment of rooftop photovoltaics (PVs) increase in Malta and Cyprus, and with past incidents of the interconnector failure between Sicily and Malta, the onus in Malta is upon the single power station (Delimara) to cater to the load requirements. Similar operational limitations are exhibited in Cyprus since it is totally isolated from any other electricity network. During the daytime, as a large number of Photovoltaics which are connected to the low voltage network as a negative load, the natural damping provided by the loads is reduced, and therefore, the effective inertia is also reduced. This can compromise the dynamic stability in the event of small load changes, even if the load-generation balance is maintained. Hence, it is an urgent need for the following:

1. To evaluate/ estimate the system inertia online with the help of phasor-based measurements.
2. To make decisional analysis on which PVs should participate in frequency response and which ones should participate in frequency regulation. To make PVs and other static sources (where inertia is decoupled through inverters) work in tandem with other distributed generators (DGs) (siting of DG systems to meet the annual energy needs).

This formed the case study presented in D6.5 of the PANTERA project, with all the details for completing the planned work and giving all evidence for the success story of this activity of the two partners.

Since we wanted to build prospects for strong R&I collaboration, we have agreed to collaborate on submitting a collective effort to the ERIGRID 2.0 open call to test an algorithm that we aimed to develop to act a controller to manage energy from PV systems to respond effectively to system needs, hence being supportive to higher RES penetration in our two islands. For the common submission we have agreed to involve experts from MCAST and FOSS to develop the algorithm, prepare submission to ERIGRID 2.0 and if successful participate in the investigation work at the premises of a specialised lab in EU offering these capabilities and finally complete all the scientific work and attempt to publish in scientific journals the developed work.
The method that was followed consisted of the following steps:

- Identify the research needs and endeavours coupled with the NECP plan of each country (bilateral meetings/non-structured interview). The effort is common but the technical starting point is different according to the NECPs of Cyprus/Malta
- Connect appropriate institutions (DSOs and Universities) together and discuss the needs and collaboration opportunities (AIT/UCY/UMIST/EAC/ENEL Malta)

- Common proposal preparation under ERIGRID 2.0. Focus on the preparation and the consortium building and to transfer good practices
- Implementation and development of our common proposal.
- Building questionnaire to have feedback and build a good practice that can be replicated and escalated to more than two partners.

Figure 3: The team of experts presenting the outcome of the research work done

The above work has revealed the valuable benefits of working together, building on commonalities, sharing lessons learned and enriching possibilities by joining strengths and possibilities.

Collaboration is fundamental in the existence of the EIRIE platform for team building in related activities knowledge creation where needed. EIRIE being a multi-functional collaborative platform, established as a reference operational point to unify European activity, incentivize further investments in smart grids and support access to exploitable results, can spark further work and cooperation capable of bridging the existing gaps. To this effect, a dedicated confluence page has been created for Desk 3 under which all members of countries Malta and Cyprus were collaborating to create content.

All the above collaborative work is targeted to be an example of how collaboration between R&I entities can flourish and learn from experience gained. For this reason, the partners agreed to host this activity on the provided collaboration area of EIRIE and CONFLUENCE and to this effect work progressed using resources from all partners.

Through this collaborative work, events were planned to boost the common aspirations. The main event orientated stakeholder interaction activities were performed by organizing workshops, nano- workshops, webinars, dedicated working meetings and interviews on which the main mid-term R&I priorities for smart grids were promoted. The following workshops have been organized in collaboration with local stakeholders giving the floor for fruitful discussions to develop and deliver:

1. **PANTERA REGIONAL WORKSHOP organised on the 10th and 11th November 2020 in Paphos Cyprus under the title "Energy transition through optimal use of the rich Renewable Energy Resources of the Mediterranean basin".** This run in parallel with the international Conference MEDPOWER20, hosting in its sessions **the consortium Navigant/SWECO that has completed a study for the benefit of the European Commission on offshore grid concepts for the Mediterranean Sea, adding to the planned offshore renewable energy agenda for the European Union and the project of Horizon 2020 INTEPLAN.** Both presented valuable results and contributed to the planned discussions of the PANTERA project with participating stakeholders.
2. PANTERA was present at the IEEE Smart Cities Conference 2022 – 27th of September 2022 hosted in Paphos Cyprus, bringing the stakeholders together to enlighten the conference on the activities pursued in strengthening the energy transition process.
3. In November 2022 the three entities MCAST, FOSS and ANEL cooperated in making the planned conference MEDPOWER22 **on Power Generation, Transmission, Distribution and Energy Conversion** a success. For this reason, MCAST undertook to coordinate the organization of the conference, PANTERA to organize a workshop using a useful parallel session and present papers from the work that the three partners have developed through their cooperation.
4. 1st June 2022, Nicosia - International research collaboration opportunities fostering EU Clean Energy transition in Cyprus. After the successful outcomes produced in Riga and in Sofia, on the 1st June 2022, the SUPEERA project team flew to Cyprus where, in collaboration with the PANTERA Project, organized a workshop aimed at sharing best practices in the field of green energy and at fostering the engagement of external stakeholders in EERA activities and towards the implementation of the SET-Plan.

Through this collaborative work of the identified stakeholders, the key mid-term R&I priorities and needs of the countries under Regional Desk 3, have been identified and had the opportunity to discuss in more detail during the planned events in the two countries. In short, we can note the following:

- Evolution of the grid in meeting the requirements of the digitalized transformation of the interconnected grid to be ready to host 100% RES in a fully electrified society that includes mobility, heating, and cooling.
- Build the critical Research Infrastructure that will facilitate R&I community of the two countries to flourish and deliver what is expected by the local economy always in collaboration with strong EU partners to avoid duplication and unnecessary redundancies.
- Build stronger collaboration between the TSO/DSO (only one in Malta) capable of managing the evolving technologies that want distributed intelligence to flourish and achieve optimality at every level and achieving the strategic objectives of the zero-emissions energy grid.
- Frequency and Voltage control at all levels by maximizing the use of the emerging technologies and effective use of flexibility on the demand side.
- Develop the digitalized grid of tomorrow capable of being observable and responsive to the needs of the grid in an automated way, capable of maximizing the benefits to the end users.

- Facilitating the evolution of the Energy Communities that will maximize the use of local resources through effective use of flexibility at all levels.
- Smartening the grid at all levels to facilitate the evolution of the emerging technologies including E-Mobility and lay the foundation for achieving optimality at all levels including the benefits of Demand Response and available flexibility.

2.2.5 Regional Desk 4

Regional Desk 4 focused on the open R&I stakeholder needs in Czech Republic, Poland, and Slovakia. The interaction with the stakeholders was achieved using workshop related activities, interviews, and individual on and offline communication.

While interacting with the regional stakeholders, the focus was on to know the current status of financial instruments in smart grid R&I activities in their respective region and also challenges in securing EU funding. The stakeholders were represented approximately equally in university/academia, private companies, and research institutes.

During the Czech Republic PANTERA workshop, it was found that despite of the good level of development of infrastructure in the region, there is a shortage of skilled personnel in the research activities. Also, the people have no confidence in the latest technologies because they are less informed about the current advancements in the energy sector which can be confirmed by the primordial power infrastructure and regulatory framework in the region.

Some important R&I recommendations based on the interaction with the local stakeholders (more than 70 stakeholders were present coming mainly from the Czech Republic and Slovakia) which can be mentioned here are:

- National programs and widespread national initiatives to encourage young people toward the STEM field and the awareness of technical education in the country are insufficient.
- Diverse R&I funding options are present. The focus should not only be on national calls but also on the EU calls.
- Awareness of EU funding programs in the Universities/research institutions and research management training for the research professionals is needed.
- Adaptation of the existing regulatory framework as per RES energy resources integration is a demanding factor which needs higher priority.
- Subsidies support is needed to cover the energy transition cost or adoption of low-carbon technologies.

