PANTERA
Pan European Technology Energy Research Approach

Work Package 6

Collaboration working groups

Deliverable D6.5

Consolidated Summary Report of Desk Activities in the Target Regions

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Abbreviations

AMI	Advanced Metering Infrastructure
ASHP	Air source heat pump
BEMS	Building Energy Management System
CO2	Carbon Dioxide
CSA	Coordination and Support Action
DG	Distributed Generator
DSO	Distribution System Operator
EC	European Commission
EERA	European Energy Research Alliance
EEA	European Environmental Agency
EIRIE	European Interconnection for Research Innovation & Entrepreneurship
ENTSO-E	European Network of Transmission System Operators for Electricity
ERA-Net SES	European Research Area Network Smart Energy Systems
ESD	Effort Sharing Decision
ETIP SNET	European Technology & Innovation Platforms - Integrated Roadmap Strategic Energy Technology Plan
ETS	Emissions Trading System
EU	European Union
EV	Electric Vehicles
FAIR	Findable, accessible, interoperable and reusable
FDR	Frequency Disturbance Recorders
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
H2020	Horizon 2020
HIL	Hardware-In-The-Loop
IEA	International Energy Agency
IP	Intellectual Property
JRC	Joint Research Centre
LEM	Local electricity market
LV	Low Voltage
LVDC	Low Voltage Direct Current
mFRR	manual Frequency Restoration Reserve
MICALL20	Joint Call 2020 Digital Transformation for Green Energy Transition
MPPT	Maximum Power Point Tracking

NECP	National Energy and Climate Plan
NRA	National Regulatory Authority
PMU	Phasor Measurement Units
PV	Photovoltaics
R&D	Research and Development
RD&D	research, Development and Demonstration
RD&I	Research, Development and Innovation
R&I	Research and Innovation
RES	Renewable Energy Source
RoCoF	rate of change of frequency
S3	Smart Specialisation
SCADA	Supervisory Control and Data Acquisition System
SGAM	Smart Grid Architecture Model
SET plan	Strategic Energy Technology plan
SM	Smart Meter
SME	Small and Medium-sized Enterprise
TIS	Technology Innovation System
TRL	Technology Readiness Level
TSO	Transmission System operator
VSI	Voltage Source Inverter
WAMS	Wide-Area Monitoring System

Executive Summary

The PANTERA project aims at setting-up a European forum composed of a wide range of stakeholders, active in the field of smart grids, storage and local energy systems. The long-term objective of PANTERA is to strengthen research and innovation (R&I) activities throughout Europe with special focus on the countries that appear to be less involved. To coordinate the work with target countries PANTERA consortium has agreed and established a Desk approach by grouping target countries under six operational Desks and additionally defining Best Practice Desk. Thus, partners committed themselves to investigate specific local contexts, challenges and barriers hindering deeper involvement of the target countries in European R&I activities and uncover opportunities for collaboration by means of constant dialogue with variety of national stakeholders.

This Deliverable (D6.5) summarises all activities performed under these headlines with special focus on the case studies.

The case study of Desk 1, the only Desk whose countries form also a geographical region (Baltic States: Latvia, Lithuania and Estonia), is investigating the ways how regional R&I calls are organised based on the example of the Baltic Research Programme financed under the European Economic Area. This is in line with the Regional Desks' objective of identifying the ways of strengthening national R&I activities in smart grid domain by providing valuable insights in the relevant procedures. Streamlining call procedures can support more effective use of existing administrative and scientific resources, thus contributing to increasing the quality of research projects. Recommendations emerging from analysis of the Baltic Research Programme call's documents and insights into call practises maintained by ERA-Net SES are listed below.

1. Call's objectives and challenges shall be defined according to national R&I priorities (linking to R&I strategies or/and NECPs) in order to support consistent development of competence and improvement of knowledge base in selected strategical areas.
2. Call's objectives and challenges shall be described in more specific manner, thus supporting applicants in shaping qualitative sustainable proposals and contributing to more accurate expert evaluation.
3. Closer cooperation of applicants with respective agencies shall be promoted, where agencies shall take a leading role in advising applicants firstly in decision to participate or not in the call, and then in the project preparation process, thus avoiding spending resources on ideas showing little promise, and contributing to suitability of the projects.
4. The number of necessary documents to submit, specifically those addressing administrative issues, shall be minimised in order to allow effective use of scientific personnel capacities. This recommendation is particularly true for Latvia.
5. Evaluation criteria shall be broadened or/and divided into more sections, and application form's structure shall clearly reflect these criteria, thus guiding applicants through all necessary requirements and providing evaluators clearer basement for justifying their scores. Hence, quality and transparency of evaluation process could be increased.
6. The threshold could be revised and lowered, so that more applications could be present during final discussions on funding decisions.
7. The programme committee composition and role shall be carefully considered in order not to compromise the transparency of the call.

The case studies of Desk 2 cover the three constituting counties: Bulgaria, Greece and Romania. Bulgaria is the country with lowest R&I activity in EU funded projects. Finding the reasons why this happens is a key factor for the success of the integrated EU R&I funding policy. Based on information gained from more than 25 contacts with stakeholders, it has been identified that one of the major hindering factors is the lack of appropriate laboratory infrastructure for R&I. At the same

time, it can be marked that although some EU funded projects[1],[2] offer easy to apply and free of charge access to the most advanced smart grid and DER laboratories in Europe these are not adequately used by the R&I stakeholders in Bulgaria. For example, the research of the laboratory access of the ERIGRID project shows that from 73 user projects in total none include participation from Bulgaria[3]. Similarly, the ERIGRID 2.0 project remains without any significant participation despite the support and promotion of this opportunity from PANTERA WT1 and PANTERA Desk 2 [4]. Hence, the case study related to Bulgaria, aimed at understanding why this happens and what are the main hindering factors for bridging the gap between the R&I stakeholders in the leading countries and those in Bulgaria. The approach implemented gave positive results. It has been noted that strengthening the R&I activities is a long bilateral process which requires significant effort from both local stakeholders and the European Commission. Based on the findings, the following recommendations to the stakeholders can be given in order to improve their smart grid related research actions and funding:

1. Improving their R&I level using local collaboration with PANTERA Desk 2, research organisations, universities, industry and other stakeholders.
2. Improving their R&I level and readiness by following the most recent trends in the leading R&I initiatives of the leading EU stakeholders.
3. Participation in ERIGRID 2.0 and other similar activities which increase the R&I capabilities and yield the connections with the leading research organisations in EU.

Still within Desk 2, Greece has elaborated the key knowledge and experience in autonomous island power systems gained over the years from real cases on the many islands of Greece. These, can serve as very good basis for the research and development of the novel micro and nanogrids. Unlike many other countries some major issues such as privacy, data collection, citizen engagement and energy cooperatives relations have been successfully resolved. Having a widest network of proven real-life concepts and experience it was identified that Greece has very high chance to become a leader in the R&I in novel power system with micro and nanogrids and can increase its activity specifically in this field for example by building research project proposals consortia. Based on this competitive advantages outlined, the following recommendations spring from this case study:

1. The similarity between the island power systems and the novel power systems which implement smart grids concepts with autonomous and semi-autonomous micro and nanogrids can give a significant advantage of the stakeholders from Greece when offering R&I projects in this field. Active research in this field regarding the existing and upcoming calls for proposals can be recommended.
2. Based on the experience gained from the island power systems a formation of research project proposal consortia for EU funding in the field of future smart grids with active micro, -mini- and nanogrids can be recommended.

Last, in Desk 2 is Romania. The pursued case study, included an analysis and identification of key competitive advantages of the recent R&I activities in Romania. Through a detailed analysis of future trends for finding ways for participation in EU funded partner consortia it has been found that Low Voltage DC networks are novel and a promising aspect of the energy transition. This new trend starts to grow and increase its significance with the fast growth of DC based RES combined with development of growing Electric Vehicle (EV) systems and powerful electronic converters. It can be noted that in this new topic the research in nearly all EU countries is in very early stage of development but Romania is active in this field with good results. Several projects with Romanian R&I Stakeholders have already gained experience and can offer useful contribution for the future of this new topic. A significant amount of research is needed at EU level in the years to come. Many technical and non-technical challenges are noted such as research on equipment with improved

[1] https://erigrid.eu/
[2] https://erigrid2.eu/
[3] https://erigrid.eu/transnational-access/selected-projects/
[4] https://erigrid2.eu/user-projects/

commutation capacity, higher insulation requirements (compared to AC). Also, some socio--centric issues as for example the need for gradual changes in the mind-set of the users and citizens need to be faced. For this reason, based on the state-of-the-art level of development the following recommendations are given:

1. Active participation of Romanian stakeholders in EU and LVDC expert groups is expected and needed.
2. Active research towards identifying key LVDC challenges and bottlenecks is needed.
3. Support of the EC corresponding directorates towards the issuing of LVDC EU funded research calls for proposals will better position the stakeholders of Romania.

Desk 3 brings together Cyprus and Malta. However, through the case study presented in this deliverable collaboration was pursued with Bulgaria and Portuguese experts as well. The Case Study dwells on building R&I collaboration for country common themes and issues that can lead to new project formulation and promotion, utilizing and sharing research infrastructure. Where, the partners luck specific research infrastructure to conduct the identified research objectives, use is made of the facilities offered through the ERIGRID 2.0 project offering access to state of the art research centres when successful. Thus this case study aims to engage stakeholders of regional desk 3 and other desks to provide support to researchers of these countries for pursuing the following:

- Strengthen their network for cooperation at national and EU level.
- Find channel of cooperation with other institutes in terms of research collaboration and data sharing
- Have access to R&I infrastructure
- Mobilization of researchers in these countries and engage them in the EIRIE platform.
- Stimulate their research interest to build their profile through the EIRIE platform and make this regional desk effort sustainable.

It is clear from the experience gained through this case study in building trust and interest between consortia of the involved countries, positive results were achieved giving valuable results to the stakeholders of the electricity grid in the respective countries. The successful submission to ERIGRID 2.0 call and subsequently the successful submission of the outcome of the awarded work through a paper to MEDPOWER 22 conference, give the evidence that collaboration work through the EIRIE platform can generate benefits to the entities involved. This is utilised as a best practice approach for the R&I community to learn and use in their future endeavours.

Another lesson learned through this process, is the importance of keeping truck of targeted objectives with the stakeholders involved constantly updated. Final results achieved should be suitably disseminated to all stakeholders contributing to the fruition of the effort. Equally important is to keep truck of achieved results and future steps clearly identified for all parties involved.

The case studies of Desk 4 and Desk 5 are built on literature review covering more global topics, i.e., smart meter roll-out in Poland, clean energy policy in Czechia, Croatia, Italy and Hungary and financing opportunities in Slovakia. Some general conclusions are drawn out of this literature review that can be guiding principles for these countries to strengthen their R&I presence in Europe.

- There is also an opportunity to increase international collaboration on projects that can be critical for RD&D. Low activity countries could participate in more EU R&D programmes beyond the traditional of their countries such as nuclear, fossil fuel related etc. They can strengthen their engagement in technology collaboration programs with international research institutes to share best practices in additional areas of RD&D and benefit both from international knowledge and private sector awareness of potential regional and global supply chains. Participation in international partnerships for energy innovation could decrease the costs of technology development through knowledge sharing and collaborative R&D on priority technology areas. This could be particularly beneficial to lower the high transaction

costs of international cooperation for innovative small and medium-sized enterprises and provide them with greater opportunities for sustainable growth and reach commercial deployment and accelerate market uptake.

- Due to the wide range of active partners in the RD&I field, there is a need to clearly allocate responsibility for co-ordinating policy in the field of technology RD&D. This should also ensure that the energy stakeholders play an active role, including academia, non-governmental organizations, small and medium-sized enterprises, and innovative start-ups, bringing all pertinent players into a collaborative framework. A multi-stakeholder process could allow these countries to set clear priorities for energy technology RD&D in emerging areas for the energy transition. There is a clear opportunity to have a national system of innovation predicated on RD&D in a range of emerging energy sources and types, especially low-carbon technologies.

Possible Recommendations that spring from this literature survey

- Consideration of the ambitious sector-specific targets that should be aligned with the other EU Member States.
- Comprehensive investments are needed to achieve the desired renovation rate of existing buildings and higher energy efficiency standards in SMEs
- Launch government-backed renewable energy and energy efficiency awareness campaign to gain public awareness to accept renewable energy sources.
- Implementation of renewable energy projects causes grid instability (voltage and frequency instability) as wind and solar are weather dependent, it is recommended to promote and invest in smart grid infrastructure research and projects within the EU framework.
- Additional grant funding for technical assistance can further incentivize investments and foster this knowledge transfer between other EU countries.

Desk 6 covers Ireland and Portugal. We have seen in the paragraphs above how Portugal coordinated work with Cyprus and Malta achieving valuable collaborative work that is reported above. However, the case study related to Ireland focuses on data issues. Thus, two PANTERA case studies are chosen on topics that provide insights into variety of technical and non-technical circumstances that might influence R&I performance of the countries. An issue that became apparent was the reliance on authenticated high-quality data to allow the research questions to be answered with high reliability. The research data need to be carefully managed to ensure GDPR compliance, and that the data are shared according to the project collaboration agreement. The DSO stakeholder strictly complies with all data sharing requirements and maintain high security levels on its IT platforms. Once data sharing agreements are in place, data can be made available to research partners for specific research purposes. In contrast, collecting the data on SD cards offers more control to the research partners but is more time consuming and can be subject to failures of the IT equipment. It is also more intrusive for the home owner. It is clear that the success of future smart grids depends on the availability of high-quality data availability, firstly for research and subsequently for sustainability of the innovation.

An important lesson learned through this case study, is that there are implications for energy transition policies. PANTERA could contribute by supporting further training for smart grid researchers on data issues. We do take note of the issues raised at the Dublin nano-workshop of PANTERA on IP protection and GDPR. The case studies point to the need to design a data sharing agreement as part of the Grant Agreement, and that meaningful Data Management Plans can help identify suitable open data, and identify a repository for data storage and archiving.

The right incentives and regulatory support for innovation play a significant role in clean energy R&I. One of the pathways to investigate and select the most effective incentives are regulatory sandboxes. A study on regulatory sandboxes and their role is included in this report under the Best Practice section revealing best practice approaches for allowing sandboxes practices to play an

important positive role in pushing emerging technologies through to playing an important active role in the energy transition. References made can play a vital role for low activity countries in building their R&I activities following state of the art practices in developed countries.

Regional corner activity of PANTERA presented through EIRIE

As noted in previous deliverables, the key and important deliverable of the PANTERA project is the EIRIE platform. Equally important is the fact that EIRIE incorporates specific pages related to regional activities, so called Regional Corner. Through this regional corner, collaboration is pursued since it is fundamental in the existence of the EIRIE platform for team building in related activities and knowledge creation. To facilitate this collaboration work the platform of Confluence is used to harness, the required collective work spirit for regions to flourish. Confluence is a team workspace where knowledge and collaboration can efficiently deliver by creating, collaborating, and getting organized in one place. Dynamic pages give the EIRIE team a place to create, capture, and collaborate on any project or idea. Spaces help the EIRIE team to structure, organise, and share work, so every team member has visibility into institutional knowledge and access to the information they need to enrich and raise the quality of their work. Confluence is for teams of any size and type, from those with mission-critical, high-stakes projects that need rigor behind their practices, to those that are looking for a space to build team culture and engage with one another in a more open and authentic way.

Many activities flourish through the collective work of regions and countries and these are reported in this Deliverable separately for every region and country. The aim through this work is to generate interest within stakeholders at local level and get them eventually active through EIRIE to strengthen collaboration work through team building efforts. The results achieved are documented in the paragraphs below.

1 Introduction

1.1 Purpose, Scope and Limitations of the Document

The work in this report is carried out under Work Package six (WP6) 'Collaboration Working Groups' of the Pan European Technology Energy Research Approach (PANTERA) project. This deliverable aims at describing regional activities and is the final version of consolidated summary report on Desk activities. The first version released in 2020 (D6.3) provided a summary of activities performed within the Regional Desks framework from building up the approach and setting the objectives and identifying next steps, it also included supportive actions (dedicated stakeholder survey, country profiles, and best-practices). Current version is focused on the country specific case studies aiming at providing deeper insights in regional specifics, challenges and barriers limiting the research and innovation (R&I) performance in the field of Smart Grids and beyond. The case studies' topics differ from country to country, from technical studies (i.e., smart grid meter layout) to institutional (i.e., organisation and evaluation of R&I calls). Where possible, case-studies were based on relevant partners' real-life experience in establishing different type of collaborations. Thus, various layers of Smart Grid ecosystem are covered. The best-practice section is enhanced further with a study on regulatory sand boxes. Moreover, the report includes information on European Interconnection for Research, Innovation and Entrepreneurship (EIRIE) Regional Corner development lead by IPE.

1.2 Structure of the Document

This deliverable D6.5 is structured to cover all aspects of the regional work. It starts with a brief introduction of PANTERA Desk approach, main activities and interaction with other WPs in Section 2. Section 3 is the key part of this deliverable and describes country specific case studies. Section 4 looks at each Desk, concentrating on specifics and progress made in building stakeholder network and populating PANTERA. Section 5 includes discussion on best practices in R&I and Section 6 describes the structure of Regional Corner on EIRIE platform. Finally, Section 7 concludes the document and sets directions for further work.

2 Regional Desk Approach

PANTERA 6+1 approach aims to organize and synchronize efforts of different actors to strengthen national participation rate in smart grid R&I activities and investment. It is a place for raising discussions with national decision-makers, sharing experience and challenges in research and innovation, inviting local stakeholders to interact more actively with PANTERA and other EU-level initiatives. Thus, it is a key opportunity for attaining PANTERA ambition of creating a true pan-European R&I community.

PANTERA 6+1 approach includes six PANTERA Regional Desks committed to target countries which appear to have a lower rate of smart grid R&I activities and investment and one best-practice Desk elaborating on gathering and systemising good experience in projects and R&I governance from more successful countries (Figure 1). The term "Regional" describes the way the work is organised within the consortium rather than geographical division, it stresses the intention of PANTERA to be closer to the local stakeholders and adapt to the local processes and cultures. A relevant PANTERA partner is responsible for the host country and for the associated countries to each and every Desk.

Figure 1: PANTERA 6+1 approach

The six main Desks serve as a PANTERA project's contact point for all potential stakeholders from the targeted region and for any other interested stakeholders from other countries. The Desk is a dynamic structure, where stakeholders may join and express different level of activity and commitment during the project implementation. It supports organising stakeholder consultations and workshops, dissemination activities on regional level, generating country specific reports and publications, developing and updating PANTERA country profiles. Through this process the regional contexts are provided for the PANTERA Working Teams and the EIRIE Platform.

The additional best-practise Desk serves as an information hub for gathering successful practical experience and knowledge which may be utilised for benchmarking and accumulating lessons

learned. The work performed within the best-practice Desk compliments the PANTERA national level activities in the target countries, supports Working Teams and fosters the EIRIE Platform implementation by providing valuable information in a structured way.

Activities related to the regional dimension of PANTERA were launched from the very beginning of the project, starting with setting the scene with review of strategic priorities, establishing country profiles framework, launching PANTERA 6+1 approach and continuous stakeholder engagement activities within each individual Desk and central supportive analysis (survey, country profile update, best practice identification).

To support meaningful insights in local contexts partners agreed and created country-specific case studies. While covering different topics from technical to institutional and implemented by different means (literature review or establishing collaborations), they all follow one common framework. Case studies are described in Section 3.

All of the mentioned activities underpin EIRIE regional corner development and implementation, see Figure 2.

Figure 2: PANTERA Desks activities and supporting measures

Other activities linked to Regional Desks are being performed within WP4 'Key topics and content management' and WP2 'Pan-European R&I community' aiming accordingly at maintaining throughout the project the significance and value of the operational topics and stakeholder interaction.

<u>Interaction with activity "Key topics and content management»</u>

The activities described in this report kept a very close interaction with WP4 "Key topics and content management». The main objective of WP4 is to maintain the significance and value of the operational topics of PANTERA by regular interaction with the stakeholders and herewith to point

out the gaps (in terms of technology, regulations, policy, national funding mechanism) and provide directions on missing subjects or aspects that are hindering the energy transition. Interaction with the stakeholders in WP4 was achieved through a set of individual interviews with key stakeholders from the target countries.

It proved to be very difficult to establish contacts with relevant and qualified stakeholders, which were willing to share their knowledge and opinions with the project. In that sense WP6 provided continuous support by contacting and recruiting stakeholder candidates to the interviews. This allowed to arrange and conduct more than 30 individual interviews as it is shown in Figure 3.

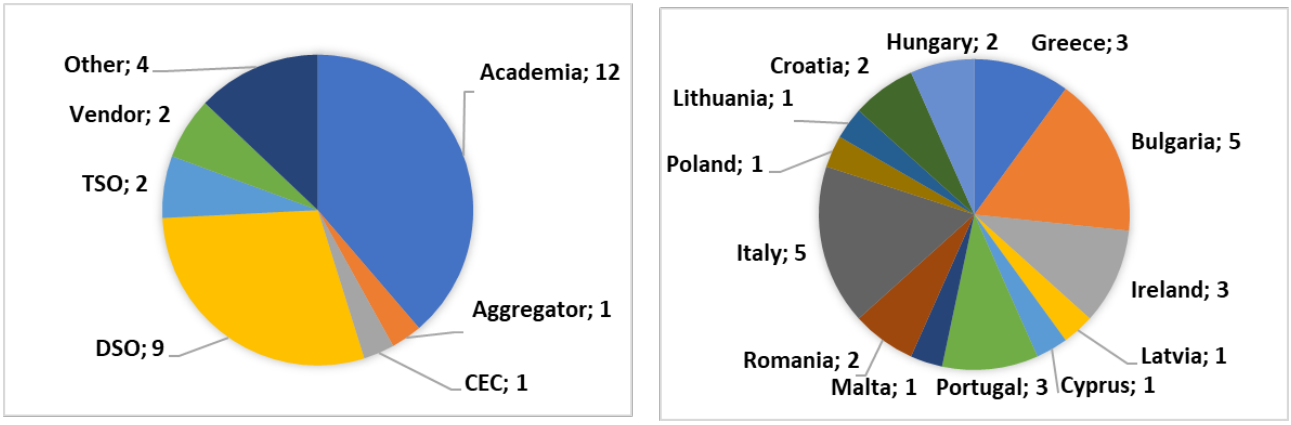


Figure 3: Overview of the accomplished interviews (pr. 2022-10-10)

Furthermore, WP6 provided additional questions and critical points, which were discussed during the interviews. Feedback from the interviews allowed to assess different factors and to add new issues, which were not initially foreseen in the project, but proved to be critically important for the stakeholders as in particular none-technical questions e.g., national decision-making and financing and creation of well-functioning national sandboxes. Based on this, several examples of “Best Practices” were introduced, showing the stakeholders how some of the indicated issues are resolved in other European countries.

3 Case studies

3.1 Desk 1 (Latvia, Estonia, Lithuania) common case study: Challenges in project proposal preparation – a case study of Baltic Research Programme financed under the European Economic Area (EEA) financial mechanism

Introduction

According to PANTERA Desk survey [1], issues in project proposal preparation process are indicated as the most important barrier in project success and thus increasing R&I activities. In order to deeper understand stakeholder concerns, a case study was carried out on how Baltic research Programme is organised.

The main goal of the Baltic Research Programme is to enhance research-based knowledge development in the Baltic States through research cooperation with Norway, Iceland and Liechtenstein (Donor States). The programme is designed, through competitive and open calls for proposals for joint research projects, to ensure the quality and high level of research. Totally three calls were issued: first call coordinated by Estonia in 2018, second call coordinated by Lithuania and third call coordinated by Latvia, both in 2020. All three calls have the same structure and similar general requirements, but different application forms. The programme funds collaborative research projects in basic and applied research. Thematic priorities of the calls are rather broad and formulated in slightly different way in each call. However, all calls have topics related to sustainable and effective use of resources, to which projects on smart grids are linked.

Aims

Baltic Research Program is one of good examples of cooperation between more advanced and lagging countries. Hence, streamlining collaborative calls organisation is one of important steps in increasing R&I activity in Baltic States. This case study aims at identifying particular gaps in the call organisation process which create unnecessary difficulties for applicants or compromise transparency of the calls. Furthermore, it aims at uncovering differences in project application organising practises in Latvia, Estonia and Lithuania. Analysis cover both application and evaluation procedures, as well as results of the calls.

Method

Information about the calls was obtained through the programme implementing agencies' web sites. Relevant documents are summarised in Table 1. The case study was carried out by analysing these documents using multiple criteria: general conditions of the call and eligibility criteria, application procedure and required documents for submitting a proposal, evaluation process, evaluation criteria and calls' results. Relevant data is summarised in Table 2.

Results

<u>General conditions and eligibility criteria</u>

Generally, the calls followed the same structure, supporting basic and applied research in the broad areas, that can be described by the following key words: heath, environment, cyber security and inclusive society. More details were given for each topic in Lithuanian and Latvian call, while the first

Estonian call included only general headlines. Including general definitions only might complicate assessment of proposals' relevance to the challenges of the call, which is very important proposal assessment criteria. According to Estonian call guidelines it could be even rewarded additional 0.5 points.

Estonian and Latvian call required participation of at least two Baltic countries, meanwhile projects including partners from all three Baltic States could apply for higher grant. In the Estonian call participation of all three Baltic States was additionally stimulated by possibility to earn additional 0.5 point during project evaluation. As for Lithuanian call, the requirement for participation of all Baltic countries was included from a very beginning. Considering the size of the countries and the limited number of institutions working in the same thematic direction, the amount of unique consortia combinations was quite limited.

The eligibility criteria for project promoters and project partners were described similarly with a minor difference in Latvian call, that required the principal investigator (project leader) to have a doctoral degree of Latvia (possibility of having equivalent degree received in any other country was not mentioned). This means that formally, a project led by researcher with a doctoral degree from another country working in Latvia could be rejected during eligibility check.

Application procedure and required documents for submitting a proposal

Calls' applications had to be submitted electronically by project promoters. As each country has its own application system, application procedures differed. Generally, all application forms included information on project promoter and partner research staff accompanied by CVs and description of roles, including involvement of PhD students and postdocs, budget, project summary in English and national language, impact assessment on the selected challenges, ethics assessment and scientific rationale. Additional question on relevance to Smart Specialisation (S3) areas was included in Latvian call. Alignment of projects with national R&I priority areas is a good practise of itself. However, considering a very broad definition of S3 priorities in Latvia, it does not provide significant added value.

Latvian call can be characterised with most demanding requirements and bigger amount of paper work. Most of written parts had higher limit of maximum characters than in another two calls. Moreover, some specific documents were required only in Latvian call, such as publicity plan, project risk assessment, project promoter's annual reports from the last three years (in Latvian), project promoter's finance and accounting policy (in Latvian) and power of attorney or internal legal act of the institution certifying the authorization to sign the project. Furthermore, Latvian call required more detailed budget calculations, that had to include data on depreciation costs and costs of inventory, tools and materials. Hence, an obvious need to attract administrative resources was created. However, only few major state universities are capable of doing so. Usually smaller organisations do not receive enough baseline financing to hire additional administrative staff. Thus, administrative tasks, sometimes including accountancy as well, are performed by leading researchers, who become constantly overloaded.

Evaluation process

Evaluation process was almost the same for all calls. At first, eligibility check was carried out by the relevant programme implementing agency (Estonian Research Council (ETAG), Research Council

of Lithuania (RCL), Latvian State Education and Development Agency (SEDA)). It shall be noted that in case of absence of any single document required, the proposal could be rejected.

Then, each eligible proposal was sent to three independent international experts. One of the experts was appointed as a rapporteur who prepared a consensus report. The results were presented to the Programme Committee. The Programme Committee consisted of eight persons (two from Estonia, Latvia, Lithuania and Norway) representing the members of the research community and main research users in the Baltic States and Donor States (Norway, Iceland, Liechtenstein).

After that, the Committee evaluated the applications from overall programme's perspective. It played a leading role in making final decision on funding in all calls. This is particularly true for the Latvian call because the Programme Committee was allowed to change expert evaluation in scope-relevance criteria. Moreover, while in Estonian and Lithuanian call it was stated that the final decision is to be taken by the Programme Operator in cooperation with Programme Committee, the Latvian guidelines included a clause that a funding decision was to be made by the Programme Committee and SEDA's role was limited to preparing and sending decisions to the applicants.

Evaluation criteria

The experts were invited to review the quality of the submitted proposals based on three core evaluation criteria: scientific and/or technical excellence; quality and efficiency of the implementation and the management, added value from the international cooperation; potential impact through the development, dissemination and use of project results. Each criterion could be scored out of 5 and the evaluation could also be expressed by awarding a half-point score. Minimum thresholds were set for all criteria and the total score. Being slightly different these were quite high in all calls. Total threshold for Estonian call was set as 11 out if 15, while in Latvian and Lithuanian call it was set as 12.5 out of 15. This along with requirements to submit many administrative documents led to demanding proposal preparation.

Moreover, criteria were described in a general manner. Hence, broad definition of the evaluation criteria and broad definition of the calls' challenges could cause subjective assessment of proposals, considering that experts could be more qualified and more enthusiastic of some specific topics.

Calls' results

All calls can be characterised with very high competition. A success rate in Estonian and Latvian call was 6% and 10% accordingly, which is lower than Horizon 2020 average success rate (12%). A success rate of Lithuanian call was slightly higher and reached 14%, that could be explained with bigger budged and stricter initial requirement to consortia composition, i.e. the need to involve partners from all three Baltic States.

Most of proposals addressed challenges related to climate change and efficient use of resources. However, in Estonian call approximately the same number of applications were linked to challenge on public health. Cybersecurity was the least popular challenge to address, it might be explained with limited number of applicants having specific knowledge and skills. Moreover, it seems to be much easier to prove a projects commitment to climate objectives then to tackle cyber security issues. Hence, it seems that more narrow definition of the call challenges could reduce the amount of applications. It shall be noted, that applicants were allowed to select multiple challenges. In

Estonian call 45% were linked to one challenge and 37% to two challenges, that might be explained by two similar challenges on environmentally friendly solutions and effective use of resources. This issue was corrected in the next calls and in Latvian and Lithuanian call almost all applications were linked to one challenge.

Discussion

As seen from performed analysis, different gaps exist in all stages of the process. Some of these are discussed below considering an example of Joint Call 2020 Digital Transformation for Green Energy Transition (MICALL20) organised by European Research Area Network Smart Energy Systems (ERA-Net SES). The overall aim of the MICALL20 is to support transnational research and innovation activities, unleashing the potential of digital transformation for a sustainable energy society. More details on the call objectives can be found in the full call text [2].

General conditions and eligibility criteria

In addition to the MICALL20 project requirements, national/regional eligibility criteria defined by each involved country/region must be respected. National eligibility criteria differ from country to country: different funding conditions may apply; different type of research might be supported (many countries do not support basic research); specific requirements like obligation to involve an industrial partner could apply (like in Germany), additional requirements for alignment to national strategies' (for example, Norway) or national programmes' objectives (for example, Czech Republic) may be included, etc. As for the Baltic States, only Latvia is represented directly. It shall be noticed, that Latvian requirements are very general, no specific conditions regarding strategy or industry are included, support is available from fundamental research to experimental development. Additionally, researches from the Baltic States are able to participate in the call through Nordic Energy Research representing Baltic and Nordic region. Except for consortia composition there are also no specific requirements defined. Meanwhile, Norway on itself has identified more specific eligibility criteria. The situation is somewhat similar to Baltic Research Programme, where one of the important notices, is that call challenges are defined quite broadly and it seems that these are not underpinned by or are weekly linked to national R&I strategies.

Another, interesting note is that there are no requirements for leading researcher of the coordinator to have specific education, e.g. a doctoral degree as in Baltic Research Programme. Meanwhile, the degree itself doesn't guarantee the high level of project managing skills.

Evaluation process

At the moment of performing this case study, the project application was ongoing. However, the first step was closed – a compulsory advisory period and registration of interest for all potential project applicants. During the advisory period, the project applicants were obliged to seek support and guidance from their respective agencies. Based on the registration of interest and (if applicable) the separate national/regional applications, the funding agencies have given the project applicants a status as:

- Green: indicating that the project and the partner(s) seem eligible and of interest for funding, with no specific issues detected so far;
- Yellow: indicated that the project could be of interest for funding, but changes may be necessary;

- Red: indicating that this partner is not eligible for funding.

This process stimulates cooperation between researches and national agencies, allows avoiding unnecessary spending of resources in case the project is considered as ineligible and there are no possibilities to resolve the reasons for that, and helps shape the project according to national priorities.
As for Baltic Research Programme, it seems that close cooperation of researches with national agencies is missing. Adopting similar practices and deeper involvement of relevant institutions could increase the suitability of the projects with respect to call requirements.

Evaluation criteria

The evaluation criteria in MICALL20 are built upon three main criteria: excellence, impact and quality and efficiency of the implementation. Each criterion is further split into four detailed sections. Each section could be scored out of 5, thus the maximum score is 60 points. Projects that achieve a total score of less than 30 points by the expert evaluation panel or a score of 0 on relevance to the call (first section of excellence) are not forwarded to the selection phase by the experts.

The application form is divided in multiple sections which are linked to the evaluation criteria (see Table 3). The benefits of such approach are twofold: applicants are guided in a way to cover all criteria and evaluators base their decision on clearly described sections. It can be noticed, that in Baltic Research Programme the threshold is much higher (11 or 12.5 out of 15 points) compared to MICALL20 (30 out of 60 points), meanwhile the criteria are poorly described.

Recommendations

This case study reflects Regional Desks' objective of identifying the ways of strengthening national R&I activities in smart grid domain by providing valuable insights in the relevant procedures. Streamlining call procedures can support more effective use of existing administrative and scientific resources, thus contributing to increasing the quality of research projects.
Recommendations emerging from analysis of the Baltic Research Programme call's documents and insights into call practises maintained by ERA-Net SES are listed below.

8. Call's objectives and challenges shall be defined according to national R&I priorities (linking to R&I strategies or/and NECPs) in order to support consistent development of competence and improvement of knowledge base in selected strategical areas.
9. Call's objectives and challenges shall be described in more specific manner, thus supporting applicants in shaping qualitative sustainable proposals and contributing to more accurate expert evaluation.
10. Closer cooperation of applicants with respective agencies shall be promoted, where agencies shall take a leading role in advising applicants firstly in decision to participate or not in the call, and then in the project preparation process, thus avoiding spending resources on ideas showing little promise, and contributing to suitability of the projects.
11. The number of necessary documents to submit, specifically those addressing administrative issues, shall be minimised in order to allow effective use of scientific personnel capacities. This recommendation is particularly true for Latvia.
12. Evaluation criteria shall be broadened or/and divided into more sections, and application form's structure shall clearly reflect these criteria, thus guiding applicants through all

necessary requirements and providing evaluators clearer basement for justifying their scores. Hence, quality and transparency of evaluation process could be increased.

13. The threshold could be revised and lowered, so that more applications could be present during final discussions on funding decisions.
14. The programme committee composition and role shall be carefully considered in order not to compromise the transparency of the call.

Table 1: Document list

Document title	***Available at:***
Common	
Programme Committee	https://www.etag.ee/wp-content/uploads/2021/03/PC-members-CVs-2019-1.pdf
The 1st call of the Baltic Research Programme Coordinated by Estonia	
Guidelines for Applicants	https://www.etag.ee/wp-content/uploads/2021/03/Guidelines-for-Applicants.pdf
Guidelines for Evaluators	https://www.etag.ee/wp-content/uploads/2021/03/Guidelines-for-Evaluators-1.pdf
Results of the Estonian call 2019 submission of proposals	https://www.etag.ee/en/funding/partnership-funding/eea-financial-mechanism-2014-2021-baltic-research-programme/
The list of the projects selected for funding,	https://www.etag.ee/wp-content/uploads/2021/03/Results-of-the-first-call-in-the-Baltic-Research-Programme.pdf
The 2nd call of the Baltic Research Programme Coordinated by Lithuania	
Guidelines for Applicants	https://www.etag.ee/wp-content/uploads/2020/11/Guideline-for-Applicants-LT_2020_02_03-3.pdf
Guidelines for Evaluators	https://www.etag.ee/wp-content/uploads/2020/11/Guidelines-for-Evaluators-LT_11_2020_02_03.pdf
Results of submission of proposals	https://www.lmt.lt/en/doclib/s0seee8h9k2faj4w4m2r1r5qsgrhyuh1
The list of the projects selected for funding	https://www.lmt.lt/en/doclib/alox8qsv0uggs1kh9s4wgva9v63yrwpn
Participation of Estonian research teams in funded projects	https://www.etag.ee/wp-content/uploads/2020/10/LT08-1.pdf
The 3rd call of the Baltic Research Programme Coordinated by Latvia	
Guide for Applicants	https://www.etag.ee/wp-content/uploads/2020/11/Guidelines-for-Applicants_LV.pdf
Guide for Evaluators	https://www.etag.ee/wp-content/uploads/2020/11/Guidelines-for-Evaluators_LV-1.pdf
List of Projects approved for funding (all partners)	https://www.etag.ee/wp-content/uploads/2021/02/EMP-BALTI-TEADUSKOOST%C3%96%C3%96-PROGRAMMI-L%C3%84TI-VOORUS-RAHASTATUD-PROJEKTID-koduka
List of Projects approved for funding	https://eeagrants.lv/en/2021/02/18/8-projects-approved-in-the-baltic-research-programme/
List of research organisations and the full version of the summary	https://eeagrants.lv/en/2020/12/04/81-applications-received-from-latvia-in-the-3rd-competition-of-the-baltic-research-program/
Additional forms to be submitted together with project application, Annexes 1-13	https://eeagrants.lv/en/research-and-education/documents/documents-and-guidelines-for-the-2020-latvian-call-of-proposal/

Table 2: Details of the calls organised under the Baltic Research Programme

EEA Financial Mechanism 2014 – 2021 The Baltic Research Programme ***The 1st call of the Baltic Research Programme Coordinated by Estonia (2018)***	***EEA Financial Mechanism 2014 – 2021 The Baltic Research Programme*** ***The 2nd call of the Baltic Research Programme Coordinated by Lithuania (2020)***	***EEA Financial Mechanism 2014 – 2021 The Baltic Research Programme*** ***The 3rd call of the Baltic Research Programme Coordinated by Latvia (2020)***
General conditions and eligibility criteria		
Program operator		
Ministry of Education and Research	Ministry of Education, Science and Sport	Ministry of Education and Science
Implementing agency		
Estonian Research Council	Research Council of Lithuania	State Education and Development Agency
Available funding		
6 million EUR	10 million EUR	7 million EUR
Funds allocation per project		
Minimum grant amount per project: 300 000 EUR Maximum grant amount per project: 800 000 EUR, 1 000 000 EUR (involving all Baltic countries)	Minimum grant amount per project: 300 000 EUR Maximum grant amount per project: EUR, 1 000 000 EUR	Minimum grant amount per project: 300 000 EUR Maximum grant amount per project: 800 000 EUR, 1 000 000 EUR (involving all Baltic countries)
Project duration		
min.36 max. 48 months	36 months	36 months
Call thematic		
- Public health; translational medicine; health technologies - Migration; social inclusion - Regional cyber security; public security - Environmentally friendly solutions - Regional economic development; employment; labour market regulations and social policy - More effective use of resources	- Technologies and innovation development to tackle climate change - Cyber security - Preventive and personalized medicine - Culture, migration and inclusive society - Economic, social challenges and innovative society	- Public health; e- health - Migration; social inclusion - Cyber security; public security - Regional economic development; employment, labour market regulations and social policy - Innovative solutions for efficient and sustainable use of resources
No details are given, but the proposals' relevance to these challenges is evaluated by the Programme Committee and can be awarded up to 0.5 additional points.	Detailed explanation and subareas are given in call requirements	Detailed explanation and subareas are given in call requirements
Type of research		
Basic and/or applied research		
Type of projects		
Joint research collaboration projects involving at least one Estonian partner (project promoter) and one partner from other Baltic States and one Norway and/or Iceland and/or Liechtenstein.	Joint research collaboration projects involving at least one Lithuanian partner (project promoter), one partner from Estonia, one partner from Latvia and one Norway and/or Iceland and/or Liechtenstein. All Baltic States must be involved	Joint research collaboration projects involving at least one Latvian partner (project promoter) and one partner from other Baltic States and one Norway and/or Iceland and/or Liechtenstein.

Eligibility criteria for project promoters Eligible applicants are positively evaluated research and development institutions established in Estonia. List of evaluated institutions is provided in the Estonian Research Information System (ETIS). Eligibility criteria for the principal investigator (researcher in charge): must be an experienced researcher/project leader with doctoral degree of Estonia or an equivalent academic degree The evaluators pay particular attention to the qualification and performance of principal investigator as well as gender when evaluating the gender balance aspect.	Eligible applicants are research organisations established in Lithuania. The principal investigator (researcher in charge) must be an experienced researcher/project leader with doctoral degree of Lithuania or an equivalent academic degree.	The project promoter should correspond to the status of a research institution registered in the national register of Latvia. The principal investigator (researcher in charge) must be an experienced senior researcher/ the project manager with doctoral degree of Latvia. The evaluators pay particular attention to the qualification and performance of principal investigator
Eligibility criteria for project partners Project partners are research organisations, as defined in the EU Framework for State aid for research and development and innovation (2014/C198/01), established in the Donor States, Estonia, Lithuania and Latvia. Adding project partners during the project is not allowed.		Project partners are research organisations, as defined in the EU Framework for State aid for research and development and innovation (2014/C198/01), established in the Donor States, Estonia and Lithuania. Attention to the qualification and performance of qualification of the project participants, as well as the gender balance.
Application procedure and required documents for submitting a proposal		
Project submission Applications are submitted electronically via Estonian Research Information System (ETIS) by Estonian research and development institutions (project promoters)	Applications are submitted electronically to RCL via JUNKIS submission system (junkis.lmt.lt) by the Lithuanian institutions as Project Promoters	Applications are submitted electronically via the rsgrants system by Latvian research organizations (project promoters).
Project application **General information** Project title in Estonian and in English Project Promoter in Estonia Timeline and total budget Does the application address some of the challenges set for this call? Impact of the project on selected challenges (max. 2000 characters) Summary in English (max. 2000 characters) Summary in Estonian (max. 2000 characters) Ethics assessment	Project title in Lithuanian and in English Project Promoter in Lithuania Timeline and total budget Does the application address some of the challenges set for this call? Impact of the project on selected challenges (max. 2000 characters) Summary in English (max. 2000 characters) Summary in Lithuanian (max. 2000 characters)	Project title in Latvian and English Project promoter in Latvia Timeline and total budget Smart specialisation area Does the application address some of the challenges set for this call? Justification of the selected challenges/priorities (max. 2 000 characters) Summary in English (max. 3 200 characters) Summary in Latvian (as annex) (max. 3 200 characters)

	Ethics assessment included in scientific rationale.	Ethics assessment (as annex)
Project promoter, partners and external experts International cooperation (description of roles and effects, max. 5 000 characters) Details of project promoters senior research staff, including: - Name and CV of principal investigator and senior research staff; - Description of roles and distribution of tasks (max. 3000 characters) - Postdocs involvement in the project (max. 3000 characters) - PhD students involved in the project – expected contribution (max. 3000 characters)	International cooperation (description of roles and effects included in scientific rationale) Details of project promoters senior research staff, including: - Name and CV of principal investigator and senior research staff; - Postdocs involvement in the project (max. 3000 characters) and PhD students involved in the project – expected contribution (max. 6000 characters)	International cooperation (description of roles and effects, max. 10 000 characters) Details of project promoters senior research staff, including: - CVs - Description of roles and distribution of tasks (max. 5000 characters) - Postdocs involvement in the project (max. 5000 characters) - PhD students involved in the project – expected contribution (max. 5000 characters)
Details of project partners senior research staff, including: - Name and CV of principal investigator - Description of role (max. 3000 characters) External expert names, affiliation and description of role (max. 3000 characters), if applicable	Details of project partners senior research staff, including: - Name and CV of principal investigator - Description of roles included in scientific rationale External expert names, affiliation and description of role (max. 3000 characters), if applicable	Details of project partners senior research staff, including: - Name and CVs of principal investigator External expert names, affiliation and CVs, comments, if applicable
Budget Direct costs: - Personnel costs (the cost of staff assigned to the project) - Travel and subsistence allowances for staff taking part in the project - Subcontracting costs (no more than 15% of total budget project) - Other costs (consumables) - Indirect costs: - Institutional overhead (flat rate of 25% of total direct eligible costs, excluding direct eligible costs for subcontracting) Budget justification (max 5000 characters)	Direct costs: - Personnel costs (the cost of staff assigned to the project) - Travel and subsistence allowances for staff taking part in the project - Subcontracting costs (no more than 15% of total budget project) - Other costs (consumables) - Indirect costs: - Institutional overhead (flat rate of 25% of total direct eligible costs, excluding direct eligible costs for subcontracting) Budget justification (max 5000 characters)	Direct costs: - Personnel costs (the cost of staff assigned to the project) (administrative costs not more that 10% of direct costs) - Travel and subsistence allowances for staff taking part in the project - Depreciation costs - Costs of inventory, tools and materials - Other costs (consumables) - Subcontracting costs (no more than 15% of total budget project) - Total direct eligible costs Indirect costs - Overheads (flat rate 25% of total direct eligible costs, excluding direct eligible costs for subcontracting) Budget justification included as column in detailed

Annexes (submitted as separate documents)
Summary in Estonian (max. 2000 characters) included in application

See above

Scientific rationale (25 000 characters):

- General theoretical background of the project along with references to the hitherto work, here and/ or elsewhere; the connection of the project with the research of the same direction of the applicant and other researchers;
- The main objectives and working hypotheses of the project;
- Research methods, equipment and apparatus to be used, incl. existence or absence thereof;
- Forecast on internationally refereed (Baltic-Donor States in a joint capacity) publications published as part of the project;
- The Expected significance of the project with respect to the science, national and regional economy, social sphere, culture, etc.;
- The expected time schedule of the research by years;
- The list of references, charts and schemes to be submitted in pdf.