In Poland, the major challenge in the smart grid implementation is the massive deployment of RES, which have very high variability, which is not adequately by the pace of development of the respective grid. It is important to deploy the Smart Grids infrastructure to increase flexibility. Voltage stability is also another issue, especially in Northern Poland, where the grid is less developed, and the wind production is located (mostly related to transmission). This can be resolved by FACTS, but it is difficult to justify the costs. Lastly, balancing issues (peak/low demand) together with some technical limitations to power import/export is also a challenging issue.

The main findings which can be noted are:

- The first step towards smart grids is Smart Metering. Then Observability is needed, and finally better use of flexible resources should be performed.
- An encouragement of national funding instruments for R&I activities for smart grid activities on short and mid-term is needed.
- Proper awareness and pilot systems demonstrating the smart grid solutions would be a significant and necessary step to bring everyone to the forefront of development.

- To deploy Smart Grid solutions, it is necessary to use public funding but ironically DSOs are less interested and reluctant to adapt to the current advancement in the power system.

Through direct discussions with a local NCP of Slovakia, it was found that there is a well-established ecosystem of R&I funding in Slovakia. The current research and development activities are funded through state budgets, structural funds, and horizon Europe funds.

National Horizon Office is an organizational unit of CVTI SR and consists of 15 national contact points (NCPs). Horizon Office provides all information services and consultations to potential applicants in Horizon Europe programme required by the Minimum standards and guiding principles published by EC, specifically:

- Informing and raising awareness;
- Assisting, partner search, advising and training;
- Signposting and cooperation.

The internal funding processes are fully adjusted to smooth implementation of all (national and international) projects. The Ministry of Education, Science, Research and Sport of the Slovak Republic is responsible for the R&I funding. Due to various parallel goals of the ministry R&I funding instruments take long time to be completed.

A clear recommendation that came through this consultation, it is related to the procurement law that is required to be modified\changed in order to make the funding process smoother.

2.2.6 Regional Desk 5

The workshops organised in the three countries of regional desk 5 (Croatia, Hungary and Italy) gave the possibility to discuss with local stakeholders about several aspects and in particular about the main barriers limiting a better integration of R&I organization at EU level and how to foster the deployment of renewable energy sources.

The wide variety of stakeholders that were involved in the organized workshops, enabled the open discussion of several relevant topics. Through this open discussion, several needs and barriers have been identified.

The opportunity to bring the raised issues at the ears of the European Commission has been always well appreciated by stakeholders that see this a relevant benefit that is facilitated by the activities of the PANTERA project.

During the interactions with local stakeholders, different types of barriers have been identified ranging from policy issues to regulatory barriers to the lack of understanding of the opportunity open by EU funding. Technical barriers have also been in some cases discussed. A summary of the main issues and needs raised during the workshops or discussed during dedicated meetings with stakeholders are listed below:

- The relevance of energy communities and the need of their uptake have been regularly discussed. In particular during the workshop organized together with the EERA Joint Programme on Smart Grids at the MELECON 2022 conference in Palermo (Italy). It has been highlighted that there is a need for transferring the outcomes of the different pilot projects dealing with energy communities to regulatory bodies in order to update the regulatory framework to really allow the massive uptake of energy communities and foster the installation of local renewable energy sources.

- Need of proper sandboxes to test innovative approaches for energy communities and customer involvement. The importance of un updated regulatory framework in supporting clean energy innovation and the deployment of innovative solutions has been highlighted several times. In addition, it has been pointed out that to change the regulation the regulatory authorities need evidence that innovative approaches are effective and have system level benefits. To this effect projects and regulatory sandboxes are valuable instruments.

Figure 4: *Pictures from some of the workshops organized in regional desk 5 countries*

- Increasing the participation in SET-Plan implementing working groups have been identified in different occasions as a relevant opportunity to foster the involvement of less involved countries at EU level. Being part of the SET-Plan allow to bring at EU level specific countries R&I needs and helps in aligning the local policies to the overall EU ones.
- It has been highlighted that the bureaucratic process needed to participate in EU projects can be challenging for small organizations and this can hinder their participation. In this view the support of national agencies can be relevant.
- Effective international cooperation and knowledge sharing play a crucial role on changing and updating energy policies, national stakeholders should be keener to work together with partners from other countries in Europe.
- It has been also pointed out that that in some cases the presence of other funding opportunities such as cohesion funds (which are in some cases less competitive compared to the European Horizon funding opportunities) divert effort from EU project proposals.

- Regarding technical barriers, during the second workshop organized in Hungary, workshop participants coming from academia pointed out that widening the current deviation limit for the primary reserves full activation (e.g. from the present value of 200 mHz to 1 Hz) would facilitate PV plants integration in the electric system. Another measure to facilitate variable renewable uptake could be relaxing the time period for imbalance settlement (e.g. from the today figure period of 15 min to 1 hour). We need to note that this are proposals that need deeper technical investigation about their system level effects.
- It has been also pointed out that it is very relevant to coordinate at EU level decisions on energy strategies and national level ones. It has been highlighted that some decisions should be taken at European level considering and harmonizing all the needs of all the member countries.
- Finally, we need to report that recently the participation of Hungarian institutions to European funding is very limited calling for serious activation of corrective actions taking most of the above into consideration.

2.2.7 Regional Desk 6

In looking at the main issues that stakeholders face in various countries, it is important to note that these issues vary from country to country. The case of regional desk 6 is no exception to this. Between Ireland and Portugal, stakeholders have identified a myriad of unique issues that hinder the progression and integration of renewables and smart grid technology.

The PANTERA project aims to identify barriers and bottlenecks, engage stakeholders, and promote research and innovation in the energy sector through engagement with local stakeholders, policy makers and research institutes. It does this through attempting to identify the barriers and bottlenecks that these stakeholders face and go about trying to find solutions to these issues.

Deliverable 6.4, focuses on understanding acceptance barriers in each regional desk and country. It highlights common barriers such as a lack of research funding and a lack of tax incentives that results in the hindering of research and development (R&D) efforts. The document provides specific insights into each regional desk, breaking down the countries involved and their own unique challenges. For example, some countries feel they are falling behind in terms of collaboration with Europe and receive less funding opportunities, perceiving a bias from the EU towards more advanced countries. Others face challenges related to improving the electrical grid and integrating new smart technologies with regards to the policies/regulations that surround these improvements.

One issue faced in Ireland is - Due to the current legislation, it is extremely complicated, costly, long, and risky for a community energy project to connect into the National Electricity Grid nowadays, and in case of achieving this connection it takes a long time for prosumers to break even on their investments.

Great points were raised by stakeholders from a regional workshop held in Dublin, Ireland, where representatives from industry, funding agencies, and academia discussed current challenges in smart grid research and innovation. The importance of data sharing and access is a major concern in Ireland at the moment. The lack of congruency between data sources makes it very difficult to collect and analyse data on a large scale. A more universal approach to data collection and open access to data needs to be adopted in order for smart grid technologies to be advanced and implemented at a substantial rate.

Also discussed was the potential for new services in the electrical field such as advancements in the area of EV's. The document also mentions the future steps identified, including increased collaboration, data sharing mechanisms, compliance with open data requirements, and the role of the PANTERA platform combined with EIRIE in supporting smart grid researchers.

In Portugal, the case study aims to align National Energy and Climate Plans (NECPs) with R&I funding from industrial players. The primary focus is on collaboration, access to infrastructure and validation cases, securing industry funding, and establishing connections with EU institutes. Currently Portugal is trailing behind in terms of research and development in renewable electricity and smart grids. The deliverable 6.4 outlines the steps involved in the approach and emphasizes the technical requirements related to renewable energy integration, market aspects, and data access and validation.

Overall, stakeholders in desk 6 emphasize the importance of data sharing, collaboration, compliance with regulations, and strategic partnerships to advance smart grid research and innovation.