See above

Scientific rationale:

- general theoretical background of the project along with references to the hitherto work, here and/ or elsewhere; the connection of the project with the research of the same direction of the applicant and other researchers;
- the main objectives and working hypotheses of the project;
- research methods, equipment and devices to be used, incl. existence or absence thereof;
- forecast on internationally refereed (Baltic-Donor States in a joint capacity) publications published as part of the project and other output is planned to be delivered;
- scientific competence of principal investigator, partners and other project implementers and the justification of the composition of a project group (including aspects of gender balance);
- the expected significance of the project with respect to the science, national and regional economy, social sphere, culture, etc.;
- the expected time schedule of the research by years and project milestones;
- international cooperation (Please submit information about international cooperation carried out within the project. Please describe the role of project partner(s). How will the partnership contribute to the achievement of the project goals? What is the project partner's technical/professional contribution to the project? Are wider effects of the partnership expected?);
- ethic issues related to project activities;
- additional information.

budget form in Annex

1. Project summary (in Latvian)

2. Gantt chart
3. Detailed budget
4. Research proposal
Description max 5 pages spited in 3 parts:

- Scientific and/or technical excellence
- Quality and efficiency of the implementation and the management, added value from the international cooperation
- Potential impact through the development, dissemination and use of project results

5. Publicity plan

		Suggested content of the publicity plan: - Target audiences - Communication goals - Communication channels - Project public and outreach activities - Planned timeframe - Evaluation indicators - Contact point **6. Project risk assessment**
Confirmation letter for each partner CVs (senior researcher from Latvia, senior research staff from Latvia, CVs of senior researcher from all partners, CV of external scientific experts (if applicable)) Ethics assessment included in application section	Letter of intent for each partner CVs (senior researcher from Latvia, senior research staff from Latvia, CVs of senior researcher from all partners, CV of external scientific experts (if applicable))	**7. Letter of intent for each partner** 8. CVs (senior researcher from Latvia, senior research staff from Latvia, CVs of senior researcher from all partners, CV of external scientific experts (if applicable)) **9. Ethics assessment** **10. Project promoter's annual reports from the last three years (in Latvian)** **11. Project promoter's finance and accounting policy (in Latvian)** **12. Confirmation Letter (in Latvian)** **13. Confirmation Letter (in English)** **14. Power of attorney or internal legal act of the institution certifying the authorization to sign the project (applicable if the project is signed by a person other than the legal representative of the institution or his deputy)**

Eligibility check

Only the proposals that meet the eligibility and administrative criteria are subject to content-related evaluation. Completeness of the form and presence of all requested files is a prerequisite for further content evaluation.

Evaluation criteria

Content evaluation, core criteria

Scientific and/or technical excellence

- sound concept, and quality of objectives
- progress beyond the state-of-the-art
- quality and effectiveness of the scientific methodology and associated work plan
- innovation and new approaches

Quality and efficiency of the implementation and the management, added value from the international cooperation

- appropriateness of the Project Promoter and Project Partners participating in the project
- appropriateness of the work plan
- appropriate allocation and justification of the resources to be committed (personnel, travel, subcontracting and other costs)
- appropriateness of research environment for the proposed research
- researcher training
- strengths of consortium complementarity of skills

international cooperation beyond the project, quality and sustainability of forward-looking cooperation between the partners
Potential impact through the development, dissemination and use of project results
- relevance of the proposal in relation to the objectives of the Programme and challenges of the call
- impact from the project to research-based knowledge development in the Baltic region
- potential of the research topic to be internationally relevant

take up and potential use of the project results by end-users including the clarity, appropriateness and efficiency of the planned knowledge transfer measures

Thresholds		
Each criterion will be scored out of 5. Thresholds: Scientific and/or technical excellence – 3.5 Quality and efficiency of the implementation and the management, added value from the international cooperation – 4 Potential impact through the development, dissemination and use of project results – 3.5 Total threshold –11 Applications with partners from the other two Baltic States, in addition to the Donor State partner(s) can apply for higher grant and can, based on proposed collaboration plan, awarded up to 0.5 extra points by Programme Committee evaluating the Project. The proposals' relevance to these challenges is evaluated by the Programme Committee and can be awarded up to 0.5 additional points.	Each criterion will be scored out of 5. Thresholds: Scientific and/or technical excellence – 3.5 Quality and efficiency of the implementation and the management, added value from the international cooperation – 4 Potential impact through the development, dissemination and use of project results – 3.5 Total threshold – 12.5 (3.5+4+3.5=11)	Each criterion will be scored out of 5. Thresholds: Scientific and/or technical excellence – 4 Quality and efficiency of the implementation and the management, added value from the international cooperation – 3.5 Potential impact through the development, dissemination and use of project results – 3,5 Total threshold – 12,5 (4+3.5+3.5=11)
Results		
Submitted projects – 130, projects selected for funding – 8 **Success rate 6%**	Submitted projects – 79, projects selected for funding – 11 **Success rate 14%**	Submitted projects – 81, projects selected for funding – 8 **Success rate 10%**

Table 3: Evaluation criteria of ERA-Net SES MICALL20

Evaluation criteria	***Corresponding fields of the application form***
Excellence	
1 Relevance to the call - Proposed piloting, validation and demonstration fit the call aim - Proposed project is clearly based on a specific need, involving (a) specific “need-owner(s)” or clearly demonstrates engagement with relevant stakeholder	Relevance to the call's aim and scope Project objectives and goals
2. Degree of innovation and innovative content - Project represents something genuinely innovative and/or is a significant improvement on current knowledge and expertise, including a clear description of the range of innovation (i.e. is it innovation on a local/international/worldwide scale) and type of innovation (such as process innovation, product innovation etc.) - Feasibility of innovation and innovative content as a whole	Innovative content
3. State-of-the-art, link and contribution to past and ongoing, relevant international initiatives in digitalisation of energy systems and networks - Clear description of state-of-the-art within the project’s field. - Clear positioning of the project in relation to the described state-of-the-art and description of how the project builds on relevant international initiatives, knowledge and systematics	Background and state of art
4. Working methods and models - Excellence in collaboration: ➢ Approaches and methods for collaboration are clearly defined, enabling relevant stakeholders to participate in co-creation of solutions. Considerations on how the execution of the project will be performed with minimal climate impact are included ➢ IPRs described and handled appropriately (licenses, patents etc.). ➢ Gender and diversity equality and perspectives are considered and implemented, both within the project group and in the development of solutions - Coverage of three-layer research model: ➢ More than one layer covered ➢ Concrete methodological approach to the three-layer model (if only a single layer project, the reasons for this must be clearly explained and justified). ➢ Specific adoption/market challenges related to technology development are addressed ➢ Theories and methods behind social or market assumptions are relevant and clearly explained. ➢ If market/social research or interventions are to be performed the methodologies should identify which kind of data to collect, how to collect it, and how to analyse it.	Working methods and scientific approach IPR management Gender and diversity perspectives Ethical aspects Three Layer Research Model applicability
Impact	

1. Expected impacts - Expected impacts are feasible and desirable, and include consideration of societal, environmental and sustainability impacts - Short-term and long-term impacts contribute to the call's aim - Implementation contributes to the expected impacts	Expected impacts
2. Scaling-up, reproducibility, replicability and interoperability potential - High scaling-up potential. - High reproducibility/replicability potential. - High interoperability potential.	Scaling up potential, reproducibility, replicability and interoperability potential
3. Transnational value - Added value of the project being transnational (as opposed to being only national) - Benefits and relevance of the project internationally and contribution to fulfilling international sustainable energy initiatives' objectives	Transnational added value
4. Appropriateness of measures for dissemination and exploitation of results - Target audience identified, clearly stating why they are important for the project and how they will be involved - Suggested communication activities appropriate and related with identified stakeholders - Means of dissemination and exploitation of results	Communication plan Dissemination plan
Quality and efficiency of the implementation	
1. Quality and relevant experience of project team - Experience, specific expert experience (CVs) - Relevant interdisciplinary experience (complimentary expertise) - Beneficial team composition (national/regional and competence diversity – skills shall match the working areas identified in the project. Gender and diversity measures should also be considered in the team composition.)	Organisation Key competences Previous experience CV of the Project manager CVs for key project members
2. Appropriateness of the management structure and resource allocation - Management structure (roles) clearly defined and appropriate - Manageability of consortium (number of partners, key players etc.) - Resources are allocated suitably depending on specific expert competencies	Project Management
3. Work plan, implementation, feasibility and manageability - Detailed, clear and logical work/implementation plan - Feasibility of deliverables and milestones with clearly defined KPIs - Project delivers results efficiently in relation to the project budget -Project has considered climate impact minimizations in the implementation	Work plan
4. Risk identification, analysis and preventive measures - Risks appropriately identified, including a mitigation strategy for loss of project partners (if applicable) - Risk analysis is clear, coherent and logical. It should be applied to the work packages and the investigation approach used in the projects - Preventive/remedial measures are proposed, and measures seem feasible and valid	Risk identification Risk analysis Risk prevention Fallback strategy

3.2 Desk 2 case study Bulgaria: Identifying hindering factors and overcoming existing barriers faced by TSO, DSO, Universities and Bulgarian energy associations in their active participation in EU funded R&I Activities.

Introduction

Bulgaria is the country with lowest R&I activity in EU funded projects. Finding the reasons why this happens is a key factor for the success of the integrated EU R&I funding policy. Based on information gained from more than 25 contacts with stakeholders, it has been identified that one of the major hindering factors is the lack of appropriate laboratory infrastructure for R&I. At the same time, it can be marked that although some EU funded projects[5],[6] offer easy to apply and free of charge access to the most advanced smart grid and DER laboratories in Europe these are not adequately used by the R&I stakeholders in Bulgaria. For example, the research of the laboratory access of the ERIGRID project shows that from 73 user projects in total none include participation from Bulgaria[7]. Similarly, the ERIGRID 2.0 project remains without any significant participation despite the support and promotion of this opportunity from PANTERA WT1 and PANTERA Desk 2 [8]. Understanding why this happens has a key role in overcoming this barrier. Also, understanding which are the other main hindering factors is critically important for bridging the gap between the R&I stakeholders in the leading countries and in Bulgaria.

Aims

This case study aims to describe some of the PANTERA Desk's 2 support activities to identify the main factors which are hindering the R&I activities. A special emphasis is given on gaps concerning the smart grid R&I laboratory infrastructure. Moreover, some propositions for finding a way of overcoming some of these barriers are identified.

Method

Since the majority of the stakeholders are not prone to share their negative experience, in order to overcome this communication barrier a set of interviews, surveys and face to face meetings with local stakeholders have been performed. Although these forms of communication imply individual approach to each stakeholder and due to this fact are time and effort consuming, the process allows identification of the main hindering factors.

The information shared is collected, processed and analysed in order to identify the gaps and to be able to seek for potential solutions and remedies. Some propositions supporting the strengthening the R&I activities of the stakeholders are provided, after which an analysis of the results achieved is made.

Results

Based on the stakeholder's feedback and a consequential in-depth analysis the following main causes and **barriers and findings** were identified:

[5] https://erigrid.eu/
[6] https://erigrid2.eu/
[7] https://erigrid.eu/transnational-access/selected-projects/
[8] https://erigrid2.eu/user-projects/

- Significant lack of trust in the Bulgarian energy sector in relation to the EU policy related to Bulgaria. Historically some EU actions led to major damages on the Bulgarian Energy sector. Cases of EU support and lack of control on local political class representatives distributing EU funding in non- transparent way led to disappointment in the main potential R&I entrepreneurs and drivers.
- Lack of experience and know how to create EU funded projects and lack of lobby to support generated project proposals.
- Lack of critical R&I infrastructure. Inability to compete with the large countries which are building their infrastructure using strong national funding. Funding schemes not available.
- Impression for lack of fair and consistent EU policy for stimulating adequate R&I funded activity in all countries.
- Significant R&I experts and manpower outflow from Bulgaria to the rich and large EU countries.

Acting in unstable and demanding environment, very few stakeholders are ready to undertake the risk to try to find financing for networking activities. The analysis uncovered points that the majority of the Bulgarian stakeholders are not ready enough to directly start a full-bodied collaboration with the best R&I players in Europe due to the significant gap between their level. Diminishing this gap requires time and small and constant steps to be performed by the most of the R&I Stakeholders in Bulgaria.

The step-by-step approach proposed and established for strengthening R&I activities and infrastructure by participation in ERIGRID 2.0 joint calls and forming and participation in joint Horizon Europe proposals tries to split the huge gap between the R&I level of the Stakeholders in Bulgaria and the one of the leading in European R&I organizations in small, possible and feasible specific action steps. It has been identified that before being able to participate in joint EU level proposals, the majority of the Bulgarian stakeholders need to gain some experience and contacts with EU leading research organizations. The ERIGRID 2.0 joint calls are found to be especially suitable and useful in this process. Moreover, it has been found that before reaching to a proposition for ERIGRID 2.0 joint call many stakeholders need first to build and study their own minimum critical infrastructure in order to understand which research actions are needed and also to lower the gap in the R&I level. Thus, three main steps (actions) are outlined:

- Building critical R&I infrastructure – this infrastructure is critical to understand the up-to-date power system and smart grid problems and reach a certain minimum R&I level required;
- Participation in ERIGRID 2.0 joint calls;
- Forming and participation in joint Horizon Europe proposals – this step is identified as highly important for gaining adequate R&I funding.

Number of interested stakeholders are identified which afterwards based on their readiness and capability are selected and allocated to the relevant actions.

Discussion

The step-by-step approach implemented gained good acceptance among the stakeholders. The prevailing stakeholder reaction can be characterized by interest and inspiration to participate in EU R&I activities they didn't before. Some specific good examples can be given as a reference:

- An agreement between the Bulgarian TSO (ESO EAD) and Technical University of Sofia (TUS) for R&I partnership and support for establishment and building of infrastructure for joint

research activities and estimation of the impact of converter interfaced generation on the power system stability. The project actions have started in June 2021 and are presently ongoing. A technical design of the project has been completed and equipment purchasing and building actions are ongoing. A joint research team between the partners is established. After the completion of the first phase of the project a joint participation in ERIGRID 2.0 is foreseen to provide system-level support and education of the researchers and to prepare them for participation in joint Horizon Europe proposals.

- A project between Bulgarian DSO (Elektrorazpredelenie Yug) and TUS for voltage regulation in distribution networks with high share of converter interfaced distributed energy resources is started aiming to build critical knowledge base and to prepare the experts of the DSO. The project has been successfully completed providing key knowledge on the specific SG related topics set. Due to the work done the R&I level of the stakeholders has been significantly improved which enables the DSO participation in full bodied participation in future ERIGRID 2.0 and Horizon Europe proposals. After this collaboration has been performed and completed the DSO expressed interest and applied for partner and a pilot provider for a Horizon Europe project proposal.
- Consortium between 1 TSO, 1 DSO and 2 universities are formed for participation in future ERIGRID 2.0 and Horizon Europe proposals. A special dedicated PANTERA nano workshop with selected Stakeholders was organized in August 2021 in Varna Bulgaria to support the process.

Recommendations

The approach implemented gave positive results. It has been noted that strengthening the R&I activities is a long-term bilateral process which requires significant effort from both local stakeholders and the European Commission.

Thus, the following recommendations to the stakeholders can be given in order to improve their smart grid related research actions and funding:

4. Improving their R&I level using local collaboration with PANTERA Desk 2, research organisations, universities, industry and other stakeholders.
5. Improving their R&I level and readiness by following the most recent trends in the leading R&I initiatives of the leading EU stakeholders.
6. Participation in ERIGRID 2.0 and other similar activities which increase the R&I capabilities and yield the connections with the leading research organisations in EU.

3.3 Desk 2 case study Greece: Using key knowledge of Greece in island power systems in the implementation of new future European power system architectures with islanded and hybrid micro and nanogrids

Introduction

Greece is the country in the Balkan region which has first entered the EU and gained widest experience in the R&I in the field of smart grids, energy storage and local energy systems. Thus, compared to the other countries it is most advanced in the R&I activities and performing at best in the region. However, compared to the western European countries, Greece remains behind the leading R&I actors. Despite of this there are some local specificities, historical background and experiences gained which can give a competitive advantage in some particular topics related to the

smart grid R&I activities.

Aims

The main objective of this study is to analyse the prospective smart grid related trends and to identify specific topic(s) in which Greece can have a competitive advantage compared to the other countries. Moreover, an attempt to research the way how R&I Stakeholders can benefit from providing, enriching and sharing this key knowledge within the EU.

Method

Analysis and identification of key competitive advantages is made. A way forward of offering and monetizing this key knowledge (for example using EIRIE platform) is identified.

Results

Being rich with many islands, Greece is historically among the first countries which have developed key technical, economic and social models, knowledge and experience in island power systems. Due to the characteristics of the majority of the other European power system for many years these systems have remained with limited application in the other countries from continental Europe mainly due to their strong, well developed and well meshed interconnected conventional grids. However nowadays the smart grid development trends are enabling and stimulating novel micro- mini- and nanogrid concepts and architectures which imply the appearance of self- sufficient autonomous island power systems which are operating in completely disconnected or in partly connected mode with the bulk power system. Moreover, with the limitation of fossil fuels and introduction of distributed renewable energy sources (RES), these new system architectures are becoming of key importance for the new European power system structure.

Discussion

The key knowledge and experience in autonomous island power systems gained in Greece over the years can serve as very good basis for the research and development of the novel micro and nanogrids. Unlike many other countries some major issues such as privacy, data collection, citizen engagement and energy cooperatives relations have been successfully resolved. Having a widest network of proven real-life concepts and experience Greece has very high chance to become a leader in the R&I in novel power system with micro and nanogrids and can increase its activity specifically in this field for example by building research project proposals consortia.

Recommendations

Based on the competitive advantages outlined the following recommendations can be given:

3. The similarity between the island power systems and the novel power systems which implement smart grids concepts with autonomous and semi-autonomous micro and nanogrids can give a significant advantage of the stakeholders from Greece when offering R&I projects in this field. Active research in this field regarding the existing and upcoming calls for proposals can be recommended.
4. Based on the experience gained from the island power systems a formation of research project proposal consortia for EU funding in the field of future smart grids with active micro, -

mini- and nanogrids can be recommended.

3.4 Desk 2 Case study Romania: Expanding key research and education aspects of Low Voltage DC grids

Introduction

Romania is the country in the Balkan region which compared to the other Desk 2 countries is lagging from Greece but at the same time is performing better than Bulgaria. However, compared to all EU countries Romania is significantly lagging in its smart grid related R&I activities. Finding a specific topic in which Romania is better or not worse compared to the other countries could support the Romanian stakeholders in positioning and funding their R&I activities.

Aims

The main objective of this study is to identify a specific topic in which Romania is well positioned in comparison with the other EU countries.

Method

Analysis and identification of key competitive advantages is made and an analysis of the recent R&I activities in Romania is performed. The possible future trends of Low Voltage DC networks (LVDC) development are studied. Based on this analysis the most prospective topic found is outlined. Ways for participation in EU funded partner consortia on this topic are identified.

Results

It has been found that Low Voltage DC networks are novel and a promising aspect of the energy transition. This new trend starts to grow and increase its significance with the fast growth of DC based RES combined with development of growing Electric Vehicle (EV) systems and powerful electronic converters. It can be noted that in this new topic the research in nearly all EU countries is in very early stage of development but Romania is active in this field with good results. Several projects with Romanian R&I Stakeholders have already gained experience and can offer useful contribution for the future of this new topic.

Discussion

The LVDC networks due to their advantages such as reduced number of conversions of RES energy, lack of frequency related problems, no reactive power transfer losses, and improved efficiency due to the reduced number of voltage conversions reveal a slow but stable trend for growing. A significant amount of research is needed at EU level in the years to come. Many technical and non-technical challenges are noted such as research on equipment with improved commutation capacity, higher insulation requirements (compared to AC). Also, some socio--centric issues as for example the need for gradual changes in the mind-set of the users and citizens need to be faced.

Recommendations

Based on the state-of-the-art level of development the following recommendations can be given:

4. Active participation of Romanian stakeholders in EU and LVDC expert groups is expected and needed.
5. Active research towards identifying key LVDC challenges and bottlenecks is needed.
6. Support of the EC corresponding directorates towards the issuing of LVDC EU funded research calls for proposals will better position the stakeholders of Romania.

3.5 Desk 3 case study Malta: Strengthen the R&I impact through collaboration building and access to R&I infrastructure

Introduction

In view of rising energy consumption and the steeper trajectory, further investments in the renewable energy sector are required to meet their RES target. But this need is directly linked to the related R&I efforts and how the researchers can have access to a regional and European network of stakeholders and to appropriate R&D infrastructure as well. Malta presents a flat R&D intensity during the last few years. Also, Research and innovation Strategy 2014-2020 of Malta has little visibility and its implementation is scattered between various governmental bodies with limited coordination whereas there is no roadmap available of the R&I infrastructures.

Aims

This case study aims to engage stakeholders of regional desk 3 and provide support to researchers of Malta and Cyprus for pursuing the following:

- Strengthen their network for cooperation at national and EU level.
- Find channel of cooperation with other institutes in terms of research collaboration and data sharing
- Have access to R&I infrastructure
- Mobilization of both Maltese and Cypriot researchers and engage them in the EIRIE platform

Stimulate their research interest to build their profile through the EIRIE platform and make this regional desk effort sustainable

Method

The method that was followed consists 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.

Results

The technical needs that are co-shaped by the consortium to serve Malta's national energy goals: As the deployment of rooftop photovoltaics (PVs) increase in Malta, and with past incidents of the interconnector failure between Sicily and Malta, the onus is upon the single power station (Delimara) to cater to the load requirements. During the day-time, 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. 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).

Using the above needs as the basis, researchers from Malta and Cyprus joined forces and drafted a common proposal through the project ERIGRID 2.0 that was successful as indicated in the table below.