It is also important to mention the EIRIE platform, a one-stop-shop for all knowledge, data and information regarding smart grids, storage, and local energy systems. The EIRIE platform helps to solve many issues that arose during meetings with stakeholders regarding open-source data and keeping informed. EIRIE provides up to date real time information for all to avail of, to help facilitate R&I and make people aware of various opportunities and happenings within the energy community.

2.3 Alignment of EU priorities with regional stakeholder needs

The alignment of the EU priorities with regional stakeholder needs represents a long process which has been pushed forward through the course of the PANTERA project. An intensive collaboration process based on inclusion of regional stakeholders from the low activity countries in the ETIP SNET, CETP, EERA JP for smart grids and other initiatives has been performed. The first results noted show that this activity brings many benefits for the R&I communities in the targeted countries and at the same time it brings additional stability of the common EU R&I policies due to their better adaptation to the needs of the low activity countries collecting all voices which need to be heard.

Through the successful provisions of the EIRIE collaborative platform which collectively achieve complete functionality with supportive tools to all urging present and prospective in mid-term R&I needs which were identified and selected, the regional stakeholder's needs are properly addressed and thus the users can only benefit. A good example which can also be noted, is the research collaborations within the regional corners of EIRIE, through which the R&I stakeholders work together to exchange ideas and experience, effectively generate and present knowledge, build project proposals consortia thus increasing the R&I activities in the respective countries and regions.

2.4 Identification of funding instruments where stakeholder needs are falling under

In the context of D7.3, the PANTERA consortium conducted an in-depth analysis of various initiatives and programmes within the European Union that play a crucial role in driving research, fostering innovation, and facilitating the transition towards a sustainable, digital, and competitive Europe. These initiatives and programmes are integral parts of a comprehensive strategy aimed at addressing pressing societal challenges, accelerating the adoption of clean energy technologies, protecting the environment, and enhancing Europe's global competitiveness. An overview of these key initiatives and programmes is provided in the next sections.

2.4.1 Horizon Europe

The Horizon Europe program is the European Union's initiative that fosters research and innovation through collaboration among universities, scientific communities, industry, and citizens. It aims to bridge gaps between different regions and generations, with a particular emphasis on the needs of young people. The program provides funding for projects aligned with the European Commission's major goals and encourages international cooperation through multilateralism and openness.

Cluster 5 within the Horizon Europe Work Programme focuses on harmonizing efforts at national, European, and global levels in research and innovation related to renewable energy and sustainable decarbonization. It promotes innovation in renewable energy through initiatives like Mission Innovation and encourages collaboration with major emitting countries in line with the Paris Agreement. The cluster aligns with the EU's strategic plan and strives to make Europe a circular, climate-neutral, and sustainable digital economy.

2.4.2 Missions

The EU Missions, which are part of Horizon Europe, address pressing societal issues through specific objectives. The missions include Adaptation to Climate Change, Cancer, Healthy Ocean, Seas, Coastal and Inland Waters, Climate-Neutral and Smart Cities, and Soil Health and Food. Each mission has a detailed execution plan with specific actions, investment plans, goals, and performance measures. The missions aim to achieve their objectives by utilizing research outcomes, such as FAIR research data and open access to scientific papers, and by involving citizens to ensure societal impact.

2.4.3 Widening participation and strengthening the European Research Area

Widening participation and strengthening the European Research Area are key components of the Horizon Europe Work Programme. The widening component aims to bridge the innovation gap and create a more integrated European research and innovation ecosystem. The ERA component focuses on establishing a new European Research Area for Research and Innovation in collaboration with member states. It aims to improve the research and innovation landscape, accelerate the transition to climate neutrality and digital leadership, aid in recovery from the coronavirus crisis, and strengthen resilience.

2.4.4 CETP

The Clean Energy Transition Partnership (CETP) is a strategic and multilateral partnership that supports the implementation of the European Strategic Energy Technology Plan (SET Plan). It

aims to achieve a climate-neutral society by 2050 and contributes to European policy goals. The partnership focuses on saving energy, creating clean energy, diversifying energy suppliers, and making clean energy value chains more sustainable. It organizes its activities around seven Transition Initiatives that address various aspects of the clean energy transition.

2.4.5 LIFE Programme

The LIFE Programme is an EU program dedicated to Environment and Climate Action. It supports the implementation of the European Green Deal and focuses on various aspects of environmental and climate action. The program aims to protect and enhance natural resources, facilitate the achievement of energy and climate targets, and promote energy efficiency and small-scale renewables.

2.4.6 DIGITAL EUROPE

The Digital Europe Programme aims to expand the digital capabilities of the European Union to meet the evolving needs of society and the economy. It focuses on strategic technologies such as data, AI, cloud, and quantum communication infrastructure. The program aims to promote trustworthy AI technologies, address societal challenges, support the digital transition of industrial ecosystems, and upskill the workforce in cutting-edge digital technologies. It also strives to accelerate the adoption of blockchain, enable interoperable digital public services, and promote an inclusive and trustworthy digital space.

These initiatives and programs play a significant role in driving research, innovation, and the transition towards a sustainable, digital, and competitive Europe.

2.5 Funding mechanisms investigated to guarantee the long-term sustainability of the EIRIE Platform at Regional and National Level

2.5.1 Regional Desk 1

Regional Desk 1 has identified and analyzed funding mechanisms for regional cooperation and development, including the EEA Grants and Norway Grants, which aim to strengthen relations between donor and beneficiary countries in Europe. These grants cover various areas such as climate change, energy, cultural cooperation, and human rights promotion. The Baltic Research Programme, under the EEA and Norway Grants, focuses on enhancing cooperation between research institutions in Latvia, Lithuania, Estonia, and the donor countries. It aims to foster sustainable collaboration, capacity building, and future research projects at the EU and regional levels. Interreg programs, including Interreg V-A Estonia-Latvia, Interreg VI-A Latvia-Lithuania, Interreg Central Baltic Programme, and Interreg Baltic Sea Region, support cross-border cooperation and address common challenges across borders. These programs prioritize areas such as governance, business development, environmental sustainability, employment opportunities, and public services improvement. At the national level in Latvia, funding opportunities are available through the Latvian Council of Science, Investment and Development Agency of Latvia, and Central Finance and Contracting Agency of Latvia. These organizations support research, innovation, and business development through programs such as fundamental and applied research, national research programs, postdoctoral research grants, innovation motivation programs, business incubators, and support for commercializing research results.

2.5.2 Regional Desk 2

The Interreg Europe program, co-funded by the European Union, is the most prevalent funding mechanism under Regional Desk 2. It has a focus on reducing regional disparities and promoting cooperation across Europe. In the 2021-2027 period, there are research and innovation opportunities available in areas such as Smart Grids, Storage, Local Energy Systems, digitization, and digital connectivity under the "Smarter Europe" theme. The program also addresses topics like Energy Efficiency, Renewable Energy, Smart Energy Systems, Climate Change, and Zero-carbon Urban Mobility within the "Greener Europe" theme. In Bulgaria, the Ministry of Regional Development and Public Works is responsible for representing the Interreg program. However, the country's unstable political situation and frequent government changes may present challenges for stakeholders interested in participating in the program. Aside from Interreg, the Bulgarian National Science Fund, under the Ministry of Education and Science, offers funding initiatives that promote research and innovation collaboration with neighboring countries. Although specific details regarding smart grid and energy storage projects are not provided, potential opportunities may arise through the National Recovery and Resilience Plan and collaboration with the Network of Research Universities. These funding sources support Bulgaria's transition towards a greener and more sustainable future, addressing challenges in the energy sector and providing support to innovative SMEs, research organizations, and higher education institutions.

2.5.3 Regional Desk 3

In the Mediterranean region, there are three main financial instruments that provide funding for cooperation and development. The Interreg MED program supports cooperation across Mediterranean borders and funds projects initiated and managed by public administrations, universities, private organizations, and civil society groups. Its objective is to create a climate-neutral and resilient society for the benefit of citizens in 14 countries from the Northern shore of

the Mediterranean. The program aims to make the region smarter, greener, and improve governance among stakeholders.