Table 4: Main detail of ERIGrid 2.0 proposal

Document Administrative Information	
Project Acronym:	ERIGRID 2.0
Project Number:	870620
Access Project Number:	116
Access Project Acronym:	GRIDPV100
Access Project Name:	Innovative RES Solutions for 100% RES Systems
User Group Leader:	Somesh Bhattacharya (Malta College of Arts, Science, and Technology, MCAST)
Document Identifier:	ERIGrid2-Report-Lab-Access-User-Project-AccessGRIDPV100-draft-vn 01
Report Version:	vn.01
Contractual Date:	14/12/2021
Report Submission Date:	01/04/2022
Lead Author(s):	Somesh Bhattacharya (Malta College of Arts, Science, and Technology)
Co-author(s):	Chrysanthos Charalambous (FOSS Research Centre for Sustainable Energy)
Keywords:	[system security, power quality, RES dominant grid], European Union (EU), H2020, Project, ERIGrid 2.0, GA 870620

This success story is of critical importance to researchers from Cyprus and Malta revealing the means for enriching their capabilities and addressing important local issues. Through, this strong collaboration has given evidence of what can be achieved when use is made of platforms like EIRIE and related entities.

Discussion

The aims of this Case Study are directly linked with the needs identified and the challenges within Regional Desk3. Researchers have difficulties in cooperation with other institutions around Europe and have access to R&I infrastructure as well. This case study offers a good practice that can be replicated within Regional 3 stakeholders and other PANTERA desks as well.

The approach

The Islands of Malta and Cyprus has seen an exponential growth in the uptake of PV technology, especially at the rooftop/ low-voltage (LV) levels. The consolidated uptake, along with the direct and indirect schemes of the governments of the two Islands, is now proceeding fast towards the plan of becoming net-zero emission countries by 2050. The high number of the PV installations in the rooftop levels, however, has seen several problems in the proper operation of the grid, especially during day-time, because of the high PV power produced, and the low-loading at the distribution levels, thereby resulting in voltage rise, however this problem is encountered at a local level. The other problem that is encountered generally on the global level is the frequency regulation problem. The high penetration of PV in a weak system, such as an LV distribution network decreases the effective load, especially during the day time, and the static converters, irrespective of being a source, are essentially constant power loads, therefore, even when there is a frequency variation on the grid side, they keep generating the same amount of power which exacerbates the frequency deviation following load changes or generator events. In order for such converters to participate in the frequency regulation problem, the control loops of such converters need to be redesigned, so that they can participate whenever there is a drop in the load, or when there is an overall frequency change seen from the utility grid side.

The droop control method is a widely used control strategy for frequency regulation within the microgrids, and the same control methodology has also been extended to active distribution networks that can seamlessly enter and exit the islanded mode with the help of a unified control. To address this identified need, the researchers working through the initiation of PANTERA, have come together and put a proposal forward to ERIGRID 2.0 with the acronym GRIDPV100. Following a successful acceptance of the proposal the researchers of Malta and Cyprus were given access to Austrian Institute of Technology (AIT) of Austria to simulate and test the designed outcome of their work.

In the GRIDPV100 project-based lab access at the AIT in Vienna, we explore the possibilities of PV providing inertial response with the help of the modification of the existing droop control philosophy, and employing a switching-based control that can provide Maximum Power Point Tracking (MPPT) power in the grid connected mode, and inertial response, when the network goes into the islanded mode. A real Cypriot reduced single feeder distribution network is used for the studies during this lab access period. Typhoon Hardware-In-The-Loop (HIL) based software is used for creating the simulations to be carried out under a real-time environment to achieve the following goals:

1. Emulate the virtual inertia control for the PV based sources in the distribution network of interest.
2. Compare the performance of the grid-following and grid-forming controls of the PV based on their individual frequency responses.

Preliminary Findings

1. The typhoon HIL based platform gives a deep insight into the grid-forming behaviour of the PV based system. The frequency responses are similar to the droop-controlled battery-based system.

2. The typhoon HIL 604 single arm setup provided to the lab access users did not manage to compile successfully, the simulations for the entire feeder of interest, therefore the reduced model was developed by aggregating the small PVs into a single controllable PV.

The GRIDPV100 project focused on the grid-forming capability of the PV, that can seamlessly work in both grid-connected and islanded modes of operation, and the synchronizer enables a transient free switching for the PVs and the energy storage to reconnect to the grid. The designed grid-forming based switching controls for the PV were tested on a Cypriot distribution feeder network using Typhoon HIL 604 based real-time simulations. Satisfactory results were obtained when several low-rating PVs were aggregated into a single PV for the ease of implementation. The main findings under the lab access were:

1. When all the PVs operate in the grid-forming mode, especially in the islanded operation, the system reliability is enhanced, as frequency and voltage deviations from their nominal values is low, and load changes within the network are catered to by all the sources.
2. Virtual inertia-based design of the outer controller for the PV helps in transient-free load change, which helps in maintaining the rate of change of frequency (RoCoF) to the minimum value.

The project implemented under the TA as the UG implements only the grid-forming Voltage Source Inverter (VSI) for PV, which forms the basis for further studies, which can be taken up as part of submission of further calls from the UG. These comprise of the following:

1. Developing a holistic control for the grid-forming PV, that can provide both frequency and voltage-based services, which essentially includes low voltage ride through capability in both modes of operation, as the grid-forming VSI can operate in the derated power range, thereby providing headroom for the reactive power, in accord with the reactive power capability of the PV inverter.
2. A phasor-based determination of the optimal location of the grid-forming PV in a large distribution network.

Moreover, the combined effort of the researchers of Malta and Cyprus coming from Department of Industrial Electric Power Conversion, University of Malta, and FOSS Research Centre for Sustainable Energy, University of Cyprus, submitted successfully the paper “Photovoltaic grid-forming control strategy investigation using Hardware-in-the-Loop Experiments” to the MEDPOWER 22 conference planned in Valetta Malta between 7 and 9 of November 2022. The main messages that are conveyed through the paper are:

The frequency stability of a power system is of paramount importance, as a fast frequency swings in the system can lead to oscillatory instability, and thereby blackouts. A grid-connected microgrid, that can operate in the islanded mode can also possess such deteriorating effect due to the higher share of converter more sources. In this paper, a coordinated frequency control within a distribution network is discussed, with a higher share of Photovoltaics (PV). The main objective of this paper is to test the grid-forming capabilities of PVs, without the requirement of an energy storage in the network. The tests are carried out with the help of the Typhoon Hardware-in-the-loop (HIL) platform using a real Cypriot network feeder. The real-time results confirm the efficacy of the PV as a grid-forming inverter, provided it has sufficient input (irradiance) to provide for the loads within the system of interest. The grid-forming PV also possesses the capability of reconnection with the utility grid through a synchronizer switch that requires minimal communication, makes the overall control independent of any other power source, subject to certain irradiance and loading conditions.

Recommendations

It is clear from the above experience in building trust and interest between consortia of Cyprus and Malta, positive results were achieved giving valuable results to the stakeholders of the electricity grid in both countries. The successful submission to ERIGRID 2.0 call and subsequently the successful submission of the outcome of the awarded work through a paper to MEDPOWER 22 conference, give the evidence that collaboration work through the EIRIE platform can generate benefits to the entities involved. This will be highly utilised as a best practice approach for the R&I community to learn and use in their future endeavours.

Another lesson learned through this process, is the importance of keeping truck of targeted objectives with the stakeholders involved constantly updated. Final results achieved should be suitably disseminated to all stakeholders contributing to the fruition of the effort. Equally important is to keep truck of achieved results and future steps clearly identified for all parties involved.

3.6 Desk 3 case study Cyprus: Strengthen the R&I impact through collaboration building and access to R&I infrastructure

Introduction

Cyprus is a moderate innovator and has set a low target for R&I density in the years to come. As Cyprus is the least populous member of EU, Researchers can have good networking relations at national level forming an operational ecosystem but they appear to be isolated from the rest of EU R&I community.

At the same time, the energy goals that Cyprus has set are jeopardized by the physical isolation that their grid system experience with the interconnection with other countries to be stalled. This appears to be challenging for achieving the needed RES penetration and intensive R&I towards this objective should be pursued.

Aims

This case study aims to engage stakeholders of regional Desk 3 and provide support to researchers of Malta and Cyprus for pursuing the following:

- Strengthen their network for cooperation at national and EU level;
- Find channel of cooperation with other institutes in terms of research collaboration and data sharing;
- Have access to R&I infrastructure;
- Mobilization of both Maltese and Cypriot researchers and engage them in the EIRIE platform.

Stimulate their research interest to build their profile through the EIRIE platform and make this regional desk effort sustainable

Method, results, discussion and recommendations are similar to the ones included under the Maltese Case Study since it was a collective effort proving the strengths of collaborative work through the EIRIE platform.

Under methods we can identify here an important addition that has given added value to the work promoted through the EIRIE platform This is the extension of collaborative work between FOSS of Cyprus and TUS of Sofia bringing in INESC TEC of Porto Portugal, hence building a new platform for cooperation.

Using the successful implementation of the case study selected for Malta and Cyprus we extended it to Portugal as well, bringing in R&I partners from INESC TEC university in Porto, inviting them to work with our successful mode of working to build stronger research opportunities for all three groups of R&I experts. This was done in close collaboration with another partner of PANTERA, Technical University of Sofia, thus bringing altogether three collaborating partners coming from Cyprus, Bulgaria and Portugal. Together we have identified areas of common interest and identified researchers from all three groups to build the agreed collaboration areas. A first noted success story of this approach is the successful submission of a paper to the conference IEEE PES SyNERGYMED22 in Thessaloniki organised on the 17th and 18th of November 2022. The paper approved is the following:

Title: A new controller for Dump Load Active Power Management of Hydraulic Generator Unit Authors: Asenov, Tsvetomir (1); Stanev, Rad (1); Viglov, Kostadin (1); Lopes, João Peças (2); Efthymiou, Venizelos (3); Fernandes, Francisco (2); Charalambous, Chrysanthos (3); Bracho, Jorge (3) Organization(s): 1: Technical University of Sofia, Bulgaria; 2: Faculty of Engineering, INESC TEC, University of Porto, Portugal; 3: FOSS Research Centre for Sustainable Energy University of Cyprus, Nicosia, Cyprus

3.7 Desk 4 case study Poland: Enablers and Barriers for Rollout Smart Meters in Poland – a case study of the market-driven approach for promoting smart meters and supporting R&D in the energy sector.

Introduction

In 2009, the European Commission's interpretative note on Directive 2009/72/EC described "the ability to provide bi-directional communication between the consumer and the supplier/operator" and to "promote services that facilitate energy efficiency within the home" as key requirements of smart metering. Additionally, it is also required that at least 80% of consumers shall be equipped with Smart Meters (SMs) by 2020 when the rollout of SMs is evaluated positively by the Member States [3]. Each EU member state was left to assess the economic viability of the SM rollout. Each member state was also free to choose between a mandated approach, which is a public policy-based approach, and a market-driven approach [4].

In 2012, Poland assessed that the long-term benefits of SMs rollout would exceed the costs of investment which encouraged the Polish government to allow liberalization of the electricity market and permit SMs manufacturers to enter the market. The government also facilitated access to the market for consumers producing the excess amount of electricity through renewable energy (RE) sources [5]. The policy changes lead the SMs rollout cost-benefit analyses to yield a positive result and it also benefited the several stakeholders in the energy systems esp. DSOs.

According to the EU directive, a proper regulatory framework intervention has been identified to be implemented for a smooth SM rollout [4]. However, until mid-2021, a no-obligation scheme for Distribution System Operators (DSOs) to install SMs was enforced, no state-approved technical requirements were set, and no operator for acquiring and sharing SM data was appointed. Despite the missing regulatory framework, by the end of 2018, Polish DSOs had already installed nearly 1.5

m SMs with benefits of 0.68 bn PLN [6]. This placed Poland in the top 10 Member States of the European Union in terms of the number of devices connected to the power grids, at the same time being the only country in this group that did not have clear and legally binding regulations for SM deployment. This intriguing observation, suggesting at least a moderate success of the market-driven approach that was followed in Poland, is an important motivation for investigating the enablers and barriers affecting the effectiveness of the Polish case [7].

Market-driven SM deployments are progressing in the many EU Member States, such as Bulgaria, Croatia, Cyprus, the Czech Republic, Hungary, Poland, Portugal, Slovakia, and Latvia, as well as outside Europe, e.g., Brazil and Australia. Studying SM deployment based on such voluntary actions of stakeholders of energy systems is of paramount importance for the worldwide implementation of smart grids, smart buildings, and energy management.

Aims

The case study is based on the EU reports, audit reports of the Polish government, and several research works published in the domain of smart grids. Referring to the Polish experiences in the SM rollout, the study provides new insights on the key enablers and barriers in the rollout of electricity Smart Meters (SMs) and demonstrates that SM rollout can be successful at the level of a single DSO, even without a binding regulatory framework. Additionally, the rollout of SMs has fostered the government and policymakers to invest in the direction of smart grid research and Innovation. The enrolment of smart meters opens new possibilities, not only for the energy suppliers but also for the consumers. Energy smart meters (SM) are advanced electricity meters that can offer a range of intelligent functions and have intended benefits for energy consumers, suppliers, and networks [8].

The aim of the study is to analyse the key elements of the smart metering innovation system (technologies and infrastructures, actors and networks, institutions, and policies) and characterizes their interaction based on desk research and a critical assessment of regulations, statistics, and literature within the technology innovation system (TIS) framework published in [7]. Additionally, the aim is to analyse the creation of a R&D ecosystem nurtured during SM rollout, capable of being a strong instrument to foster the R&D activities in support of decarbonization, decentralization, and digitization and leading to a recommendation to maximize its impact.

Method

The study [8] of the SM rollout in Poland is based on the TIS framework “A set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion, and utilization of variants of a new technology and/or a new product”. The purpose of the TIS is to explain the nature and the rate of technology change.
The study is carried out by exploring the processes of SM diffusion entails the identification and characterization of the technological, economical, and social domains in which the innovation processes run, and at the same time Investigating the interactions between the system actors and institutions. Following the TIS framework, the final analysis is focused on the three specific elements:

1. **Technologies and infrastructures**: analyse the past development of SM technologies and infrastructures in which SMs are rolled out.
2. **Actors and networks in the SM rollout**: map key stakeholders, i.e., public and private institutions as well as their collaboration platforms.

3. **Policy instruments affecting SM rollouts**: classification of the policy instrument.

Result: TIS Framework Findings

(1) Technologies and Infrastructures

Incumbent and Emerging Technologies

In 2019, over 12 m electricity meters (including SMs) were produced in Poland, hitting a record high. Between 2009 and 2019, the annual production of electricity meters increased by over eleven times [7]. In view of the number of electricity end-users (17.4 m), this demonstrates a strong export capacity of the Polish market. Energy induction meters are the most prevalent and oldest commonly used meter type in Poland [7]. However, Polish DSOs started installing more advanced measuring devices (SMs) in 2013. By the end of 2020, 9.2% of Polish households had been equipped with SMs, including both consumers and prosumers of energy (1.6 million and 0.4 million SMs, respectively) [4]. As per Polish law, the legal validity period for active energy induction meters with a capacity not higher than 30 kW is 15 years, while for other types of meters, the period is 8 years. After this time, each meter must be examined to ensure it has not become obsolete or replaced with a new meter (e.g., a smart one). In that regard, as well as in view of the recent changes in the regulatory framework for pushing SMs, it is expected that standard, non-electronic induction meters will become outdated in Poland by 2030. Other technologies likely to become obsolete are unidirectional energy meters (which do not allow for net metering for prosumers) and meters not resistant to the external magnetic field (due to the threat of meter tampering) [4]. Several private companies and start-ups have emerged in Poland to manufacture smart meters based on 3G communications or PLC. Electronic meters, after equipping with additional telecommunications devices, that would allow for remote acquisition of measurement data, are used by three of the five largest DSOs: Tauron, PGE, and Innogy.

Complementary Technologies and Services

Due to the emergence of RES and liberalization in the Polish market grid integration is much needed for the prosumers to sell electricity. Generation of electricity at low voltage levels causes disturbances in the power system network which leads to the increasing demand and use of switched power supplies, frequency converters, nonlinear inductive devices, thyristor controllers, and LED lighting [8].In this context, a complementary technology emerges, i.e., anti-interference filters, e.g., by Maschek Polska, which reduce interferences to a level that enables reliable communication between energy meters and data concentrators. In addition to complementary products, complementary services are also emerging on the market. In 2017, Tauron Dystrybucja was the first DSO in Poland to provide its clients with the Home Area Network (HAN): a Tauron AMIplus service that allows remote activation of the wireless communication interface with an SM using Wireless M-Bus. Data on energy consumption is passed to the domestic receiving device. The HAN network allows households not only to connect several different ‘smart home’ devices but also enables data exchange with SM and control of BAS devices and communication with other IoT devices.

Technological Trajectories

Five main technological areas of SM development in Poland can be distinguished: data collection (measurement), data storage, data communication (technology/protocol), data security, and data display [9]. These are the areas of technological advancements in SM that consistently develop over time through the accumulation of knowledge. The specification of technological trajectories is a generalization based, on the one hand, on the technical standard published in 2018 by the

PTPiREE—an industrial association uniting inter alia Polish DSOs [9] and, on the other hand, on two products offered on the Polish market on a large scale, namely:

Table 5: Images gathered from the SM company sources

1) SMARTEMU-3	2) AD13A.1-3-1
SM produced by Apator, a Polish company, which is sold to Tauron and Energa, the DSO that is the SM leader in Poland	SM produced by ADD Group, a company based in Moldova, which is used also by Energa
	

Based on the maturity of the five technological areas, the first two (measurement and data storage) could be regarded as well-established, with limited innovation potential. Technological accelerations (experimentation, research activities, new standards) are most visible in the last three fields. First, in the data communications area, there is an observable process of technology pathway testing (PLC vs. GSM/GPRS/EDGE/LTE). Second, in the data security area, the requirements concerning Advanced Encryption Standard (AES) are becoming stricter—from 128 bit to higher levels. Third, in the data display and identification area, the Object Identification System (OBIS) codes are subject to frequent amendments [10]. Despite the identified areas for technological developments and innovation, low patenting activities in SMs are observed. Between 2010 and 2020, only 18 successful patents in electricity metering were granted by the Polish Patent Office.

(2) Actors and networks in the SM rollout

<u>Demand</u>

The first group of demand-side actors of SM systems in Poland is their main end-users, i.e., consumers. Polish consumers have a low level of awareness regarding SM as technology and its benefits in terms of energy efficiency and savings. Consumers do not play an essential role in the current stage of the SM rollout in Poland. They have no power to push DSOs to install SMs, or to install them on their own. However, they could inhibit the rollout in case of their active disagreement with SM. Still, no such anti-SM movement has been observed in Poland so far [11].

Table 6: SM penetration in power grids of the five main DSOs in Poland

DSO's	Energa	Enea	Tauron	innogy	PGE
Customers	3100 k	2600 k	5700 k	1100 k	550 k
SM installed	1334 k (2021)	35 k (2018)	5000 k (2021)	106 k (2019)	350 k (2020)

The second group of demand-side actors of SM systems in Poland is their owners, i.e., DSOs. Energa, innogy, PGE, Enea, and Tauron are five major DSOs in Poland that play a crucial role in the Polish SM innovation system [7], as they are responsible for SM deployment, as well as several

critical functions in power grids [12]. As shown in Table 1, Energa-Operator is the national leader in terms of the share of SM in the total number of owned meters (SMs installed at nearly 50% of customers), followed by Innogy, PGE. Energa-Operator started the implementation of the Tauron pilot SM projects as the first DSO in Poland in 2013 (pilot in Kalisz City). While the success of Energa was preceded by a long preparatory phase that started in 2011, the other four operators have not been so enthusiastic about SMs since early 2010. all four DSOs started their SM rollouts after the positive experiences of Energa.

According to Energy Law, the DSOs must submit their development plans to the Energy Regulatory Office (URE) for approval. The plans must include inter alia information about projects in the acquisition, transmission, and processing of measurement data from remote reading meters. However, there is no obligation to include any SM rollout projects in the plan.

Supply

The total value of sold electricity meters in Poland in 2019 was over 1.2 bn PLN [13], though there is no data on the share of SMs in this number. The major suppliers of SMs are Grupa Apator (Toru´ n, Poland) with over a 50% market share, T-MATIC System SA (Warsaw, Poland), Systemy Pomiarowe Elgama Ltd. (´Swidnica, Poland), and Landis+Gyr (Zug, Switzerland). The leading manufacturers of the SMs installed in Poland are from Poland, Switzerland, and Moldova. Apart from the above-listed big suppliers, there are also niche actors: start-ups and spinoffs (e.g., OneMeter), who work on innovations that deviate from existing regimes (e.g., the OneMeter beacon).

Supporting Institutions

- Research and Education

According to a Polish National Science Centre database query, the Centre has funded only five projects, whose titles refer to Smart Grids or SMs till July 2021. They were implemented by five major universities.

Figure 4: Universities implementing smart grids projects

An interesting initiative implemented by the research and education actors in the field of SMs were the 'AMI Picnics', events popularizing SMs, organized by AGH University of Science and Technology in Cracow in collaboration with Wrocław University of Technology and DSO, Tauron.

- Government Bodies

As per Energy Regulatory Office, there are five government bodies in Poland which are actively participated in the SM rollout.

Table 7: Governmental bodies which participated in SMs' rollout in Poland

Institution	***Type***	***Role in SM's***
The Ministry for Energy (ME)	Central body (Ministry)	Set and implement nationa policy,control energy markets, energy security, energy efficiency schemes, energy infrastructure and regulation
The Energy Regulatory Office (URE)	Central body (tariffs planning and regulation)	Approves tariffs prepared by DSOs, draft development plans, including planned investments in SM rollouts.
The Personal Data Protection Office (UODO)	Central body (data protection)	Guard, upholding unjustified processing of data from SMs
The Central Office of Measures (GUM)	Central body (standards regulation)	Compliance and accuracy of the national standards, traceability to the international measurement standards, approval of SM's installation
The Supreme Audit Office (NIK)	Independent state audit body	Track the public spending, controlling public authorities and state DSOs

- Industrial and Financial

Table 8 Industrial and financial bodies which have participated in SMs' rollout in Poland

Institution	**Important activities**
The Polish Power Transmission and Distribution Association (PTPiREE)	Support the transformation of the Polish power industry by consulting services, training, and publications.
The Polish Chamber of Informatics and Telecommunication (PIIT)	To develop the supporting conditions for the development of the ICT industry, to ease collaboration between the ICT industry and public administration, to support the development of regulations for digital innovation
Polskie Sieci Elektroenergetyczne S.A. (PSE)	Energy Market Information Operator, establish and manage the Central Energy Market Information System (CSIRE)
The Bank for Environmental Protection (BOS)	Bank providing preferential loans for environmental investments, such as renewables, energy efficiency, waste and water management, urban areas revitalization, and others
The National Fund for Environmental Protection and Water Management (NFOSiGW)	To support the ecological activities of Polish institutions (public and private), provides grants and soft loans for activities related to water and sewage treatment, thermal upgrade of buildings, and renewable energy sources

(3) Policy Instruments affecting SM rollouts

Regulations, economic and financial instruments, and soft instruments are the major policy catogories which need to analysed to understand the SM rollout [7].

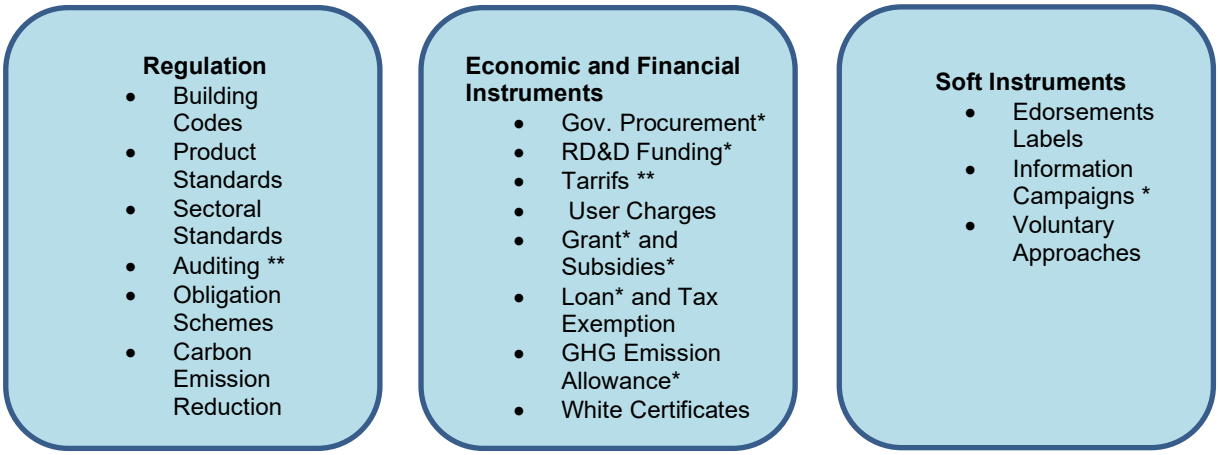


*Figure 5: * (single asterisk) represents the limited usage and **(double asterisk) represents the active usage of the respective Instruments in SM rollout*

Regulations:

- **Building codes**: No requirements concerning SMs are provided in the Polish building codes [14]. Therefore, building codes can be regarded as regulation instruments that are not effectively used in Poland for SM TIS development.
- **Product Standards**: Till July 2021, no regulation on technical requirements for SM has been formally adopted by the Polish government. The currently binding related standard is the general regulation on the measuring instruments subject to legal metrological control, which does not include any requirements concerning remote reading, data storage, or communication protocols. In the absence of legal regulations of SM standards, Polish producers of SMs in principle also refer to the technical requirements binding standard electricity meters. On the other hand, DSOs refer to their own internally-developed technical requirements or the standards developed by PTPiREE [9].

The main governmental document explicitly dedicated to SM was published to provide guidelines for the public procurement of SM systems by URE in 2015 [15]. With regard to the communication section of the document, it was not possible to establish a unified position, and a number of decisions were left to individual investors. The Polish Chamber of Commerce for Electronics and Telecommunications proposed technical and performance requirements for single and 3-phase meters, designed for operation in Polish AMI systems [15].. Despite several industry-led standardization initiatives, in view of the limited government's activity in the SM standardization area, product standards can be regarded as regulation instruments that are not effectively used in Poland to support the SM TIS development.

- **Sectoral Standards**: The standardization for cross-sectoral digitization of the Polish energy transition is not coordinated by any designated governmental body. The DSOs, who install remote reading meters at the sites of end-users connected to their network, are obliged to protect measurement data regarding these end-users on the terms set out in the provisions of the Law on Personal Data Protection [16]. Even though there were several governmental declarations on the planned sectoral standards concerning SGs, as of July 2021, there were no binding governmental regulations. Overall, sectoral standards can be regarded as regulation instruments supporting SM TIS development that are significantly delayed in Poland.
- **Auditing**: In 2018, NIK negatively assessed the activity of the ME in the area of the SM rollout. It stressed that the prolonging process of the SM deployment and the missing obligation scheme negatively affected Polish consumers' capacities for active energy management and achieving

energy savings [17]. Overall, auditing can be regarded as an SM TIS development regulation instrument that is effectively used in Poland.

- **Obligation Schemes**: Following EU regulations and the positive results of the cost-benefit assessment [17], Poland was required to prepare a target plan for the implementation of Smart Metering systems in at least 80% of households by 2020. The initial draft of the energy law amendment, setting an obligation for DSOs to install SMs, was came into action in 2011. But due to the adoption of EU regulation on the internal electricity market, the worked delayed up to 10 years to pass the bill's final version in 2021. The regulation adopted in 2021 requires DSOs to install SMs in at least 80% of end-users, including at least 80% of households, by 2028, with intermediate break-even targets. Overall, the obligation scheme can be regarded as a regulation instrument that has been significantly delayed.
- **Carbon Emissions Reduction Target:** No Polish regulation setting Carbon Emissions Reduction Targets for SM has been identified. Therefore, Carbon Emissions Reduction Targets can be regarded as regulation instruments that are not used to support SM TIS development in Poland.
- **Net Metering:** Net metering regulation comes under the Law on Renewable Energy Sources. Prosumers settles their electricity sale based on the difference between the amount of electricity collected from the grid and the amount of electricity introduced into the grid is carried out in the given half-year. Therefore, installing SMs at the facilities of prosumers has been a priority for DSOs, as evidenced by the fact that 20% of SMs are installed for this type of consumer [18]. However, the power grid regulations in net metering do not require the use of SM systems. Therefore, net metering can be regarded as a regulation instrument that is not used effectively in Poland for SM TIS development.

Economic and Financial Instruments:

- **Government Procurement:** As per EU, 47 public procurements related to SM were awarded in Poland between 2012 and 2019 in which 42 were run by utilities. Furthermore, three out of four notices on "Innovation Partnerships" for the supply of energy meters in the whole EU were announced in Poland. No evidence shows that URE or the ME have commissioned any expert reports or technical standards concerning SM. Overall, government procurement can be regarded as a direct investment used in Poland for SM TIS development, although only to some extent. Overall, the government procurement can be regarded as a direct investment used in Poland for SM TIS development, although only to some extent.
- **RD&D Funding:** As per ministry of development [19], Five SM-related areas have been included in the Polish National Smart Specializations, which set priorities for RD&D funding from the European Structural and Investment Funds in Poland. They include:

(1) Digital measuring systems, including remote measuring systems (Advanced Metering Infrastructure—AMI)

(2) Development of techniques and technologies of data transmission for the electricity industry needs

(3) Development of cybersecurity techniques—development of software, devices, and IT security services in the electricity sector

(4) Integration of measuring and reading systems for utilities (electricity, water, gas, heating), including the Smart Cities solution

(5) Application of the Phasor Measurement Units (PMU) systems in transmission and distribution networks.

The main funding sources for RD&D in the field of SM are national funds (National Fund for Environment Protection and Water Management) and EU funds (Smart Growth Operational

Program, funded from the European Regional Development Fund and the Infrastructure and Environment Operational Program, funded from the European Regional Development Fund and the Cohesion Fund). Overall, RD&D funding can be regarded as a direct investment instrument that is moderately used for SM TIS development in Poland.

- **Tariffs:** As per ERU, Dynamic pricing tariffs have been regarded as fundamental measures for exploiting the full potential and benefits offered by SM since 2012. Contrary, costs of SM system installation can be charged to the users indirectly, through energy tariffs. According to the Energy Law, when calculating electricity prices covered by tariffs, the reasonable costs of the business activity of energy are taken into account. In particular, DSOs' return on capital approved in their tariff may significantly depend on the discretion and individuality for particular DSOs. It was a major milestone that instigated the SM rollout in Poland, yet it was neither a formal regulation nor a legally binding decision. Nevertheless, the regulator announced that, due to the many benefits that SM implementation may bring, both to consumers and electricity companies. Additionally, the individual actions of DSOs leading to increasing the benefits from the implementation would also be accepted by URE as justified costs in tariff approval procedures. Considering this tariff-based support for the financing of SM rollouts in Poland, they can be regarded as financial instruments that are actively used in Poland to support SM TIS development.
- **Grants and Subsidies:** Poland's government and its agencies have not provided any grants or subsidies for SM deployment, apart from the grants and subsidies for RD&D projects described above. Overall, grants and subsidies can be regarded as financial instruments that are not widely used in Poland to support SM TIS development.
- **Loans:** However, no loan mechanisms dedicated specifically to the SM rollout have been identified in Poland, these types of financial instruments are used to support SM TIS development. European Fund for Strategic Investment supports of EUR 250 m from the, Energa, one of Poland's three largest electricity suppliers, has acquired EUR 750 m for the installation of SMs [20]. In this context, loans can be regarded as financial instruments used in Poland to support SM TIS development.
- **Tax Relief/Exemption:** No tax relief or exemptions for the SM rollout have been identified in Poland [21]. Therefore, such instruments can be regarded as fiscal incentives not used in Poland to support SM TIS development.
- **User Charges:** In May 2007, the Minister of Economy passed a regulation on the detailed conditions for the operation of the power system, the DSO installs, at its own expense, the metering and billing systems, except for energy producers. Therefore, any direct user charges for SM systems are not legally allowed (except energy producers). In this context, user charges can be regarded as fiscal incentives not used in Poland to support SM TIS development.
- **GHG Emission Allowance Trading Scheme:** In 2017, Poland sold GHG emission allowances worth over EUR 0.5 bn, while, in 2018, this value increased to over EUR 1 bn. In 2019, it reached EUR 2.4 bn, and in 2020 it remained at a similar level (EUR 2.5 bn) [22]. However, there is no evidence that any share of these revenues has enabled the financing of SM TIS development. Therefore, the EU GHG emission allowance trading scheme can be regarded as a financial instrument for which there is no evidence that it is effectively used to support SM TIS development in Poland.
- **White Certificates:** According to the Polish Law on Energy Efficiency, white certificates are tradable assets that can be awarded for the implementation of 'projects aimed to improve energy efficiency', which have been defined as activities consisting of introducing changes or improvements in a facility, in a technical device, or in an installation, as a result of which energy

saving is achieved and positively audited. Poland's white certificates scheme allows for granting certificates for measures indicated in the eligible energy-saving measures list published by the Minister of Energy. However, the auditing guidelines do not allow for collecting evidence on the energy savings achieved directly thanks to SM deployment. Therefore, no SM deployments can be considered as projects enabling the acquisition of white certificates. In this context, white certificates can be regarded as financial instruments that are not used to support SM TIS development in Poland.

Soft Instruments

- **Endorsement Labels:** There is no evidence for the existence of any scheme for SM endorsement labels in Poland. There is also no evidence that any non-endorsement labels (labels discouraging SM installations) have gained wide popularity. Overall, endorsement labels can be regarded as soft instruments that are not effectively used to support SM TIS in Poland.
- **Information Campaigns:** According to the public survey of 2014, which was regarding the benefits of SM. The most essential favoured benefit related to SM is greater control over consumption and expenses related to electricity i.e., payment for actual electricity consumption instead of only estimates (56.9%), lower electricity prices (41.9%), and lower power consumption (41.4%) [16]. In 2020, the Ministry of Climate started a project to support the construction of smart grids, co-financed by the EU. The project also assumes the implementation of a nationwide educational and information campaign and training on the functionalities of SMs and other related SG topics. Information campaigns can be regarded as soft instruments that are used only to some extent to support SM TIS in Poland
- **Voluntary Approaches:** No unilateral commitments of the private sector (e.g., organization of DSOs), setting voluntary SM targets in Poland, have been identified. Therefore, voluntary schemes can be regarded as soft instruments that are not used to support SM TIS development in Poland.

Discussion

The Polish experiences in the market-driven rollout of SMs shows that DSOs has emerged as a major innovating stakeholder and may also have a critical function in these processes. The inconsistent response of the DSOs to the same signal of support from the market regulator. The regulator's long-term vision was the necessary first step in starting the national rollout of SMs in Poland but the low rates of SM penetration in the power grids of some of the Polish DSOs show that such signals may be insufficient for convincing more risk-averse stakeholders. A substantial reason for this is that, unlike typical markets, power distribution is controlled by a few companies, with a large part of ownership by the state. At least at first glance, they should have fairly uniform interests as well as risk appetite and risk aversion levels. The study [7] findings illustrate well the contrasting examples of DSOs' expectations of benefits from SMs rollout. On the one hand, the limited activity of Enea in the SM deployment ties well with the previous studies that stress that network regulations need to be fine-tuned to ensure clean energy transition [23]. On the contrary to the Enea response, Energa's experiences show the opposite. Their high penetration rate of SMs suggest that, for some DSOs, only a small amount of assurance from the market regulator may be sufficient to initiate significant technological changes without modifying the pre-existing regulations [7].

The major actors responsible for the SM deployment in Poland are ME, URE, and DSOs but there has been a lack of cooperation among them which causes the overall increment of the cost of SM rollout. The Ministry has delayed the SM rollout obligation scheme for DSOs and has not approved the technical standards designed by the operators and their networks. Initially URE was actively

involved in the SM rollout by incentivizing DSO investments but over the time the regulator became less active, leaving DSOs to develop and implement their individual rollout plans, procedures, and standards. some bottom-up collaboration initiatives emerged, e.g., joint procurements of SMs by three Polish DSOs.

The low number of patents in SM technology area is evidence that the SM innovation system in Poland is a low-risk incremental innovation. There is the low interest of Polish firms and research organizations in acquiring EU and national funding for research, development, and demonstration projects, it represents the limited opportunity to create innovative products and services in the field of SM. Social awareness of SM is low, and the information campaigns that would inform customers about the benefits of SMs have been limited, mentioned in the study [7].

The Polish SM rollout has been initiated due to the strong vision of the EU and Polish governmental stakeholders. The regulator and DSOs took up several individual initiatives to increase the rollout of SM, anticipating several types of benefits. But still due to the underdeveloped policy framework and the inconsistent vision of different actors it is unable to reach the government targets [7].

SM TIS in Poland is still in the early phase of development and involves struggles between policymakers and companies. It still requires some form of regulatory support, as evidenced by the fact that the market formation is relatively slow, even with the existing strong domestic SM production capacities. A more focused study, concentrating at the sub-national level of SM diffusion, provides significant additional insights into the dynamics of market-driven SM rollouts, allowing the study of different companies' reactions to the same policy framework [7].

High investment costs related to meter purchase and installation and the development of the surrounding infrastructure inhibit SM rollout. On the other hand, the strong SM production capacities may be seen as significant resources that accelerate innovation diffusion. According to NIK [17], the installation of an SM is from 30% to 66% more expensive than a traditional one. Most of the costs are incurred by DSOs, mainly for meters, their installation, development of software, and system maintenance. The benefits, on the other hand, are gathered mainly after the rollout and are split between customers (18%), suppliers (15%), DSOs (29%), and TSO (38%). The outdated Polish power infrastructure is another barrier for the adoption of SMs [17]. Replacement and upgrading of power grids into smart grids to address the needs of growing distributed energy sources constitute a higher priority for the DSOs than the SM rollout.

The Polish case shows that, without binding regulatory intervention, the SM rollout may start and even be successful at the level of single DSOs. Additionally, the acceleration of SM diffusion relies not only on policy choices but also on the expectations of benefits by the market stakeholders

Recent developments in energy R&D:

As per IEA, in 2020, Poland spent 0.015% of its GDP on energy-related R&D activities, although most of the spending expanded after 2020. These are some activities, which give us an insight into R&D activities in the domain of renewable energy, climate change, and smart grids.

- New technologies in the field of energy (2020-2029) [24]: launched by The National Centre for Research and Development (NCBR), the main goal of the program is to support the achievement of Poland's climate neutrality by implementing solutions to increase country's energy security and increase the competitiveness of the Polish economy. As a result, the share of energy from

renewable sources in the overall energy mix of the country will increase by 20-50% (compared to the level from 2020). The specific objectives of the program are:
  - increasing the potential of the renewable energy industry (including prosumers);
  - development of intelligent grid infrastructure (energy);
  - lowering the emissions of the energy sector by increasing the use of biodegradable raw materials and waste products.
- December 2021, The NCBR, Polish Development Fund (PFR), and PFR Ventures have signed an agreement for the development of pro-ecological and pro-environmental technologies, to support the transformation of the Polish economy towards carbon neutrality. It is an important milestone in building a cooperation platform between the institutions that offer knowledge and capital for the different stages of the development of an innovative project. The joint initiative aims to make it easier for entrepreneurs to develop projects that will create a positive impact on the climate and will help with the energy transition of Poland. The offer for the companies will consist of both capital and expertise in the n implementation of innovative technologies [25].

Recommendations

Roll-out of Smart meters is the fundamental and essential milestone towards the establishment of smart grids in support of the energy transition. This gives the prosumers the facility to install, and interconnect the distributed energy resources to the grid and this also encourages the government, research institutes, industry, and utilities to converge their vision in the direction of the energy transition. Here are some recommendations to foster the R&D&I in the energy sector related to the SM rollout.

- Building codes must include the mandatory installation of water or electricity meters. Mandatory SM installation in the new infrastructure through government policy instruments
- It is recommended that DSOs combine their SM rollouts with a tailor-made set of soft measures addressing the preferences of their individual customers. DSOs should explore collaboration opportunities with providers of BEMS to integrate SM installation with other systems used by consumers to empower them and facilitate activities targeting energy savings. It could also facilitate the acquisition of energy from renewables, improved control, including additional tariff and service options.
- Support research and innovation in the industry with a focus on technology transfer and the commodification of academic research, supporting SMEs and start-ups in the energy sector.
- Analyse the possibilities of introducing tax incentives in the form of tax reliefs or exemptions that could boost foreign direct investment as well as R&D and deployment of smart grid supporting services and infrastructure i.e., smart charging of electric vehicles, distributed RE sources, etc
- Define an ambitious energy R&D strategy that distributes R&D funds in line with energy and climate goals which will be implemented and supervised by an independent entity, consisting of government, academia, and industry
- The R&D strategy should focus to maximize the coordination of participation in EU-funded projects. This includes greater efforts to inform the research community about upcoming calls and programs, and support their applications, but also working to clearly align EU-funded research with Poland's energy and climate goals
- Most of Poland's R&D funding programs, notably those implemented by the NCBR, are aimed at the demonstration and deployment of mature technologies with higher technology readiness levels. It is recommended to Implement a transparent, open, and accessible funding scheme for energy research at a variety of technology readiness levels

- It is recommended to support the projects which integrate the technology as well as a social ecosystem that will foster public-private-people partnerships, to accelerate the energy transition via public acceptance of new technologies and new market models

3.8 Desk 4 case study Czechia: The Czech Republic energy policy review and the challenges in energy research and innovation ecosystem to nurture the low-carbon economy

Introduction

Research, Development, and Innovation (RD&I) are one of the key factors that will drive the energy transition process and decarbonize the energy sector. At its core, RD&I is the application of new technologies and practices with enhanced and desirable features. Limiting climate change to below 2 °C implies reducing energy-related carbon dioxide (CO_2) emissions by nearly 70 % from 2015 levels. Many governments and other organizations have recognized that the world is under-investing in R&I if we are to achieve cost reductions and performance improvements at the pace needed to transition the world's energy systems to low carbon by 2050 [26].

Today, the Czech Republic's 50% electricity generation and 25% of its residential heating demand are coal-dependent. As shown in Fig. 6, In 2020, the Czech energy mix was made up of 52.5 percent fossil fuels (40 percent lignite, 9.6 percent natural gas, 2.6 percent bituminous coal, etc.), 40.75 percent nuclear power, and 6.75 percent renewables (3.4 percent biomass, 2.27 percent solar, 0.65 percent water, 0.43 percent wind energy) [27].
Under the EU Green deal 2020, phasing out coal will be a key challenge for the Czech Republic. For this purpose, the government established a Coal Commission in 2019 that delivered its recommendations in December 2020. The recommendation for a phase-out of coal by 2038, the Coal Commission projects that initially coal would be replaced largely by natural gas generation, while the share of renewable sources would increase to 25% [28]. All the recommendations are aligned with the State Energy Policy (SEP) of 2015 and the country's National Energy and Climate Plan (NECP) of 2019.

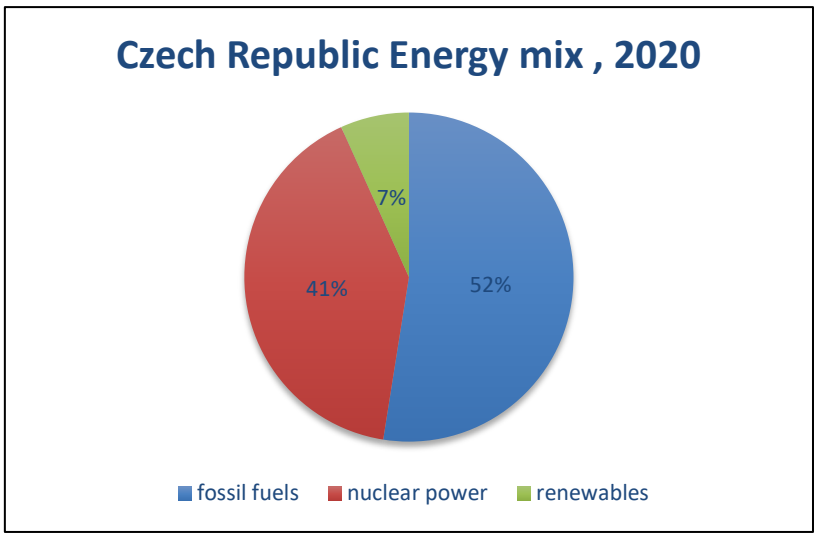


Figure 6: Czech Republic Energy mix, 2020

The coal commission stated that nuclear capacity would become the single largest energy generation source if coal were to be phased out in 2038. There are continuous planning and investments in the expansion of nuclear energy to meet the energy demand by 2036 [29]. According

to the NECP, coal would still account for 38% of electricity generation in 2030. However, new energy and climate targets agreed by the European Union for 2030 are likely to drive an earlier phase-out, as CO2 prices are set to increase in the coming years making coal less competitive relative to other fuels.

The case study of the Czech Republic's energy policy is an exemplary case to establish a balance between socioeconomic challenges and Research and Innovation (R&I) investment. The phase-out of coal and coal mining in the Czech Republic poses economic and social challenges because the coal sector is an important employer, including in parts of the country with weaker economies. Therefore, there should be an introduction of an all-inclusive framework for restructuring and transforming the areas concerned so that the communities affected will not be ignored. Additionally, for the transition of energy infrastructure, a comprehensive plan to strengthen energy-related research, development, and Innovation by developing a clear road map that would make R&I a core pillar of energy policymaking and align it with long-term energy and climate goals with international research collaboration and public-private participation. This will provide an excellent basis to leverage resources available through the European Just Transition to ensure that Czech citizens benefit from the energy transition.

Aims

An energy policy document focuses on multi-dimensional challenges related to energy transition and climate change. The main goal of the case study is to analyse the current status and challenges of energy research, development, and innovation activities and further recommend substantial measures to shift the Czech Republic into a low-carbon economy.