The ENI CBC Med initiative is the largest Cross-Border Cooperation program in the Mediterranean region under the European Neighbourhood Instrument (ENI) for the 2014-2020 period. It brings together the coastal territories of 14 countries to foster fair and equitable development on both sides of the Mediterranean. ENI CBC Med finances cooperation projects that contribute to a more competitive, innovative, inclusive, and sustainable Mediterranean area. The program is based on four thematic objectives and eleven priorities addressing socio-economic and environmental challenges in the region.

At the national level, the Research and Innovation Foundation (RIF) of Cyprus is responsible for supporting and promoting research, technological development, and innovation in the country. Established in 1996 as the Research Promotion Foundation (RPF), it underwent restructuring in 2018 and was renamed as the Research and Innovation Foundation (RIF). The foundation plays a vital role in developing the research and innovation ecosystem in Cyprus and contributing to the country's productivity growth and prosperity. It provides support, coordination, and funding opportunities for research, technological development, and innovation activities.

2.5.4 Regional Desk 4

In terms of regional calls and of interest to the Regional Desk 4, the EU has launched Cross-Border Renewable Energy (CB RES) projects to facilitate the cost-effective deployment of renewable energy. These projects aim to generate renewable energy from various sources and include elements such as grid connection, storage, and conversion facilities. While these projects may not directly support R&D activities like those of PANTERA, there are opportunities for cooperation and funding between countries, such as Germany, Poland, and the Czech Republic, to develop district heating networks and participate in CB RES projects.

At the national level, the Federal Ministry for Economic Affairs and Climate Action (BMWK) in Germany plays a significant role in energy and climate change cooperation and funding. BMWK has initiated various funding opportunities related to the green energy transition, decarbonization, and smart grids. One of the current funding calls is the "Development of Digital Technologies" program, which aims to address thematic priorities and challenges in a timely manner. The program focuses on three priority areas: Technologies, Applications, and Ecosystems. Projects funded under this program should leverage findings from basic research and explore the economic potential of new digital technologies, including those applicable to the energy industry.

2.5.5 Regional Desk 5

Regional Desk 5 focuses on instruments and financing mechanisms for the countries of Hungary, Croatia, and Italy. These countries participate in the ERA-Net Smart Energy system financing mechanism, which has been succeeded by the Co-funded European Partnerships. The current successor program relevant to the energy system is the CETPartnership, in which all three countries participate. The CETPartnership covers a wide spectrum of energy system innovation and recently issued a Joint Call in 2022. PANTERA partners will monitor future call modules as they align with the smart grids field and provide opportunities for collaboration.

Interreg is another relevant program that supports cross-border cooperation through project funding. It covers various topics such as health, environment, research, education, sustainable energy, and more. Interreg is organized into different programs, some of which are relevant to the countries in Desk 5, including the transnational programs, ESPON 2020, Interreg Europe, and ITERact. These programs support territorial research, better policy development, and learning events across Europe. While some calls may have recently closed and no further calls

are presently open, they are worth monitoring for future opportunities that align with PANTERA targets.

The Interreg ADRION program's priority axis 1, "Innovative and Smart Region," supports topics closely aligned with PANTERA projects. Additionally, Italian and Croatian organizations can participate in the Alpine Space program, which facilitates cooperation among key players in the Alpine region. Hungary, Italy, and Croatia can join forces in responding to Interreg Central Europe calls, which aim to improve regional development in innovation, carbon dioxide reduction, protection of natural and cultural resources, and transport and mobility. While calls for these programs may have recently closed, monitoring future calls is important for potential support in smart grids and energy system-related activities.

At the national level, Italy has regional tenders through the European Regional Development Fund (ERDF) that support sustainable development. The Emilia Romagna and Lombardia regions, where PANTERA partner RSE is located, have several open calls that address research, innovation, competitiveness, sustainability, decarbonization, biodiversity, resilience, sustainable mobility, air quality, attractiveness, cohesion, and territorial development.

Furthermore, the Italian Recovery and Resilience Plan, established at the EU level to support economic recovery from the COVID-19 pandemic, provides a relevant source for smart grid and energy system-related activities. The plan covers various fields, including renewables and batteries, with funding instruments such as development contracts focusing on these areas.

2.5.6 Regional Desk 6

In terms of Regional Desk 6, the INTERREG Atlantic Area program offers funding opportunities for transnational cooperation projects in 37 Atlantic regions across Ireland, Portugal, France, Spain, and the United Kingdom. It focuses on addressing regional challenges in innovation, resource efficiency, environment, and cultural assets to promote economic, social, and territorial cohesion. The program has had three funding calls since 2016, with a significant number of approved projects and allocated funds.

In Ireland, there are national funding opportunities that support smart grids and energy transition as well as mechanisms for commercializing and exploiting research outputs. The SEAI National Energy RD&D Calls by the Sustainable Energy Authority of Ireland (SEAI) provide funding for innovative energy RD&D projects aligned with national climate action, energy, and technology development goals. The program emphasizes stakeholder collaboration and research capacity development.

The SFI Research Frontiers Programme by the Science Foundation Ireland (SFI) supports highly innovative and collaborative research with the potential for economic and societal impact. It offers funding for both high-risk, high-reward projects and larger-scale research programs, aiming to build research capacity and facilitate partnerships.

In addition, researchers in Ireland can seek support for commercialization and access short-term project funding through mechanisms like Enterprise Ireland. Enterprise Ireland assists with commercialization efforts and provides minor research funding opportunities through their Grant Offers.

2.6 Support to regional stakeholders for their promotion (profiles creation) through the matchmaking functionality of the PANTERA platform

The EIRIE platform enables users to create an organizational cooperation profile, including details about their assets, network of collaborators, competencies, and research interests. Users can also access a list of upcoming funding opportunities, such as H2020, Horizon

Europe, ERA-NET, and national programs, and post project profiles aligned with their organization's profile. As stated in D7.1, the matchmaking functionality facilitates connections between researchers, companies, and institutes involved in international and European projects, supporting the formation of partnerships in research and innovation endeavors. The platform particularly benefits low spending countries by assisting them in building collaborations for research and innovation initiatives.

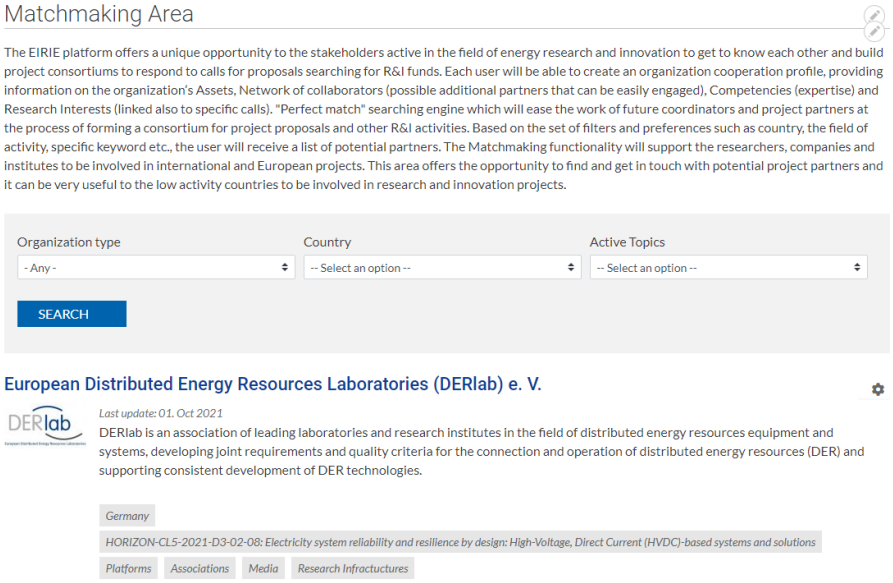

Figure 5: EIRIE matchmaking area

2.7 Review of best practices at EU level and identification of the means to overcome the previously identified barriers

One of the key objectives in PANTERA is to research and transfer best practices across countries to support and accelerate R&I activities in the Smart Grid domain. Throughout the project period several challenging issues and barriers were gradually identified through direct interaction with the stakeholders via dedicated PANTERA workshop (see the full overview of the accomplished workshops in deliverable D5.3 [1]). To compliment this, a series of individual interviews with relevant stakeholders from the focus countries were arranged (for a complete overview of outcomes from the interviews see deliverable D4.4 [2]). The latter was further supported by several case studies, which were elaborated for selected areas, as for example “national funding mechanisms”, presented in deliverable D4.2 [3] and “regulatory sandboxes”, presented in deliverable D6.4 [4]. Based on the feedback and national case studies, developed in T4.2 several best practices proposals have been developed.

The general approach is that the project group does not advice other countries to specific actions but provides a selection of alternatives, which proved to work.

Selection of the best practice topics was done based on several assumptions:

- The proposal should avoid any controversy political, ethical or commercial.
- The suggested best experiences should be justified or substantiated by existing positive experience, feedback from the stakeholders or conclusions from the 3rd parties.
- The suggestions should be as much as possible universally relevant and applicable to different countries and different stakeholders (both academia, R&D and industry).

A complete overview of list of the suggested best practices was presented in deliverable D6.3 [5], while a short summary of the suggested best practices is presented below:

2.7.1 Common industrial funding of R&D projects

Pooling resources from several industrial organisations and for solving specific challenges is a well-established practice. There are several different ways to organise the process i.e. schemes, which can be applied depending upon the scope and TRL level of a specific challenge.

Common funding by several DSOs is one of the most well-functioning financing schemes. Apart from a simple raising of funds for research, the common financing involves different actors into projects thus making the final results more interdisciplinary, replicable and scalable due to considering interests of different involved actors.

2.7.2 Mixed funding of R&D projects

The previously mentioned scheme focuses on specific challenges with high TRL and is not applicable for broader R&I topics, involving more fundamental research activities and thus having fairly low TRL indicators. These projects however can be still interesting for industrial partners as minor financing parties. The remaining budgeting needs can be covered by national funding agencies to ensure that these projects will be developed and maintain certain level of scientific research. The funding agency providing the major part of the funding is normally responsible for tendering and follow-up of the projects.

2.7.3 Tax exemptions

R&I activities and corresponding investments often include substantial risks and uncertainties. There are several ways to create additional financial incentives encouraging different actors to get involved into R&I project. One of the most well-known is tax exemptions or tax credits, when companies substantially investing in R&D work both internally and externally, can reduce their tax burden. Normally this applies to full or partial exemption of Value Added Tax (VAT) but can vary according to national taxation rules. Tax exemptions normally are not automatic and a given organisation has to comply with certain requirements e.g. certain TRL level or thematic priorities in order to get tax exemption for its investments or activities.

2.7.4 Regulation of DSOs

As it was previously mentioned in this section DSOs are regulated natural monopolies. There are several different methods of regulation of DSOs across Europe. Evaluation of national regulation schemes for DSOs and taking any specific positions is a complicated task, which is not within the scope of the present project. In addition, this is a somewhat sensitive issue and has to be decided by the National Regulating Authorities (NRA) upon the local conditions in each specific country.

2.7.5 Regional cooperation

The general observation so far is that there are normally two layers of research programmes and operating funding agencies: national and Pan-European. In the Nordic region there is however a long-term tradition of having regional cooperation, functioning as an additional intermediate level. The conclusion is that regional cooperation is one of available well-functioning mechanisms, which support deployment of Smart Grids technologies. As a limitation it has been observed so far that funding for this type of cooperation is usually low. It also seems like establishment of such cooperation requires presence of common regional challenges and strong political will and engagement.

2.7.6 Regulatory sandboxes

Implementation of new or modification of the existing regulatory terms and conditions require a solid justification that this will be beneficial for the society i.e. will increase the social welfare. In a regulatory sandbox it is possible for a project to be granted exemptions from following the current regulations. This makes it possible to investigate and test new technologies and business models that are not fully compliant with the existing legislation. Additionally, it will make it easier for the regulatory authorities to follow and develop the regulatory framework in a most purposeful way.

3 Regulation needs to be addressed in the mid-term

3.1 Regulations, standards and up-coming directives of EU that address the needs

The main EU Regulations and standards have been considered and presented in detail in PANTERA D3.1. Some of the most important key smart grids related mid-term R&I priority needs which were promoted are extracted and will be shortly presented below.

3.1.1 Bulgaria

According to the targets set in Annex II to Regulation (EU) 2018/1999 Bulgaria has raised its ambition to increase the share of energy from renewable sources. In this regard energy efficiency is seen as a top priority for improving energy security by lowering dependence on energy imports etc.

Safety standards for network operation and emergency situations should be applied in order to ensure maximum transmission capacity of power lines and network elements. Electricity system interconnection target Bulgaria has set according to applicable EU requirements is of at least 15 %. The capacities available at Bulgaria's borders with third countries (Turkey, North Macedonia and Serbia) are calculated according the agreement reached on the application of Article 16(8) of REGULATION (EU) 2019/943

The main regulatory/ legislation crucial measures ensuring the realization of the NECP priorities for Bulgaria are:

- Improvement of electricity transmission and distribution infrastructure, development of smart networks, storage facilities and interconnectors
- Requirements for the use of renewable energy in buildings
- enable a higher penetration of renewable energy by strengthening the role of the central and local authorities
- Introducing a simplified procedure of connecting to electricity distribution networks for installations less than 10.8 kW
- Evaluation of the potential of renewable and waste energy sources for heating and cooling in the respective sector
- Access to and operation of grids
- Stimulate the development of renewables self-consumers and renewables communities
- Promoting the renewable energy for heating and cooling
- Promoting the geothermal energy
- Introducing legal requirements for issuance of guarantees of origin for energy from renewable sources
- Improving the legal framework for application of the stricter requirements stipulated in Directive (EU) 2018/2001 as regards sustainability criteria and GHG emission reductions when using biofuels and liquid, gaseous and solid fuels from biomass
- Introducing an obligation for fuel and electricity suppliers for achieving the target set for the transport sector
- Promoting the use of renewable energy in public transport

- Creating conditions for the development and use of advanced biofuels, renewable liquid and gaseous biofuels of non-biological origin and recycled carbon fuels
- Promotion of the development and deployment of electric mobility in transport, including by building road transport infrastructure and introducing new technologies in railways
- Creating appropriate financial incentives to ensure the achievement of the target in the transport sector
- Production of hydrogen from renewable sources

3.1.2 Czech Republic

The basis of the Czech Republic's National Energy and Climate Plan is been a Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. for the Czech Republic The regulation sets emission reduction target of 14 % compared to 2005.

The Czech Republic has not set any specific quantifiable targets in public research, development and innovation specifically related to the Energy Union.

3.1.3 Croatia

The Republic of Croatia has set the following targets for reducing greenhouse gas emissions by 2030 in the ETS sector: at least 43% and for non-ETS sectors: at least 7% compared to the 2005 level. For the ETS sector the expected reduction in emissions is at least 43% by 2030 compared to 2005 and for the non-ETS sectors, a target of at least 30% reduction in emissions by 2030 compared to 2005 (Regulation (EU) 2018/842) has been set (-7% for Croatia).

The Act on State Aid for Research and Development Projects regulates requirements for granting state aid for research and development projects. Its purpose is to increase private sector investments in research and development and foster cooperation between different bodies for research and dissemination of knowledge in research and development projects.