The case study aims to shed light on the current status of the energy policy of the Czech Republic and to demarcate the conditions needed to promote low-carbon technology research and innovation. Extensively there are two main aims of the case study. These are as follows:

1. To analyse the current policy framework for the RD&I ecosystem and give recommendations to strengthen their ecosystem for decarbonization of the energy sector.
2. To analyse the involvement of the social, political, economic, and institutional stakeholders and their challenges in nurturing the RD&I ecosystem to create a low-carbon economy. This analysis is based on the four-pillar approach of International Energy Agency (IEA) mentioned in the Czech Republic energy policy review 2021.

Method

The prime source of the case study is the energy policy review 2021 of the Czech Republic [30], done by the IEA review team. The report was drafted based on the information obtained during these meetings, the team's preliminary assessment of the Czech Republic's energy policy, the response of the government of the Czech Republic to the IEA energy policy questionnaire, and information on subsequent policy developments from the government and private sector sources. Additional information is based on the European Commission published reports and the Czech Republic's online government sources i.e., the ministry of Trade, and the ministry of energy.

The methodology is based on the IEA four-pillar approach [30], which aims to support government efforts in assessing the effectiveness of national innovation systems. Innovation processes are complex and may be influenced by a broad variety of factors, such as policy action, sectoral spill-overs, macroeconomic fundamentals, the domestic "ease of doing innovation" or regional specificities. Designing a successful technology innovation ecosystem requires several components,

including, but not limited to, public funding for energy research, development, and demonstration (RD&D). As innovation strategies are being implemented, decision-makers may benefit from taking a systemic approach to energy innovation policymaking, and should ideally aim to cover all four of the following core functions of innovation systems.

- **Resource push**: A sustained flow of R&D funding, a skilled workforce (e.g., researchers and engineers), and research infrastructure (laboratories, research institutes, and universities) is required. These resources can come from private, public, or even charitable sources, and can be directed to specific problems or basic research.
- **Knowledge management**: Knowledge should flow smoothly between researchers, academia, companies, policymakers, and international partners, among others.
- **Market pull**: The expected market value of new products or services must be big enough to make the R&D risks worthwhile, and this is often a function of market rules and incentives established by legislation. If the market incentives are high, then much of the risk of developing a new idea can be borne by the private sector.
- **Socio-political support**: There needs to be broad socio-political support for new products or services, despite potential opposition from those whose interests might be threatened.

Assessment based on the four-pillar approach of the IEA

- **Research, development and innovation strategy and policy framework:** The promotion of sustainable energy and the reduction of energy intensity of the economy are the two comprehensive objectives of the Czech Republic's energy RD&I [31]. Projects listed under the priority of developing sustainable energy include the development of renewable energy sources, electricity networks including energy storage, heat generation, increasing the share of liquid biofuels, hydrogen and cleaner use of fossil fuels. Research in nuclear energy is also a core priority, with a focus on the nuclear fuel cycle, the radioactive cycle, and fourth-generation advanced systems and nuclear reactors. Under the objective of "reducing" the energy intensity of the economy", research focuses on maintaining the current rate of improvement of the energy intensity of the economy and fostering less resource-intensive means of production. The Czech Republic embeds energy research, development and innovation (RD&I) strategy guidelines and priorities in other strategic and policy documents such as:
    - National Research Development and Innovation Policy (NRDIP); State Energy Policy (SEP), 2016
        - Priority I – balanced energy mix
        - Priority II – savings and efficiency
        - Priority III – infrastructure and international cooperation
        - Priority IV – research, development, and innovation
        - Priority V – energy security
    - Innovation Strategy, 2019, an extension of NRDIP
    - National Priorities for Oriented Research, Experimental Development and Innovation, 2012

  Energy RD&I is one of SEP's five strategic priorities, aiming to ensure the competitiveness of the Czech energy industry. The government has established a new programme for applied research in the energy sector, the THETA Programme. The NRDIP guides overall RD&I in the Czech Republic and provides the framework for the preparation of sector-specific RD&I policy developments.

- **Public budget on energy RD&D:** As per the IEA policy review, The Czech Republic has significantly increased public energy-related RD&D in the last decade. The steep increase in spending in 2019 relative to previous years was mostly driven by more significant spending in nuclear, energy systems analysis, power technologies including storage, and energy efficiency, and is largely related to the new THETA Programme allocation of energy RD&D funds, the share of public funds for energy efficiency and renewable energy remarkably decreased from 2009 to 2019, while the share for fossil fuels increased. As shown in Fig. 1, In 2019, nuclear energy received the largest share, at 34% of the total RD&D budget. Energy system analysis received the second-largest share (14%), while electricity and storage technologies accounted for 12% of the total budget, mainly for electric power conversion and electricity transmission and distribution. Fossil fuels accounted for 10% of the total RD&D energy budget, and this was mainly used for the development of coal technologies. Renewable energy RD&D received just 9% of the total public energy budget, of which 78% went to biofuels, mostly for solid biofuel production. The Czech Republic is also funding hydrogen by allocating 8% of the total energy-related RD&D budget. The Czech Republic's energy RD&I covers a broad range of topics and has notably diversified towards programmes supporting the energy transition. However, the allocation of public funding is still heavily focused on nuclear research and fossil fuels. While the country clearly has a significant and accomplished research community in this area, it will be important to ensure that the new priorities identified in the THETA Programme and among others, are equally well-funded and supported.

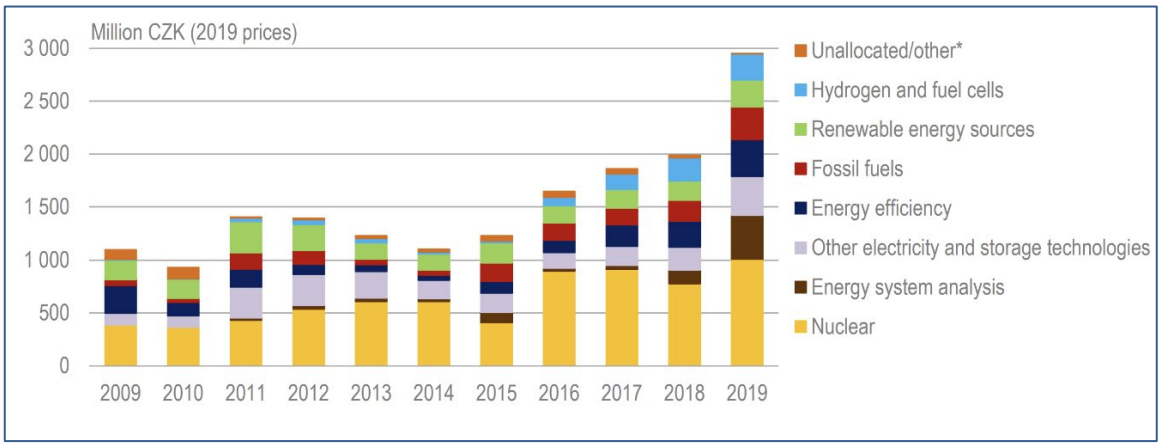


Figure 7: The Czech Republic's energy-related public RD&D budget during the last decade, Source: IEA (2021)

** Unallocated/other includes basic energy research and unallocated energy RD&D budget*

- **Institutions:** The key strategic policies for RD&I are developed at the national level but there is no dedicated ministry for RD&I.

Table 9: Institutions impacting RD&I policies

Institutions	***Role and responsibilities***
Research and Development Council	Co-ordinating body responsible for the preparation and implementation of national RD&D policy, evaluation of RD&I projects funded by the public sector

Ministry of Education, Youth, and Sports	international cooperation in RD&D
Ministry of Industry and Trade	energy-related RD&D
The Technology Agency	implements government-funded programmes in cooperation with central government bodies.

Additionally, the different ministries and public agencies mandated with energy R&D and innovation activities align strategic priorities, and share resources and outcomes of their respective activities.

- **THETA Program:** Based on the long-term energy goals of the SEP, to support applied research, experimental development, and innovation, the THETA Programme was launched in 2016 for the duration of 8 years (2018-2025). The aim of the programme is to contribute in the medium and long term to fulfilling the vision of transformation and modernization of the energy sector in accordance with the approved strategic materials through the outputs, results, and impacts of the supported projects. This aim will be achieved by supporting research, development, and innovation in the energy sector with a focus on [32]:

  - Supporting projects in the public interest,
  - New technologies and systemic components with a high potential for rapid application in practice,
  - Promoting long-term technological perspectives.

  The programme is divided into three sub-programmes based on focus and scope and they are mutually supported and complementary.

Table 10: THETA Programme objectives

THETA Programme (2018-2025)	
Sub-programmes	***Objectives***
Sub-programme 1 – Research in the public interest	Improve the management of the energy sector to create strategic and policy documents
Sub-programme 2 – Strategic energy technologies	Transformation and modernization of the energy sector
Sub-programme 3 – Long-term technological perspectives	To support long-term technology perspectives in the energy sector

The THETA programme is an exemplary way to align innovation activities with long-term energy goals and create a channel to provide stable funding for continued research on topics relevant to the energy sector, and that can act as a catalyst for growth and competitiveness across the economy. Moreover, the THETA's sub-programmes are good examples to strengthen the engagement of private sector actors in energy innovation allowing tapping into a greater pool of resources and talents, leveraging constrained public funds, and increasing the chances of bringing new ideas and concepts to markets. The government could consider using a similar approach for other energy-related programmes as well.

- **National competence centres:** The programme launched in 2011, aims to support the establishment and activities of centres for R&D and innovation in economic sectors with the high innovative potential to improve the competitiveness of the Czech Republic. The Programme focuses on the entire economic activities including the energy sector. Six competence centres were established in the energy sector, two of which have a focus on nuclear.

To create one integrated system and link them to operational programs and other research units within one research area, the government established National Competence Centre (NCC) programme which was approved in 2019. The aim of the NCC is to support the building of a stable and long-term base for applied research, to significantly strengthen the research organizations focused on applied research, and to concentrate existing capacities in the NCCs. One of the newly established NCCs is dedicated to energy, with the objective to leverage synergies and complement work under the EU programmes Horizon 2020 and its successor Horizon Europe, and other international RD&I cooperation in the energy sector.

- **Energy Regulatory Office's (ERU) RD&I involvement:** The ERU considers RD&I an important contribution to supporting an equitable and efficient energy transition. Outcomes of RD&I undertaken by the ERU are used to define new rules, regulations, and price methodologies for the functioning of the changing power and gas sectors. For the power and gas sectors, the ERU has identified five priorities for RD&I that address important aspects of energy system functioning and emerging issues [33]. They are
    1) Regulatory framework for the power sector
    2) Tariff system innovation for dynamic tariff
    3) Smart metering/advanced metering management:
    4) Local energy entities for promoting RE
    5) Developing software tools for energy market regulation

  The ERU undertakes the above-mentioned research activities through ongoing RD&I programmes such as the THETA Programme and Horizon 2020. It is also taking the lead in research projects that focus on new regulatory methodologies in line with the demand for more decentralized power and gas sectors, solutions for processing, analyses, and assessments of statistical data, and the evaluation of investment efficiency in regulated energy sectors.
- **Monitoring and Evaluation:** The Research and Development Council is responsible for the overall evaluation of RD&I projects funded by the public sector. The council has created a methodology for evaluating results obtained by the various research organizations and from completed programmes. The council applies a number of indicators to ensure that the funded projects and programmes are aligned with the national research priorities. As per the technology centre CAS report [34], Indicators applied within the observed terminated and already evaluated programmes show certain deficiencies linked with their relevance to evaluated issues, their information value and measurability as well. These deficiencies are evident while comparing established indicators with general rules and trends in the application of indicators for RD&I evaluations used in other EU countries. Indicators used in the observed programmes lack the connection with the intervention logic of the programmes or relevant evaluation questions [34]. A more streamlined RD&D evaluation process would also allow the government to link the outcomes of funded projects to future RD&D planning and design, which would further enhance value for money.
- **International cooperation:** As per the Ministry of Industry and Trade the Czech Republic is involved in three international cooperation [35]. These are as follows:
    1) The EU Strategy for the Danube Region: The EU Strategy for the Danube Region (EUSDR) is one of the macro-regional strategies that provides an integrated framework for strengthening the cooperation between nations. Bringing together 115 million people from nine EU member states, three EU candidate countries, and two EU neighbour countries, it has an important integrative and cohesive function [35].

2) "Fit for 55" - EU Energy Ministers discussed new energy legislation and rising energy prices: The "Fit for 55" package is a set of proposals to revise and update EU legislation and to converge new initiatives with the aim of ensuring that EU policies are in line with the climate goals agreed by the Council and the European Parliament [36]. Under the "Fit for 55" initiative, Energy ministers met in Slovenia on 22 September to discuss proposed changes to the energy directives in the "Fit for 55" climate and energy package, which aims to reduce CO2 emissions by 55% by 2030 compared to 1990 and move towards climate neutrality by 2050. The rising electricity and gas prices across the European Union were also discussed in the meeting.
3) International Energy Agency: The Czech Republic is already a member of one IEA TCP: Technology Collaboration Programmes (TCP). It has joined two more TCP, the Energy Storage TCP in March 2021 and the Gender in Energy Programme in August 2018. In addition, the country also participates in the Energy in Buildings and Communities TCP and the Fluidised Bed Conversion TCP [30].

Insights and Recommendations

- From the investment perspective, the Czech Republic aims to strengthen energy-related research, development, and demonstration (RD&D) funding through the National Research, Development and Innovation Policy (NRDIP) and the State Energy Policy (SEP), though the country does not have a specific energy RD&D strategy. The main energy RD&D program in the Czech Republic is the THETA Programme, which was approved in 2019 and is based on the SEP. The THETA Programme contributes to transforming the energy sector into a low-carbon economy. In particular, the Czech Republic places nuclear energy at the heart of its RD&D spending, ensuring the reliability and technological development of nuclear installations. It is recommended to expand the ecosystem for RD&D programmatic engagement for energy technologies beyond nuclear energy.
- In order to ensure that policy decisions are delivering measurable results, the Czech Republic could consider strengthening the existing monitoring and evaluation framework by making it more uniform and bringing it in line with international best practices for independent evaluation of the pertinent research infrastructures models. Currently, monitoring and evaluation are not uniform nationally, and there can be differences in the framework, thus objective comparison and analysis between the programmes are lacking. An independent evaluation would streamline data collection, facilitate greater international collaboration and bring transparency, which could, in turn, attract increased private sector finance or project support [34]. Integrate the energy technology RD&D data collection within the regular annual statistical activities and complete its coverage. There should be efforts in expanding efforts to collect data related to private sector energy R&D and share methodologies and knowledge with international peers.
- The THETA Programme has led to an overall increase in public funding for energy-related RD&D and serves as the main instrument of support for applied research. A critical element of the programme is to preferably support projects that have significant opportunities for the Czech business community, through dedicated schemes to support energy innovation by small and medium-sized enterprises and start-ups, which could help bring new ideas, concepts, and technologies to markets to enable clean energy transitions. The projects under the THETA program show the full range of low-carbon technologies and demonstrate the

relative state of development between low-carbon RD&D topics (including nuclear) and fossil fuels [37]. These projects could be better expressed on international platforms to attract the research community and investors and open up the gates of diversified RD&D.

- There is also an opportunity to increase international collaboration on projects that can be critical for RD&D. The Czech Republic could participate in more EU R&D programmes beyond nuclear. The Czech Republic could strengthen its engagement in technology collaboration programs with international research institutes to share best practices in additional areas of RD&D and benefit both from international knowledge and private sector awareness of potential regional and global supply chains. Participation in international partnerships for energy innovation could decrease the costs of technology development through knowledge sharing and collaborative R&D on priority technology areas. This could be particularly beneficial to lower the high transaction costs of international cooperation for innovative small and medium-sized enterprises and provide them with greater opportunities for sustainable growth and reach commercial deployment and accelerate market uptake.
- Due to the wide range of active partners in the RD&I field in the Czech Republic, there is a need to clearly allocate responsibility for co-ordinating policy in the field of technology RD&D. This should also ensure that the energy stakeholders play an active role, including academia, non-governmental organizations, small and medium-sized enterprises, and innovative start-ups, bringing all pertinent players into a collaborative framework. A multi-stakeholder process could allow the Czech Republic to set clear priorities for energy technology RD&D in emerging areas for the energy transition. Referring to Fig. 6, the current RD&D funding portfolio involves a high share of research related to nuclear technology. But there is a clear opportunity to have a national system of innovation predicated on RD&D in a range of other energy sources and types, especially low-carbon technologies, but also including advances in cleaner fossil fuel applications, which are still a significant building block of the energy mix in the Czech Republic.

3.9 Desk 4 case study Slovakia: Channelizing finances to sustainable energy projects reducing Greenhouse Gas (GHG) emissions: A case study of the Slovak Energy Efficiency and Renewable Energy Finance Facility (SlovSEFF)

Introduction to SlovSEFF

As per European Environmental Agency (EEA), Slovakia is one of the most energy-intensive economies in the EU at levels almost twice the European Union (EU) average [38]. The building sector consists to a large extent of very energy-inefficient and poorly insulated buildings from former times. In addition, non-electric energy in Slovakia is emission-intensive and electrification/sector coupling is rather limited. That is why Slovakia faces considerable challenges in mitigating emissions in the non-Emission Trading System (ETS) housing and industrial sectors.

SlovSEFF stands for the Slovak Sustainable Energy Financing Facility. It was initiated by the European Bank of Reconstruction and Development (EBRD) in 2007. SlovSEFF was one of the first in a series of financing facilities implemented with the objective to promote energy efficiency and renewable energy projects. There are three main components in the SlovSEFF [39], these are as follows:

1. **Extend credit lines:** given to local financial institutions that aim to develop energy financing as a field of their business. Acting as intermediaries, these financial institutions use the funds to on-lend to clients engaging in energy efficiency or small-scale renewable energy generation projects.

2. **Technical assistance:** implemented by external consultants, to both financial institutions and their clients. This includes the training of bank staff in promoting specific financial products and in recognizing technically eligible projects as well as the provision of support to borrowers in identifying energy-saving projects and in developing financing applications
3. **Incentive payments**: can be provided to kick-start markets or to compensate financial institutions for "the restricted use of proceeds, costs incurred in training staff and fulfilling monitoring requirements"

The Eligible projects for the SlovSEFF facility are divided into three different categories, with each of these groups having specific eligibility criteria that need to be satisfied:

Table 11: SlovSEFF categories

Renewable Energy [40]	**Industrial Energy Efficiency** [41]	**Housing Energy Efficiency** [42]
purchase and installation of equipment, systems, and processes that use renewable energy resources	equipment, systems, and processes that enable the reduction of primary energy consumption, final consumption of electricity, fuels, and other forms of energy	major thermal rehabilitation projects of blocks of flats

About 700 projects were financed under both SlovSEFF phases I and II. Under the SlovSEFF, since 1 July 2014, the funding mechanism has verified 151 sub-projects worth €50.7 million; committed incentives linked to the portfolio amount to €5 million, and the annual GHG savings reach 23,282 tCO2e. During the last quarter of 2020, 18 sub-projects have been added to the portfolio, technical assistance has been provided in 13 sub-projects and 5 sub-projects have been verified [43].

Aims

The Slovakia SlovSEFF policy proves that besides triggering emission reductions, a comprehensive financing scheme can also potentially have significant impacts on the transfer of expertise among banks and companies related to sustainable energy investments which foster a sustainable energy techno-economic ecosystem. To understand a feedback loop, the aim of this case study is:

- To study the overall implementation and the impact of the SlovSEFF policy instrument in Slovakia. Additionally, focus on the effectiveness and benefits of the policy.
- Discuss the parameters of SlovSEFF success and the challenges. Also, the recommendations to enforce the need for Research and Investment funding in the sector of energy efficiency and smart grids.

Method

The information is gathered from the official website of SlovSEFF [44] and from the Energy Efficiency Watch 3 project reports that inform the progress of EU Member States with regard to energy efficiency policies [45].

Results/Analysis

The initial phase (SlovSEFF I), 2007: Started in 2007 and involved sub-projects with four participating banks. EBRD extended credit lines of EUR 15 million to each of these banks (in total: EUR 60 million) [46].

The second phase (SlovSEFF II), 2009: Due to the success and quick uptake, the facility was extended by EUR 90 million in December 2009. As in the first phase, EUR 15 million were provided to each participating bank (including the four initial banks and two additional banks as of November 2010). Donor funding for incentive payments and technical assistance was provided by the Bohunice International Decommissioning Support Fund (BIDSF). The supplemental grant funding for technical assistance and performance fees amounted to EUR 30 million. In total, about 700 projects were financed during the first two SlovSEFF phases [46].

Third phase (SlovSEFF III), 2014: In contrast to SlovSEFF I and II, the new programme design has changed considerably. Firstly, in order to maximize the facility's impact on GHG emission reductions, the focus of the facility has been placed on renewable energy and industrial energy efficiency projects. Secondly, the incentive payments are now funded from the carbon credit sales from Slovakia to Spain, thus representing EBRD's first credit line funded through a market-based mechanism [47]. In addition, the programme's technical assistance component is also directly financed by the Spanish state [39].

Functioning of the SlovSEFF:

As outlined in the introduction, three categories of projects are eligible under SlovSEFF: Renewable energy (max. project size: EUR 10 million), industrial energy efficiency (max. project size: EUR 5 million), and housing energy efficiency projects (max. project size: EUR 2.5 million) [47]. In order to receive funding, a project must comply with specific eligibility criteria. Furthermore, only specific private legal entities may apply for SlovSEFF support, namely private enterprises, Energy Service Companies (ESCOs), and housing associations or cooperatives [48].

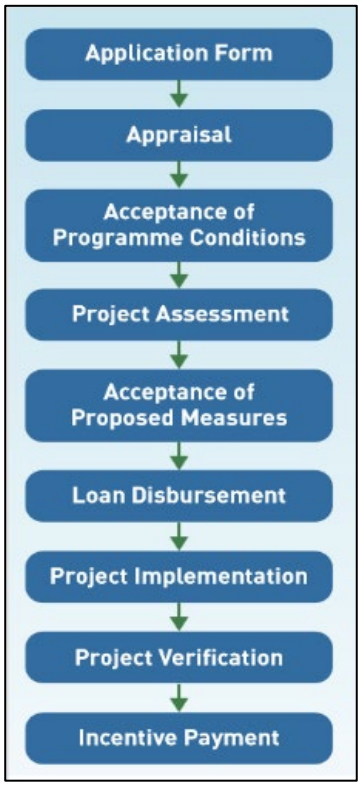


Figure 8: SlovSEFF procedure

The procedure from application to project implementation and incentive payments follows specific steps as depicted in Figure 8. First, an applicant/project applies for inclusion in SlovSEFF (Application Form). Then, a simple project analysis is conducted to assess whether basic eligibility criteria are fulfilled (Appraisal). Based on the positive appraisal, the applicant accepts SlovSEFF conditions by signing a Letter of Engagement (Acceptance of Programme Conditions). Further, the consultant performs a technical assessment (e.g., Project Assessment Report, Energy Audit, Simplified Energy Audit, or Energy Performance Certificate) to identify and/or confirm the best energy/carbon saving measures (Project Assessment). The project developer confirms that the investment recommendations are understood (Acceptance of Proposed Measures). Subsequently, the bank loan is disbursed (Loan Disbursement) and the project implemented (Project Implementation). Once the project is completed, the Verification Consultant assesses whether the project has been implemented in compliance with the Project Assessment Report (Project Verification). Upon successful verification, incentive payments are disbursed (Incentive Payments) [49] [50].