Five national priorities contributing to the realization of the NECP priorities for Croatia have been identified under which climate change adaptation measures need to be implemented. These are:

- sustainable regional and urban development
- preconditions for the economic development of rural areas, coastal areas and islands
- sustainable energy development
- strengthening management capacity through a networked monitoring and early warning system
- continuity of research activities.

In order to stimulate the development and growth of the Croatian economy, all public, private and science and research representatives has been grouped in innovative sectors, with the aim of strengthening the competitiveness of Croatian companies, and consequently the Croatian economy and society.

3.1.4 Cyprus

The NECP adopts the quantitative targets set in the context of the implementation of Directive 2016/2284/EC on the reduction of national emissions of certain air pollutants for the period 2020- 2029 and for the year 2030 compared to 2005.

In May 2019 the National Board for Research and Innovation has issued the Cyprus Strategy Framework for Research and Innovation 2019 – 2023, entitled “Innovate Cyprus”. An implementation roadmap is designed for the initial period of 2019-2021. The roadmap has been updated and further enhanced according to progress and developments in the national R&I plans, as well as with the support of case-studies and the elaboration of a detailed R&I strategy.

The most indicative regulatory/ legislation steps that Cyprus should undertake, to fulfill and accomplish the NECP priorities, are summarized as follows:

- Achieve the fulfillment of the climate neutrality objective, maintaining the consistency with all relevant EU and national policies
- Deploy policies promoting the penetration of RES in electricity generation, in heating, cooling and in transport
- Deploy strategies for the renovation of the building stock
- Increase diversification of energy sources and import routes
- Promote flexibility, storage and response systems, ensuring Cyprus’s power adequacy
- Upgrade and strengthen electricity and gas interconnectivity with neighboring countries

3.1.5 Estonia

Estonia’s renewable energy trajectory is based EU targets laid down in Directives (EU) 2018/2001 and (EU) 2018/1999). The target levels of the trajectories are based on projections that take into account current renewable energy generation and consumption trends. Estonian renewable energy target for 2020 is 25% and will remain its baseline.

On the Research, innovation and competitiveness dimension, the current national development documents in Estonia have not set independent research and development targets related to the energy sector. Research and development and innovation for increasing competitiveness are governed by the following current sectoral development plans:

- Estonian Rural Development Plan 2014-2020
- Competitiveness Plan ‘Estonia 2020’
- National Waste Plan 2014-2020
- Estonian Forestry Development Plan 2020
- Transport Development Plan 2014-2020

The most indicative regulatory/ legislation steps contributing to the realization of the NECP priorities for Estonia are summarized as follows:

- Promoting RES in Estonia’s energy mix and enhancing the interconnections of the autonomous island systems
- Deployment of strategies for the renovation of the governmental and residential building stock
- Promote flexibility and storage systems, ensuring Estonia’s power adequacy

- Increase diversification of energy sources and ensure the reduction in energy dependency
- Strengthening of electricity and gas interconnectivity with neighboring countries

3.1.6 Greece

The objective in reduction in GHG emissions in Greece is set for a 40% in 2030 compared to 1990. Regarding the non-ETS sectors, the reduction in GHG emissions exceeds 35.4% compared to 2005. As for the ETS sectors, the estimated rate of reduction in GHG emissions under the NECP is over 70% compared to 2005. In addition to that, the NECP integrates and adopts the quantitative targets set in the context of the implementation of Directive 2016/2284/EC on the reduction of national emissions of certain air pollutants for the period 2020-2029 and for 2030 compared to 2005

Promoting research and innovation will continue to be a priority in the period 2020-2030, by strengthening important technologies which will contribute to the attainment of all energy objectives.

The regulatory/ legislation measures that have to be considered as crucial for the realization of the NECP priorities, are summarized as follows:

- Attain a climate neutral economy, through lignite phase-out, while also promoting RES in Greece's energy mix and enhancing the interconnections of the autonomous island systems
- Deploy strategies for the renovation of the building stock in the residential and tertiary sector
- Increase diversification of energy sources and import routes
- Promote flexibility, storage and response systems and ensuring Greece's power adequacy
- Strengthen electricity and gas interconnectivity with neighboring countries and upgrade the existing ones
- Encourage the digitization of energy networks
- Increase in the penetration of RES to ensure the reduction in energy dependency
- Development of interconnections of non-interconnected islands to the mainland system
- Maintenance of social tariff scheme

3.1.7 Hungary

Hungary is among the less ambitious EU members targeting relatively small reductions of GHG emissions until 2030 compared to the 2005 levels. However the country is actively participating in the smart grid and the energy transition related incentives.

The main regulatory needs which need to be considered include:

- Revision of the market regulatory framework in order to reach highest possible retail electricity market liberalization without administratively determined end-user prices. In this process the protection measures focusing on vulnerable customers and sensitive households need to be responded in the social policy instead in the energy policy.
- Revision of the current regulations which significantly hinder the development of wind parks.

- Revision and improvement of the regulations for installation of smart meters in order to provide better scheduling of meters to the most critical locations, allowing provision of flexible service packages to smart metered customers.
- Intensifying the work on regulations which enable and put stronger focus on “digital twins and artificial intelligence” technologies.

3.1.8 Ireland

The European Union energy policy is currently defined by a framework called the “Energy Union”. The European Commission’s strategy as set out in the Energy Union package is about achieving an energy resilient union with a forward-looking climate policy. The strategy seeks to ensure secure, affordable, and climate-friendly energy for citizens and businesses and to allow a free flow of energy across borders with a secure supply in every EU state.

Research, innovation and competitiveness dimension

- To support research, development, demonstration & innovation in low carbon technology / energy sector
- To support research into climate science

The strategy states that the Irish energy research system should:

- Develop new technologies for the harnessing and integration of indigenous renewable resources (e.g. wind energy, ocean energy and bioenergy).
- Identify and develop products and services that will radically transform the efficient utilization of energy across all sectors of the economy
- Undertake basic research in such areas as material sciences and bio-sciences, to expand the knowledge base on which breakthrough innovations in energy supply and utilization can be made.
- Take innovative ideas and concepts developed elsewhere, and examine how they might usefully be adapted, further developed, demonstrated and deployed by Irish companies both in Ireland and abroad.
- Help Irish companies in the energy sector to develop and grow at national and international level.
- Seek to collaborate and attract investment from indigenous and foreign businesses in order to enhance the benefits of energy research.
- Contribute to effective policy making, through the development and maintenance of an energy system modelling capability
- Investigate and address the various technological and behavioural barriers to the uptake of new energy efficient and low carbon technologies.

3.1.9 Italy

In terms of the energy efficiency dimension, a long-term strategy for the renovation of the building stock will be prepared, setting intermediate and final targets, in accordance with the provisions of Directive (EU) 2018/844 on energy performance in buildings.

On the Research, innovation and competitiveness dimension, during the COP 21 in Paris, Italy signed up to the multilateral initiative which aims to promote an acceleration of technological innovation to support the energy transition by means of a significant increase in public funding dedicated to cleantech research. The initiative comprises a series of ‘Innovation Challenges’.

The most indicative regulatory/ legislation steps that Italy should undertake, in order to fulfill and accomplish the NECP priorities, are summarized as follows:

- Accelerate the decarbonisation process by setting 2030 as an interim milestone for achieving full decarbonisation of the energy sector by 2050
- Promotion of self-consumption and renewable energy communities
- Foster the evolution of the energy system, particularly in the electricity sector, from a centralised structure to a distribution predominantly reliant on renewable sources,
- Adopt measures to improve the capacity of renewables to contribute to security while at the same time promoting frameworks, infrastructure and market rules which, in turn, contribute to the integration of renewables.
- Continue to ensure adequate supplies from conventional sources, by pursuing security and continuity of supply, with the understanding that the demand for these conventional sources is in progressive decline as a result of both the increase in renewables and energy efficiency.
- Promote energy efficiency across all sectors as an instrument for protecting the environment, improving energy security and reducing energy costs for families and businesses.
- Promote electrification of consumption, in particular in the civil and transport sectors, as an instrument for additionally improving air and environmental quality.
- Guide the evolution of the energy system through research and innovation activities to develop, in line with European guidelines and the requirements for full decarbonisation, solutions able to achieve sustainability, security, continuity and cost effectiveness of supply based increasingly on renewable energy in all usage sectors.
- Adopt, taking into account the conclusions of the strategic environmental assessment (sea) and related environmental monitoring, measures and expedients to reduce the potential negative impacts of energy transition on other equally relevant objectives, such as the quality of air and bodies of water, the limitation of soil consumption and landscape protection.

3.1.10 Latvia

The energy communities' developments are not adequately represented in Latvia and need to be addressed in the mid-term. Though the National Development Plan 2021-2027 aims at "providing access to innovative and efficient energy solutions achieving greater self-sufficiency and distributed generation" and also targets support of "civic micro-projects for involving households in RES deployment and housing renovation" still the definitions of energy communities need to be provided in amendments to the Law on Energy and the Electricity Market Law. The Law specifies that a renewable energy community operates in the renewable energy sector, and it owns, develops or manages territorially related renewable energy production facilities. Correspondingly the electricity energy community operates in the electricity sector. Still the definitions need to be further developed and interpreted on a national level.

From regulatory point of view the RES community development in Latvia remains in early stage. The following measures on regulations could accelerate the development in Latvia:

- Incorporating community definitions and general provisions in the Energy Law & Electricity Market Law
- Enabling wider flat owner associations and synergies with renovation projects

- Allowing better representations of public/local authorities in community RES projects
- Enabling inclusion of metering systems for community organizations
- Providing balancing costs and benefits with other players, as well as adoption of rules among the community members.

3.1.11 Lithuania

Concerning the Research, innovation and competitiveness dimension, the main objective for Lithuania is to evolve from a country importing energy technologies to a country creating and exporting energy technologies. Lithuania aims at becoming a center of information technology and cybersecurity solutions for energy, solar and wind energy technologies, biomass and biofuel technologies, geothermal technologies, energy market development and creation of new electricity system management approaches. Synergies between scientific and academic institutions, energy companies and engineering industry companies will be enhanced by promoting different forms of cooperation.

The regulatory/ legislation measures that have to be considered as crucial for the realization of the NECP priorities for Lithuania, are summarized as follows:

- Achieve climate neutral economy and ensure the resilience of the sectors to the environmental changes brought by climate change
- Develop a competitive low-carbon economy through sustainable financing and investment
- Overcome energy poverty and create new green jobs
- Increase the use of RES in all economy sectors
- Increase diversification of energy sources and import routes
- Promote innovation in the energy sector
- Increase the number of RES installations owned by private consumers and communities
- Reduce energy cost and increase the competitiveness of Lithuanian business
- Improve conditions for energy supply by integration into the EU’s internal energy market

3.1.12 Malta

In line with the decarbonisation ambitions of the Energy Union Malta has initiated the process of developing a national Low Carbon Development Strategy in accordance with requirements under the UNFCCC, European Union legislation, the Climate Action Act 2015 (CAP543) . In relation to this, the Maltese Government published a Vision Document, in 2017, highlighting its aspirations for socio-economic development in a low-carbon and climate resilient manner.

Malta will seek to support and bolster R&I initiatives on the Research, innovation and competitiveness dimension, relating to Energy Union priorities, specifically those which address national policy priorities and challenges, and those contributing to national competitiveness and economic growth. The Draft National Strategy for R&I in Energy and Water 2021-2030 aims to strengthen and increase coordination and cooperation on R&I projects between the public sector, research institutions and business enterprises.

The high-level objectives under the dimension of Research, innovation and competitiveness dimension, are presented as follows:

- renewable solutions for islands

- integration of RES electricity
- energy efficient solutions for industry and services

The most indicative regulatory/ legislation steps that Malta should undertake, in order to fulfill and accomplish the NECP priorities, are summarized as follows:

- Deployment of sets of measures for the exploitation of all indigenous RES sources
- Extension of the current policy framework in the area of RES, providing new initiatives tailored to local specificities
- Enhancement of funding schemes for R&I projects
- Encouragement of public-private partnerships in energy R&I

3.1.13 Poland

National objectives and budgetary funding targets for research and innovation, including with regard to the Energy Union, are carried out within the framework of the state science, technology and innovation policy.

The main criteria applied in the NRP to choose strategic directions for research and development include the long-term needs of the economy, the high level of research in national centers – the competitiveness at the global level, the micro-, small- and medium-sized-scale development of business sectors based on new Polish technologies or the priority directions in research development defined in European research programs and strategies (e.g. the SET-Plan and Horizon 2020 which constitutes the main source of funding for the measures defined in the SET-Plan and the EU energy and climate policy).

- New energy technologies,
- Diseases of affluence, new medicines and regenerative medicine,
- Advanced information, telecommunications and mechatronic technologies,
- Modern materials technologies,
- Natural environment, agriculture and forestry,
- Social and economic development of Poland in the conditions of increasingly global markets,
- State security and defense.

The regulatory/ legislation measures that have to be considered as crucial for the realization of the NECP priorities for Poland are summarized as follows:

- Meeting the non-ETS (ESR) 2030 reduction target.
- CO2 emission reduction in the energy sector
- Ensuring maximum availability (high efficiency and coefficient utilization, controllability, energy storage utilization), with relatively the lowest at the expense of producing energy
- Satisfying local energy needs, but also related to waste management and using local potential.
- Increase the role of individual renewable energy technologies in the energy mix by controllable and non-controllable source

- Transfer and implementation of joint renewable energy projects
- Support for the production of electricity and heat from renewable energy sources and biofuel production support
- Support for innovative solutions in the production of second generation bio-components
- and other renewable fuels
- Distributed energy development
- The development of stabilizing technologies (manufacturing and storage) non-controllable renewable energy sources
- Development of installations for generating heat from renewable energy sources
- Development of offshore wind energy
- Improving the service of electricity producers included in the auction
- Renewable energy support system

3.1.14 Portugal

As Portugal strives for sustainable energy solutions, smart grids play a crucial role in optimizing energy usage and facilitating the integration of renewable energy sources and Portugal's NECP demonstrates a commitment to promoting such renewable energy adoption. Portugal's R&I priorities for smart grids emphasize the integration of renewable energy sources, energy efficiency enhancement, and the active involvement of energy citizens.

Efforts to improve energy efficiency are essential for Portugal's smart grid development. Thus, research should concentrate on implementing policies and strategies that foster energy-saving practices, particularly in buildings, industry, and transportation sectors.

Despite these challenges, Portugal stands out with one of the most comprehensive NECPs, setting quantitative targets for renewable energy technologies. However, the specific share of citizens in these targets remains unclear.

The main regulatory/ legislation measures that need to be faced can be summarized as follows:

- With Portugal’s smart grid R&I priorities revolving around empowering energy citizens and fostering energy communities, a new legal framework, Decree-Law No 162/2019, was introduced. It promotes individual and collective self-consumption of renewable energy. A need to reduce information asymmetries and enhance energy literacy for consumers to make informed choices in the energy market is present.
- The identified gaps in the policies hindering energy citizen engagement and energy community development include a concentration of renewables ownership among large utility companies and limited involvement of residential and small-scale projects. Additionally, there is a lack of a clear tariff scheme for self-consumption, which may deter further investment in Community Energy Communities (CECs). The role of digitalization in engaging energy communities is recognized but requires better planning and explanation. These needs should be adequately transferred to the regulatory framework.
- The provision of a clear local market trading platform and corresponding market regulations is a notable gap in the country's policies which need to be covered.

Addressing these identified gaps and strengthening the focus on energy communities in the NECP can pave the way for a more inclusive, sustainable, and integrated energy market in

Portugal. Moreover, highlighting the importance of energy literacy and incentivizing citizen engagement will further drive the nation towards its energy transition objectives.