The incentive payments (or carbon reduction compensation) are a crucial component of SlovSEFF III and are directly linked to a project's GHG emission reduction/energy savings potential. Incentive payments are provided to support markets by incentivizing financial institutions and borrowers to comply with higher standards for energy efficiency and renewable energy projects. In the case of financial institutions, they also occasionally compensate

for costs of staff training and monitoring activities.
For renewable energy and industrial energy efficiency projects, the incentive payment is equal to the project's estimated annual greenhouse gas emission reductions in tonnes of CO2 equivalent (tCO2e) multiplied by a crediting period of 3 years, a carbon price of EUR 20/tCO2e and a discount rate of 3% applied over the crediting period [51]. For housing energy efficiency projects, the incentive payments are calculated as a percentage of the loan amount disbursed and depend on a project's total energy savings. The minimum level of energy savings that needs to be achieved is 30%. Between 30% and 40% of energy savings achieved, the incentive payment is equal to one-tenth of the loan amount disbursed. For 40% and more energy savings, the incentive payment is 15% of the loan amount disbursed [47].

Impact of the Policy Instruments:
SlovSEFF has supported investments in housing and industrial energy efficiency as well as renewable energy since its launch in 2007. In total, 688 projects were funded in SlovSEFF I and II across Slovakia about EUR 200 million [52]. An evaluation by the EBRD in 2014 shows that the largest share of projects took place in the housing sector (87%), followed by the industrial sector (11%) while renewable energy projects represented only 2%. Yet, when considering the allocation of funds, 61% went to housing, 27% to industrial projects, and 12% to renewable projects, due to the larger financial size of renewable and industrial projects. SlovSEFF III has recently made a shift towards more projects in the industrial sector, a development that is related to the amended eligibility criteria. Overall, about half of the total annual CO2 emission reduction resulted from industry sector projects, although this fraction fell strongly from 61% in SlovSEFF I to only 37% in SlovSEFF II [53]. At the same time, the fraction of total CO2 savings resulting from housing projects rose from 15% up to 30%. These shifts reflect the more comprehensive housing projects undertaken under SlovSEFF II, as a result of the change in incentive payments [53].

Table 12: Summary of quantitative results of SlovSEFF I & II [44]

		SlovSEFF I	***SlovSEFF II***	***TOTAL***
Housing projects	*Number*	251	348	**599**
	Investment	EUR 32.6 million	EUR 58.6 million	**EUR 91.5 million**
Industrial projects	*Number*	34	42	**76**
	Investment	EUR 19.3 million	EUR 21.2 million	**EUR 40.5 million**
Renewable energy projects	*Number*	8	7	**15**
	Investment	EUR 8.1 million	EUR 9.8 million	**EUR 17.9 million**
Emission savings per year		63,564 tCO2e	50,948 tCO2e	**114,512 tCO2e**
Primary energy savings per year		283 GWh	300 GWh	**583 GWh**
Average energy saving in Housing projects		32%	35%	**33%**

Under the SlovSEFF III initiative, 182 projects have been completed in the category of Industrial energy efficiency, renewable energy, and residential energy efficiency [44]. The details are as follows:

Table 13: Summary of quantitative results of SlovSEFF III [42]

SlovSEFF III

GHG Emission savings per year	23.742 tCO2e
Energy savings per year	99.186 MWh
Carbon reduction compensation	EUR 4.9 million

Cost efficiency:
Under SlovSEFF I, the mean annual final energy saving per unit of investment was 3.38 GJ/EUR but had fallen to 2.78 GJ/EUR under SlovSEFF II [52]. In terms of annual primary energy savings, the mean values were 3.77 GJ/EUR and 3.75 GJ/EUR respectively [45].
In the case of industrial energy efficiency projects, the annual final energy saving per unit of investment also decreased between phases I and II. The EBRD sees this as a reflection of the lower internal rate of return under SlovSEFF II and the increase in small-scale projects. The mean annual final energy saving per unit of investment was 13.8 GJ/EUR under SlovSEFF I but had fallen to 8.78 GJ/EUR under SlovSEFF II. In terms of primary energy saved, the mean values were 20.4 GJ/EUR and 16.7 GJ/EUR respectively [45].

Co-benefits:
According to EBRD [52], the project is also expected to have two sources of transition impact:

- The policy instrument can generate a
- transition impact by demonstrating the benefits of energy conservation and promoting the expansion of energy efficiency and renewable energy lending in the Slovak Republic. In addition, the project demonstrates the positive effects of rational energy utilization by reducing energy costs for private households and companies and the reduction of GHG emissions.
- The instrument is also expected to transfer and build expertise related to sustainable energy investments, both among banks and borrowers. Participating in financial institutions will build capacity in identifying sustainable energy opportunities as well as assessing the risk and creditworthiness of clients for energy efficiency and renewable energy loans. Sub-borrowers are expected to become more familiar with banks' requirements for providing such loans. Borrowers are helped in identifying energy-saving opportunities through energy audits and are advised on high-performing technologies

Discussion
Success factors:
SlovSEFF is considered to be an innovative policy instrument due to the technical assistance that is provided by the project consultant who helps clients of the local banks identify the most appropriate energy efficiency investments, through Rational Energy Utilisation Plans (REUPs), Simple Energy Audits (SEAs) [54], and assistance to the formulation of loan applications.

- **Free technical assistance**: It carried out by local consultants is crucial for the success of a policy instrument for financing energy efficiency. Local consultants contributed to the success by preparing technical assessment packages (REUPs and SEAs) and through monitoring activities.
- **An integral incentive payment system**: All successfully verified renewable energy and industrial energy efficiency projects are granted a one-off payment to compensate for carbon reduction, and housing projects receive a payment as a percentage of the provided loan depending on the total savings.

The combination of technical assistance and incentive payments rather than the mere provisioning of funds is considered an additional success factor. To measure impact, a monitoring system is in place through several project assessment steps, including project verification and annual reporting to the Slovakian Innovation and Energy Agency (SIEA). Compliance is ensured by the reporting of annual GHG emissions and energy savings by the borrowers to SIEA for a period of 5 years after project completion.

Challenges:

- Market barriers can impede the implementation of energy efficiency projects. The main barriers to such projects are long payback periods and a large upfront investment burden. Incentive payments provided by SlovSEFF have helped overcome these market barriers. The incentive payments included in the SlovSEFF scheme are provided to push markets by incentivizing financial institutions and borrowers to comply with higher standards for energy efficiency and renewable energy projects [45].
- The absence of initial targets was an area of improvement in the initial phase of SlovSEFF. In addition, energy-saving thresholds to receive incentive payments were found to be too low under SlovSEFF II, which is why they were doubled under SlovSEFF III. The minimum internal rate of return (IRR) threshold for renewable energy projects has been set to 10%, which may lead to superficial, rather than in-depth, energy refurbishment [45].
- A low level of awareness and limited knowledge of available technologies to reduce energy consumption (industrial sector).
- Difficulties in gaining consensus in the case of a large number of owners within apartment buildings (housing sector).
- Lack of an adequate incentive system, fragmented regulation, non-guaranteed purchase tariffs, etc. (renewable energy sector).
- Energy efficiency-related incentive schemes can also support free-ridership (or windfall gains). Free- ridership describes a phenomenon where public money is provided to companies or households that would have undertaken the envisaged actions anyways, also in the absence of the financial incentive.

Potential Impacts in other countries:

In general, the impact of a financing scheme such as SlovSEFF for the building and industrial sectors targeted the ETS and non-ETS sectors. Two aspects are particularly relevant for the distinction of sector impacts:

- Fostering energy efficiency for district heat (mostly ETS) and decentralized heating systems (non-ETS)
- A shift among heating systems, e.g., from distributed heating based on fossil fuels to electricity-based heating, radiators, and heat pumps, or to district heating (with both electricity generation and district heating being under the EU ETS)

In general, electrifying heating or moving to district heating expands the scope of what is under the EU ETS which results in lower Effort Sharing Decision (ESD) emissions. Electric heating is therefore desirable from an ESD-reduction perspective, and, additionally, in Slovakia electricity has a relatively low carbon intensity because of the highest share of nuclear energy. Similarly, the reduction of electricity consumption or district heating consumption from increased energy efficiency in electrically heated/district heated dwellings cannot reduce emissions in ESD sectors as they are

already covered by the EU ETS umbrella. Consequently, the aim of a financing scheme such as SlovSEFF should be to enable energy savings and, thus, to reduce GHG emissions in the non-ETS sectors, whereas other emission sources should be covered by the ETS. Certain policy design amendments should promote increased GHG savings in non-ETS sectors, such as buildings and SMEs within the industry sector.

Recommendations

- Consideration of the ambitious sector-specific targets that should be aligned with the other EU Member States.
- Comprehensive investments are needed to achieve the desired renovation rate of existing buildings and higher energy efficiency standards in SMEs
- Reconsideration on the design of SlovSEFF to allow for greater cost efficiency by supporting cost-efficient measures and by avoiding free-ridership. Contract assurances could be a solution for the free ridership.
- Launch government-backed renewable energy and energy efficiency awareness campaign to gain public awareness to accept renewable energy sources.
- Implementation of renewable energy projects causes grid instability (voltage and frequency instability) as wind and solar are weather dependent, it is recommended to promote and invest in smart grid infrastructure research and projects within the EU framework.
- Additional grant funding for technical assistance can further incentivize investments and foster this knowledge transfer between other EU countries.

3.10 Desk 5 case study Hungary, Croatia and Italy: policies and incentives for smart grid R&I

PANTERA Desk 5 is composed by Hungary (HU), Croatia (HR) and Italy (IT). These countries have been grouped by the PANTERA project mainly for organisational reasons rather than for their belonging to a well-defined geographical area. To give an overview of these three countries in few figures we report here their population and gross domestic products (GDP). Italy has almost 60 million of inhabitants (59.55) while Hungary has 9,75 million and Croatia 4,7 million. The Italian GDP is 1.782 billion € (29.924 € per capita), the Hungarian GDP is 153,758 billion € (15.770 € per capita) while the Croatian one is 57,199 billion € (12.170 € per capita), data are taken from Eurostat.

Aims

The main aim of these case studies is to provide a high-level overview of the present status of policies and incentives (especially related to the energy sector) for the deployment of greener economies (thus involving renewable energy sources uptake, electric vehicles, energy efficiency measures, etc.) as well as provide an outline of the involvement of organisation and companies in research and innovation efforts at EU level.

Method

Different ways have been exploited to gather the information reported in the following. The figures reported, the graphs below, regarding the funding received by the organisation coming from the different countries, are elaborations of data taken from the from CORDIS[9] portal; while other information has been gathered form several websites (always duly cited) often in native language exploiting the automatic translation for Hungarian and Croatian tongues that are not known by any member of the PANTERA consortium. Besides this source of information, contacts with stakeholders have been pursued by different means, either organising dedicated events at conferences (such as

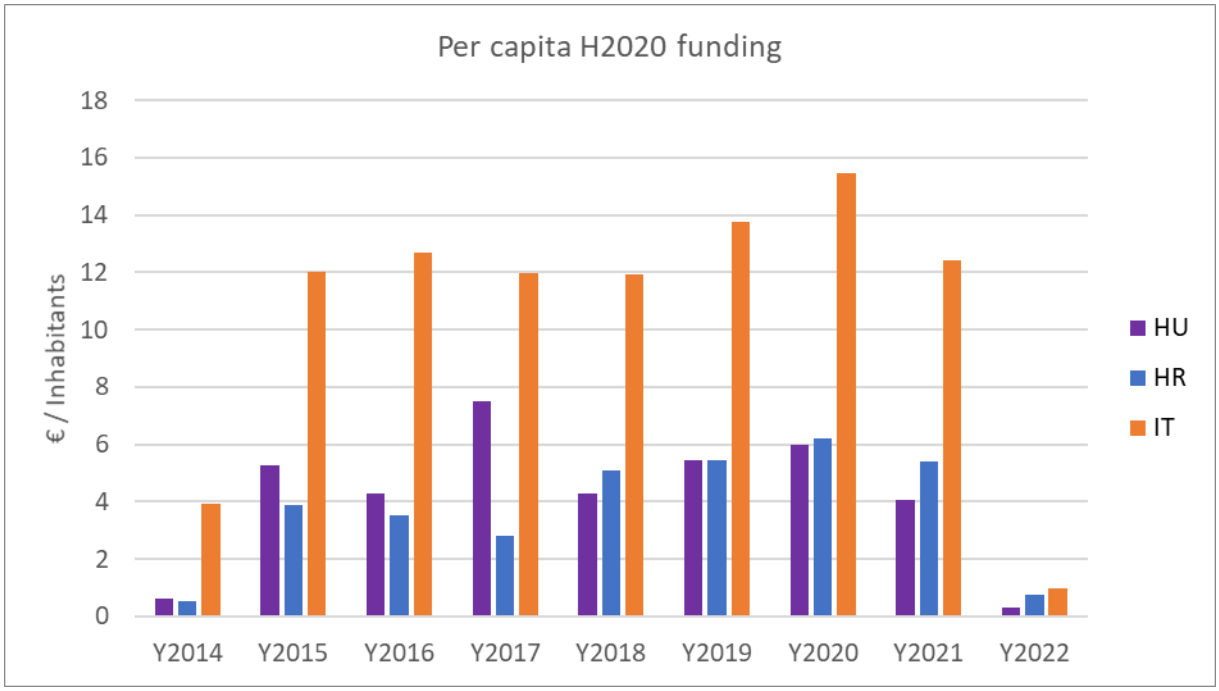
[9] *https://data.europa.eu/data/datasets/cordish2020projects?locale=en*

the workshops organised at the Croatian SpliTech conference and at the MELECON 2022 conference in Palermo, Italy) either participating as PANTERA project in events like EUSEW and ENLIT where there was the opportunity to contact stakeholders from the Desk 5 countries that were present there. Some of these contacts resulted in interviews that gave key insights about the actual status and possible hints to improve the actual R&I framework. More details about these interviews are reported under the WP4, while the outcomes from the workshops that PANTERA has organised at the mentioned conferences are reported in detail under the WP5. It is worth to mention that PANTERA is organising two workshops also in Hungry, one will take place on October 26th and it will be a joint event with SUPEERA[10] projects while the second one will be organised within the CANDO EPE conference[11] at the end of November.

Results

In the following graphs are reported a high-level analysis of funding granted under the Horizon 2020 framework programme. Data are taken from CORDIS[12] portal.

In Figure 9 it is reported the per capita funding that has been granted to organisation from desk 5 countries through the H2020 yearly. H2020 is organised in completive call for projects and looking at the funding received by the different nation can give an insight to the status of their R&I field. The data reported in Figure 10 cover the whole H2020 program (considering the data available through the portal reported in the footnote and already mentioned). It worth to note the lower amount funding granted in the years 2014 and 2022 is since these were transition years for the H2020 framework program. Besides the annual variability that could be due also to the topics of the calls, from the graph could be noted that Croatia and Hungary receive a smaller amount of per capita money with respect to Italy. Besides it is interesting to note that while Hungary has received slightly less money moving from 2014 to 2021, Croatia has increased the success in receiving H2020 funding.



[10] https://www.supeera.eu
[11] http://conf.uni-obuda.hu/Kando2022/
[12] https://data.europa.eu/data/datasets/cordish2020projects?locale=en

Figure 9: Per capita H2020 funding received by Hungary, Croatia and Italy

In the Figure 10 are reported the number of organisations involved in H2020 (the ones participating in more than one projects are accounted once), while in Figure 12 the same figures are displayed relatively to the number of inhabitants of the country. This second graph gives a better insight showing that Hungary, Croatia and Italy reach good levels of engagements in terms of organisations involved. Slightly decreasing for Hungary and Italy, while slowly increasing for Croatia over the years. These findings however need to be viewed together with the graph in Figure 11 showing the total funding received by the countries. Considering that Hungary and Croatia receive less funding, the received money for the single organisation is less.

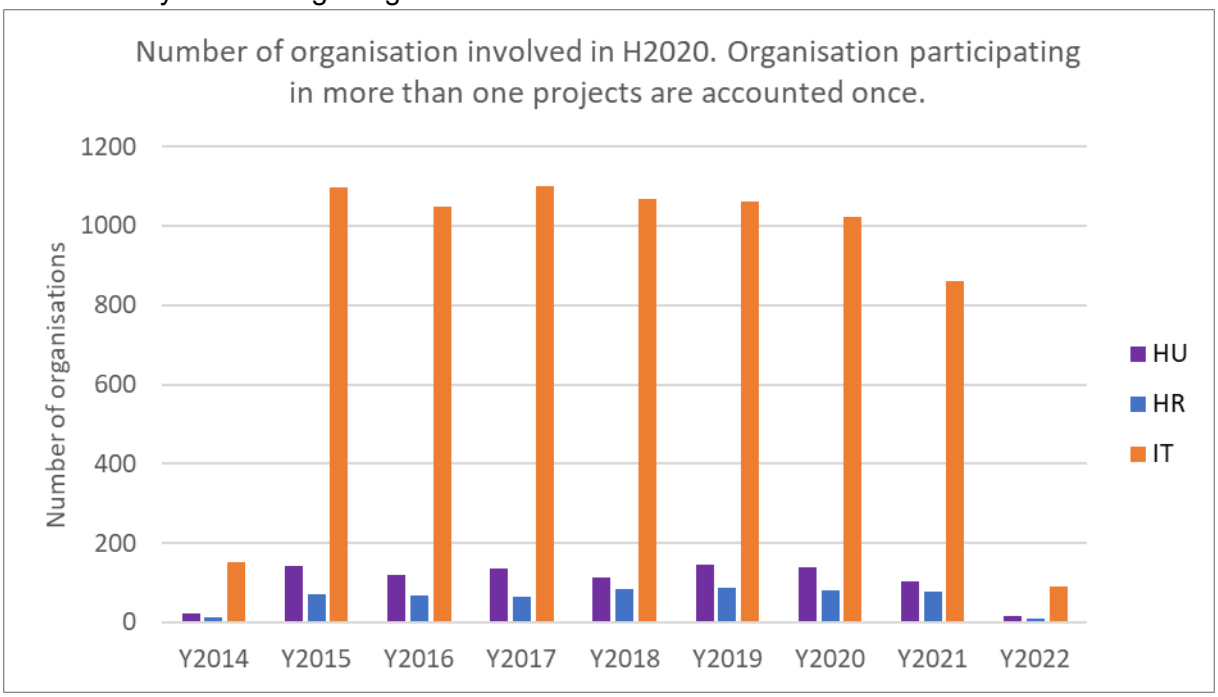


Figure 10: Number of organisations involved in H2020 from Hungary, Croatia and Italy. Organisation participating in more than one projects are accounted once.

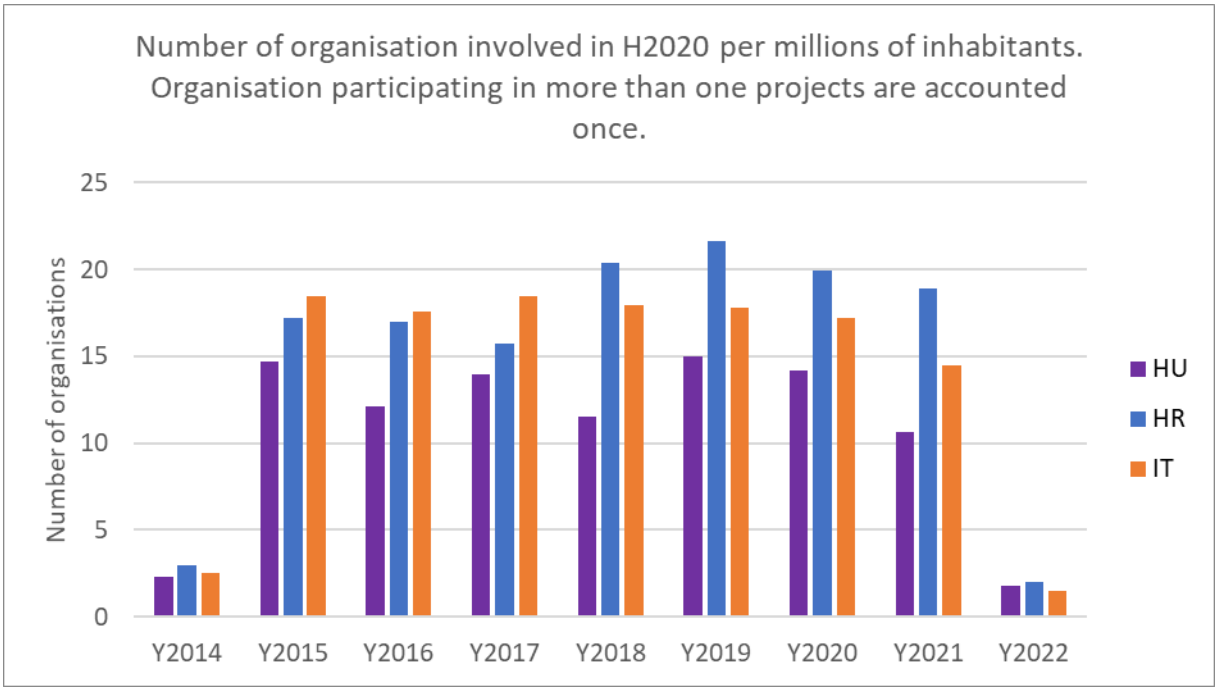


Figure 11: Number of organisations involved in H2020 from Hungary, Croatia and Italy per millions of inhabitants. Organisation participating in more than one projects are accounted once.

Hungary

According to the European innovation scoreboard[13] Hungary is an emerging innovator, the fourth of four categories in which countries are categorised according to their innovation performances. However, within this category Hungary has one of the highest scores and its performances are improving. In this view it is reported that: foreign doctorate students, government support for business R&D, medium and high-tech goods exports, public-private co-publications and job-to-job mobility of in science and technology jobs are the relative strengths, while design applications, business process innovators, employment in innovative enterprises, R&D expenditures in the public sector and number of doctorate graduates are the main relative weaknesses.

In the "Peer Review of the Hungarian Research and Innovation system"[14] the Policy Support Facility of the European Commission laid out some key policy message to support the strengthening of the Hungarian R&I ecosystem. We briefly summarising these messages here since this is a relevant starting point for supporting the strengthening of the Hungarian R&I ecosystem.

While recently the Hungarian R&I system has been reformed introducing more competition, transparency and focusing more on scientific excellence concentrating resources on the most relevant areas, it still needs improvements. Hungary should invest more in the internationalisation of its R&I activities and in general in R&I activities.