3.1.15 Romania

Programs for stimulating the research / innovation activities developed at Cabinet level have a general scope, with fundamental research being prioritized across all domains, including Energy. The progress of the research sector would continue upon priorities, in order to optimize the capacity of the existing research infrastructure in Romania.

The regulatory/ legislation measures that have to be considered as crucial for the realization of the Romanian NECP priorities can be summarized as follows:

- Complying the current activities and projects of energy companies with environmental legislation and apply best international environmental protection practices; extension of EMAS certification throughout the economy
- Management of the carbon stocks in forests in protected areas, according to forestry legislation and regulations
- Primary and secondary legislation will be amended to offer possibility to the final customers and projects developers to conclude, on centralized markets, according to the regulation project elaborated by NERA, a long-term contract, in fact a market instrument, which can also attract private funding.
- to create the conditions for maximizing the offered interconnection capacities.

3.1.16 Slovakia

The Effort Sharing Regulation (ESR) covers GHG emissions from sectors outside the EU ETS, all non-ETS sectors, except for emissions from international maritime transport, domestic and international aviation and the LULUCF sector.

Concerning the Research, innovation and competitiveness dimension, Slovakia's main priority is to ensure sustainable energy. Key areas for R&I funding are: improving the transmission capabilities and security of the Slovak electricity network; developing smart grids and renewable energy sources; developing nuclear energy. In the upcoming years, the Ministry of Education, Science, Research and Sport of Slovakia will focus, through R&D incentives, on: research and development into highly efficient energy sources and technologies for transport systems; research and development into biodegradable plastics, including composite materials; the use of RES for the automotive industry.

The regulatory/ legislation measures that have to be considered as crucial for the realization of the NECP priorities for Slovakia, are summarized as follows:

- Achieve economic growth based on a low carbon, circular and a less energy- and material-intensive economy
- Intensify activities to reduce CO2 emissions, particularly in the transport sector
- Optimise the RES share, especially in heat generation
- Implement a more harmonised tax regime in heating and energy use in industrial processes
- Increase the use of natural gas and, in the long term, decarbonised gases and hydrogen
- Use waste-to-energy
- Promote self-generation and self-consumption of energy

- Improve the thermal and technical characteristics of buildings
- Provide financial support for research and innovation
- Raise public awareness

3.2 EIRIE linking regulations, standards and codes to technologies

Within the scope of PANTERA WT 2 it was found that linking regulations and standards to technologies brings many benefits for the regional stakeholders all across Europe. Thus, in order to support the R&I community WT2 performed an extensive work through the course of the PANTERA project on linking more than 2500 standards and regulations to the ETIP SNET technologies that form the basis of the relational taxonomy of projects and the integrated energy system. This relational work is being presented using the functionalities and tools of the EIRIE platform and hosting library.

The task has been successfully fulfilled in 2022 and is already operational on the EIRIE Platform following the links indicated below.

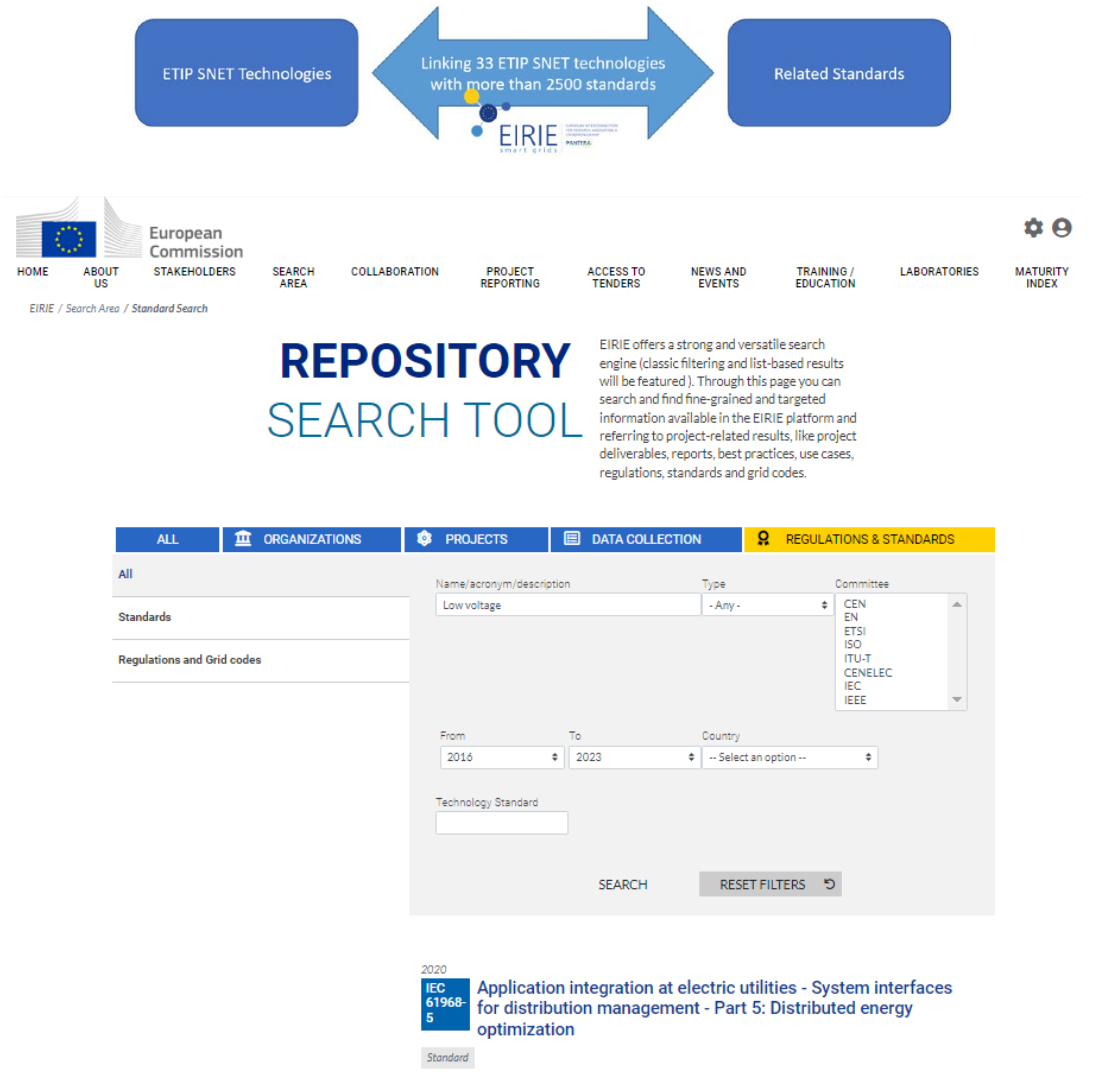

Figure 6: EIRIE linking regulations and standards

4 Conclusions

Deliverable D7.2 outlines the promotion of key mid-term R&I priorities for smart grids for the PANTERA project, towards achieving long-term viability of the project's activities and the sustainability of EIRIE Platform by specifically extracting information on the work done and also by giving latest update of some results coming through the stakeholders' interactions.

Providing selected presentation of the R&I recommendations promoted among the R&I community focusing on the smart grid needs and priorities at EU and regional level and noting the alignment of EU priorities with the regional needs a fine-tuned list with priorities is given.

The main funding instruments where stakeholder needs are falling under, are analyzed and provided in a structured way. Following that, the most important funding mechanisms which secure the long-term sustainability of the EIRIE platform are specified.

Focusing on the regulation barriers which need to be addressed in the mid- term providing the regulations and standards of EU addressing the main hindering barriers the importance and the benefits of linking regulations, standards and codes to technologies through the EIRIE platform is given.

Through the provision of the work performed and by noting the first results from the stakeholder interactions, which can be marked, the objective of the deliverable has been fulfilled.

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