The Hungarian public research system is composed by a number of universities and institutes supervised by different ministries. This make difficult to achieve a deep coordination of research and the limited dimension of some institutes could be the reason of a partial participation in activity at international level. Besides public funded R&I, private local private companies (often small medium enterprises) invest low budgets in R&I activities and the main results in R&I activities form the private sectors is achieved by foreign companies with divisions in Hungary. It's reported also that Hungarian R&I priorities need to better defined R&I priorities that now are defined in multiple strategic documents. In this view, an important role could be played by the National Smart Specialisation Strategy (S3) - 2021-2027*15* and the National RDI strategy.

These documents are developed by the National Research Development and Innovation Office[16] (NRDIO) that is the main entity responsible for science and innovation funding. Its main aim is to increase the excellence and competitiveness of the Hungarian science system. NRDIO is also responsible for R&I policies and it is committed in embedding research and innovation in the overall policy mix of Hungary. Recently established (2015) is expects to give more stability in the R&I system. NRIDO is in charge of science and for innovation funding, including the EU Structural Funds, and integrates vertically almost all political responsibilities and the different relevant structures need to run support programmes resulting in both a policymaker and R&I funding agency.

[13] *https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en*
[14] https://ec.europa.eu/research-and-innovation/sites/default/files/rio/report/H2020PSF%2520peer%2520review%2520report%2520Hungary-KI0216982ENNHU.pdf
[15] *https://nkfih.gov.hu/english/national-smart-specialisation-strategy/s3-2021-2027*
[16] *https://nkfih.gov.hu/palyazoknak*

The major role played by NRDIO in Hungary is somehow an exception in comparison with other EU countries. While this can lead benefits in terms of effectiveness and efficiency of R&I governance, it could have also some drawbacks such as a decision-making process defined without a broad consultation of stakeholders.

Policies and incentives

In the following are reported relevant policies and measures related to renewable energies development that have been established by the Hungarian government as an overview of the ground-field that it is actually present in the country to support the clean energy transition.

- ***Hungarian Green Champion Program*** (https://znb.ifka.hu/hu/page/program-leiras)
  Through this programme, the Hungarian Government aims to support the technological developments of the manufacturing sector linked to the low carbon economy. In particular small and medium enterprises are supported, through calls for applications, in investing in energy efficiency, recycling, water management and electromobility.
- ***Economic Development and Innovation Operational Program (GINOP) - supporting green economy of SMEs*** (https://2015-2019.kormany.hu/hu/nemzetgazdasagi-miniszterium/hirek/tobb-mint-hetmilliard-forintra-palyazhatnak-a-zold-cegek)
  With a budget of HUF 7.3 billion (~17 M€) the Hungarian government aims to support SMEs in the COVID-19 crisis by creating jobs and supporting the growth of the Hungarian green economy.
- ***Climate and nature-protection action plan - Tender for purchase of EV and Mopeds*** (https://www.iea.org/policies/11626-climate-and-nature-protection-action-plan-tender-for-purchase-of-ev-and-mopeds)
  Through this programme the government intends to support, through tenders, the purchase electric cars and mopeds.
- ***Climate and Nature Protection Action Plan*** (https://2015-2019.kormany.hu/download/5/07/c1000/Climate%20and%20environmental%20protection%20action%20plan_EN.pdfhttps://www.iea.org/policies/13951-climate-and-nature-protection-action-plan-res-support)

  RES support

  The Hungarian Climate and Nature Protection Action Plan contains measures to support the environmentally friendly technologies and delivers HUF 32 billion (~75 M€) to support SMEs in boosting renewable energy production. Moreover, the partial or full replacement of energy supply with local renewable energies is supported.

  Green Bus Program

  https://humda.hu/portal-valaszto

  The Hungarian government under the Ministry of Technology has launched the Green Bus Program in September 2019, aiming to lead the way in the field of electromobility. The program consists of the purchase of electric buses and self-propelled trolleybuses in cities with a population of more than 25,000. The programme is supported by the government, which will allocate HUF 35.9 billion from 2020 to 2029 and it will provide a maximum 20%-80% subsidy for local governments and public transport companies.
- ***2050 climate neutrality law***
  https://www.europarl.europa.eu/hungary/hu/aktualis/2021-hirek/2021-junius/2050-re-klimasemleges-eu-megvan-az-ep-jovahagyas.HTML
  The Hungarian Parliament has played an important role towards the creation of a stronger

EU climate legislation for a climate-neutral EU by 2050.
In fact, the 2050 climate neutrality law has been set by the Hungarian parliament in June 2020 and includes phasing out of lignite fired generation after 2025 and the rapid expansion of solar and gas fired capacity, with a focus on power-to-gas technologies and the establishment of energy communities. The goal is to reach at least 21% of renewable energy sources' share in the gross final energy consumption by 2030.
The Law no. XLIV 2020 on Climate Protection includes the reduction of GHG emissions by at least 40% by 2030.

- ***Renewable Energy Support Scheme (METAR) – 2021*** *http://mekh.hu/julius-elsejen-nyilik-a-metar-tender-benyujtasi-szakasza*
  A third METÁR tender towards the support of electricity production, using renewable energy sources, has been announced by the Hungarian Energy and Utilities Regulatory Authority. Established since 2019 the fund is part of efforts to create a more stable investment environment and to adhere to EU regulations with regards to higher capacity renewable energies plants. It is reported that auctions brought 72 successful renewable projects in the year 2020, all based on solar PV, except one dealing with waste to energy. The maximum capacity of power plants supported in these auctions could not exceed 20 MW, and a total of 193 GWh has been sourced via METÁR.
- ***Regulation for the installation of 1 million smart meters in the electricity sector*** *https://zoldbusz.hu/files/NE2030.pdf*
  To ensure optimal scheduling of meters to the most useful locations is necessary to involve distribution licensees in the installation of the oscillators, providing flexible service package to smart metered customers.
- ***Climate and Nature Protection Action Plan - E-AUTO – 2021*** *https://elektromobilitas.ifka.hu*
  The programme is supported by the Ministry of Innovation and Technology and aims to promote electromobility in Hungary in order to make road traffic cleaner. The programme delivers three types of support (provided with a grant form): for companies and individuals, for non-governmental organizations, associations and higher education institutions and for taxi and car passenger transport services.
- ***EU Funded Lignite generation decarbonization project*** *https://ec.europa.eu/energy/sites/ener/files/documents/transforming_the_lignite-fired_matra_power_-_platform_for_coal_regions_in_transition.pdf*
  The Matra Power Plant, part of the LIFE Environment and Climate Action program, is an example of renewable energy utilisation in Hungary. The goal is to decarbonize the plant by 2030 through a mix of renewable energy, reducing Hungary's greenhouse gas emissions by 14%. The funding of this program, announced by the European Commission, consist of €121 million.
- ***National Hydrogen Strategy (NHS)*** *https://cdn.kormany.hu/uploads/document/a/a2/a2b/a2b2b7ed5179b17694659b8f050ba9648e75a0bf.pdf*
  Hungary's National Hydrogen Strategy has developed the pathway for the integration of low-carbon hydrogen in the economy by the 2030. The strategy is structured in 7 elements to support the foreseen objectives aimed to create a stimulating operational environment, promoting partnership and international collaboration. Another objective is related to usage of RD&I and education to promote the success of hydrogen during the transition and demonstrating its the legitimacy on the domestic market.

Croatia

Main institutions in charge of energy policy

In the following are reported the main institution and entities in charge of developing R&I policies and financing R&I activities within the energy field in Croatia.

Table 14: Main institutions and entities in charge of developing R&I policies in Croatia

REPUBLIKA HRVATSKA Ministarstvo gospodarstva i održivog razvoja Ministry of Economy and Sustainable Development www.mingor.gov.hr	The Ministry of Economy and Sustainable Development takes strategic directions, develops sustainable development programs and plans based on the principle of green and circular economy. Just and prosperous society with a resource-efficient and competitive economy, ensuring climate neutrality, conservation and sustainable use of natural goods are the main drivers of the developed strategies
REPUBLIKA HRVATSKA Ministarstvo prostornoga uređenja, graditeljstva i državne imovine Ministry of Spatial Planning, Construction and State Property www.mpgi.gov.hr	The Ministry oversees the area related to real estate valuation, determination of conditions for design and construction of edifices, energy efficiency in buildings and other related matters
CEI Center for Monitoring Business Activities in the Energy Sector and Investments Center for Monitoring Business Activities in the Energy Sector and Investments (CEI) www.cei.hr	CEI was established with the objective of finding solutions for improving the financial effectiveness of companies in the energy sector in which the state has shares or holds stock
FOND ZA ZAŠTITU OKOLIŠA I ENERGETSKU UČINKOVITOST Environmental and Energy Efficiency Fund (FZOEU) www.fzoeu.hr	The Environmental and Energy Efficiency Fund is the central place of collection and investment outside the budget in environmental and nature protection programs and projects, energy efficiency and the use of renewable energy sources.

Energy Institute of Croats Fire, EIHP www.eihp.hr	The main areas of activity of the institute include strategic planning in energy, development of electricity, gas, oil and heat systems, activities related to the market, and legislative framework and restructuring of the energy sector.
Croatian Energy Regulatory Agency (HERA) www.hera.hr	The Croatian energy regulatory agency is established by the law as a regulatory body in the energy field. HERA is an independent and a non-profit legal entity with public powers to regulate energy activities. HERA responds to the Croatian Parliament for its work.

Regional energy agencies

In Croatia there are 5 regional energy agencies. Their role is to promote and foster regional sustainable development in the field of energy and environmental protection by fostering the uptake of Renewable Energy Sources (RES) and by the introduction of measures to increase energy efficiency. Local aspects are especially tackled by the agencies that develop local energy efficiency programs and action plans according to the national energy efficiency action plan.

Table 15: Energy agencies in Croatia

Istrian Regional Energy Agency www.irena-istra.hr	IRENA was founded in 2009 as an independent non-profit organization, providing advisory services in form of information, help in raising awareness and training to local decision makers on energy issues in the public and private sectors considering also households and citizens.
Medjimurje Energy Agency www.menea.hr	Medjimurje Energy Agency (MENEA) is a regional energy agency established in 2008. MENEA has the main goal of promoting the idea of sustainable development in accordance with actual needs in the area of the County of Medjimurje while focusing on enhancement of the use of Renewable Energy Sources and Energy Efficiency.
Regional Energy Agency Kvarner www.managenergy.eu	Regional Energy Agency Kvarner (REA Kvarner) was established in 2009 as a non-profit public owned company with the task of establishing a single institutionalized framework for a more rational use of existing energy resources, and encouraging the energy production from renewable and alternative sources in the County.
Regional Energy Agency North	Regional Energy Agency North (REA North) is a public non - profit institution founded in 2009 operating mostly in the area of northern Croatia. REA North is partner in local and regional self-government units, public sector institutions, small and medium-sized enterprises, citizens and other stakeholders to whom it provides expert support in the implementation of ambitious sustainable

www.rea-sjever.hr	development plans
North-west Croatia Regional Energy Agency www.regea.org	REGEA is a regional energy agency and a recognized center of knowledge and excellence with references and projects throughout the European Union

Legislative framework

In January 2016 camo into force the Act on Renewable Energy Sources and Highly Effective Cogeneration[17] approved by the Croatian parliament in September 2015. The act regulates and fosters the production of electricity from plants that use renewable energy sources and highly efficient cogeneration determining incentive measures, regulating the construction of new plants and regulating the register of RES and co-generator plants to a national register. The Act also regulates the sale of surplus of self-generated energy. It sets out conditions which collective prosumers must fulfil to be able to obtain remuneration for the sale of surplus electricity.

The main purpose of the Act is to promote the production of electricity from RES and highly efficient cogeneration by incentive mechanisms and by setting a clear regulatory framework. Through this law Croatia adopts also different EC directives. The new incentive system introduced by the act is directed to RES and highly effective cogeneration facilities and features a market premium and a guaranteed purchase price for their surplus energy that these plants are able to deliver to the grid.

It has been reported that[18] one of the causes of the slow development of RES in the last years was a shortage of funds for financing the incentives. However, countermeasures have been taken and the RES has deployment is increasing. The Croatian Energy Market Operator (HROTE) oversees setting up auctions for premiums and feed-in tariffs for small-scale renewables projects. The first call for premiums and for guaranteed purchase prices (feed-in tariffs) has been issue on January 13th 2021[19].

Relevance to R&D activities

The Act defines a demonstration project (in the field covered by the Act) as a non-commercial project by which a technology is demonstrated as the first of its kind in the European Union and represents a significant innovation that greatly exceeds the "peak of technology". The demonstration has also to aim to prove the sustainability and commercial potential of a new solution. Moreover, it is foreseen that demonstration projects may exercise the right to encourage in state aid schemes for research and development and state aid programs for innovation.

The Environmental Protection and Energy Efficiency Fun

The Environmental Protection and Energy Efficiency Fund (EPEEF) of the Republic of Croatia has an important role in financing innovation in the energy sector. It is a structured extra-budgetary fund which finances the preparation, implementation and development of programmes, projects and similar activities:

[17] https://narodne-novine.nn.hr/clanci/sluzbeni/2015_09_100_1937.html
[18] https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/croatia
[19] https://balkangreenenergynews.com/croatia-grants-renewables-incentives-for-25-5-mw-in-first-ever-auction/

- environmental protection
- energy efficiency
- use of renewable energy sources

EPEEF represents one of the main examples of green economy policies in Croatia and it is based on 'polluter pays principle' which is regulated by Environmental Protection Act: the polluters actually bear the costs of the necessary measures and costs of removing the damage to the environment, the costs of environmental monitoring, and the costs of undertaking measures for preventing environmental pollution.

Status of RES in Croatia

In the following image it is reported the electric RES energy production of Croatia from 2005 to 2019. We can see that hydropower plants have always been an important source of renewable electricity, while other RES have started to begin significative since approximately 2013. Hydropower energy production is expected to grow in the next years thanks to the retrofitting of existing plants.

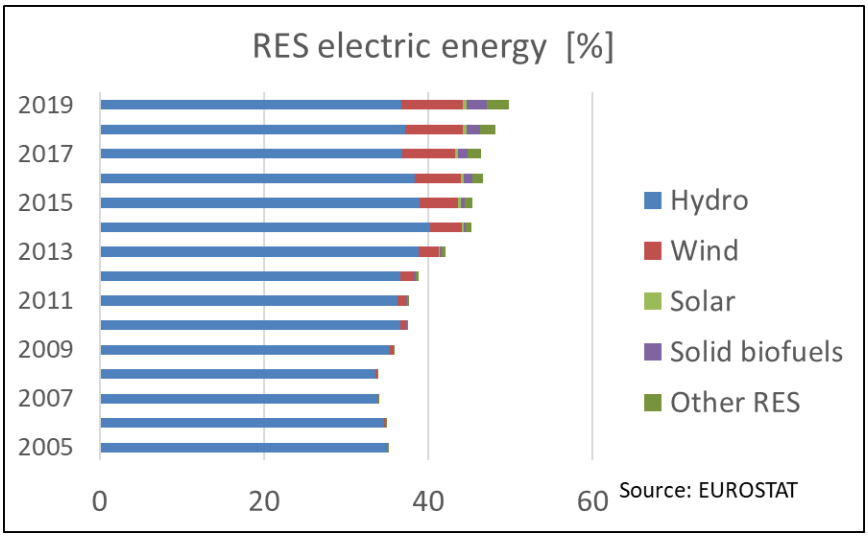


Figure 12: RES in electricity in Croatia

In the following graph it is reported the overall Croatian electric energy mix of the year 2019, as we can see a relevant amount is covered by import follower by hydropower.

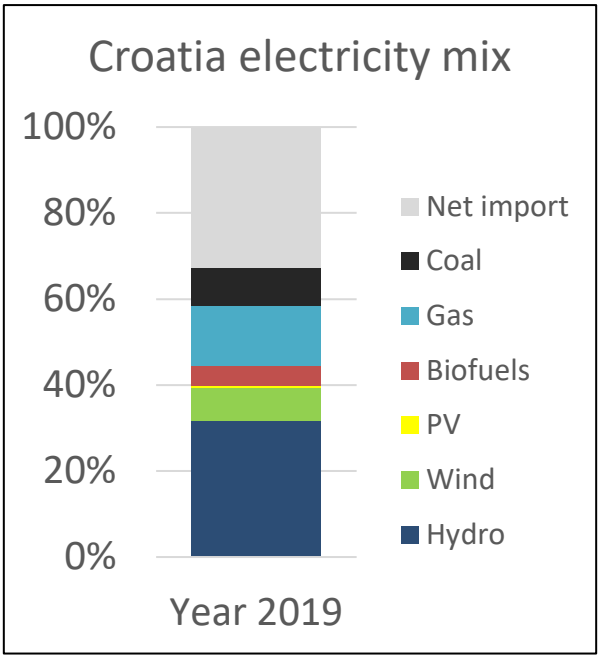


Figure 13: Energy mix in Croatia

H2020 projects in Croatia

H2020 Thematic priority

Secure, clean and efficient energy

Projects with at least one Croatian partner

Reference city	#	Toatal EU funding (k€)
Zagreb	122	18.229
Rijeka	9	1.526
Koprivnica	3	386
Split	2	191
Krk	2	111
Topusko	1	1.204
Cres	1	188
Labin	1	139
Pula	1	128
Cakovec	1	123
Osijek	1	74
Solin	1	50
VelikaGorica	1	40
PorecParenzo	1	37
Pazin	1	20
Krizevci	1	18

Figure 14: Participation of organisation from Croatia in H2020 projects under secure, clean and efficient energy dimension

- Croatia received ~ 0,19 % of H2020 UE contribution
- Croatia has the ~ 0,90 % of EU-27 population (2019)
- Croatia accounts for ~ 0,39 % of EU-27 GDP (2019)

Policies and incentives

In the following are reported relevant policies and measures related to renewable energies development that have been established by the Hungarian government as an overview of the ground-field that it is actually present in the country to support the clean energy transition.

- ***EU Cohesion policy: Energy-efficiency heating system***
  https://ec.europa.eu/info/news/eu-cohesion-policy-over-eu55-million-more-reliable-and-energy-efficient-heating-system-croatia-2021-jan-25_en
  An investment worth over €55 million from the European Regional Development Fund, as part of the EU's strategy for the infrastructure/territorial cohesion, has been approved by the European Commission, aiming to replace more than 68 km of Zagreb's heating pipes with more efficient and reliable networks.
- ***National Recovery and Resilience Plan*** https://planoporavka.gov.hr/o-planu/9
  Croatia's Resilience and Recovery Plan (RRP) aims to achieve a sustainable growth and to strengthen the cohesion of Croatia, increasing economic productivity and creating new jobs. The plan, which is organized into five components and an initiative, has been approved by

the European Commission and allocated to climate objectives above the EU's 37% minimum target. The funds are almost HRK 75 bn (EUR 9.9 bn), of which HRK 47.5 bn (EUR 6.3 bn) are grants and HRK 27.5 bn (EUR 3.6 bn) are loans.

- ***National Recovery and Resilience Plan / 1. Economy – 2021***
  https://ec.europa.eu/info/sites/default/files/recovery_and_resilience_plan_for_croatia_hr.pdf
  Croatia's Recovery and Resilience Plan is committed to provide HRK 25.7 bn to address and improve the resilience of the economy against future shocks. It is composed of six parts regarding resilient, green and digital economy; energy transition for a sustainable economy; water management and waste management; development of a competitive, sustainable and efficient transport system; the use of natural resources and strengthening the food supply chain; development of sustainable, innovative and sustainable tourism. A significant part (40%) of the budget/funds supports climate objectives.
- ***National Recovery and Resilience Plan / 1. Economy / 2. Energy transition for a sustainable economy***
  https://ec.europa.eu/info/sites/default/files/recovery_and_resilience_plan_for_croatia_hr.pdf
  The second point of the economy component from Croatia's Recovery and Resilience Plan focuses on the decarbonization of the energy sector, fostering the energy transition. The plan will be funded upon the Commission's endorsement of Croatia RRF plan with a budget of €658.3 million.
  The measures include the encouraging towards the use of renewable energies, the support to infrastructures and the modernization of energy systems, the development of hydrogen and new technologies, the investment in biorefineries for the production of biofuels.
- ***National Recovery and Resilience Plan / 1. Economy/ 4. Development of a competitive, energy sustainable and efficient transport system – 2021***
  https://ec.europa.eu/info/sites/default/files/recovery_and_resilience_plan_for_croatia_hr.pdf
  The 4th part of Croatia's Recovery and Resilience Plan is fully dedicated to the transport sector, in particular, the ways of making it competitive, sustainable and efficient. It includes several pathways from the application of green technologies in railway passenger transport and procuring alternative propulsion vehicles for public urban and suburban traffic to the R&D and production of new vehicles and supporting infrastructure and a new vehicle co-financing program on the development of alternative fuels and supporting infrastructure in road transport. The EU Commission aims to finance around 728.7 million EUR.
- ***National Recovery and Resilience Plan / 6. Initiative: Renovation of buildings***
  https://planoporavka.gov.hr/o-planu/inicijativa-obnova-zgrada/111
  This 6th part of the RRP aims to renew the buildings after the recent earthquake, through some actions, including renovating buildings (culturally significant buildings and buildings damaged by the earthquake) in an energy efficient way, developing a new financing model and implementing systematic energy management. The European Commission provided a total budget of 292.0 million EUR for this initiative.
- ***Tax reduction / exemption - CO2 based tax***
  https://alternative-fuels-observatory.ec.europa.eu/
  The European commission has adopted the Green Deal, setting out the goal of reducing by 90% transport emissions (compared to 1990 levels). This transition from the use of fossil fuels for mobility to the use of alternative fuels needs to be accelerated. The Commission has installed the European Alternative Fuels Observatory – EAFO in order to create a key information support tool for the implementation process.
- **Act on Renewable Energy Sources and High-efficiency Cogeneration**
  The Croatian parliament has approved the Law on renewable energy sources and high

efficiency cogeneration, aiming to efficiently use the energy and reducing the impact of fossil fuels on the environment. This law supports the development of innovative technologies, contributing positively to local community. Moreover, it introduces a support scheme for RES-electricity producers.

Italy

Here are summarized some information about the main institutions in charge of defining the Italian energy policies, incentives schemes that are in place to support the clean energy evolution.

Main institutions in charge of energy policy

In the following are briefly mentioned the main institution of Italian energy policies. The panorama of the clean energy evolution is complex and growing steadily. This chapter is not meant to be exhaustive, but it reports the three main actors.

The Ministry for the Ecological Transition (MITE)

The main body in charge of the Italian policies concerning the transition towards a more sustainable economy is the Ministry for the Ecological Transition (MITE)[20]. Recently established by merging the former Ministry of the Environment and Land and Sea Protection with the responsibilities on energy and related matters (in the past part of the Ministry for the Economic Development), the new ministry if in the front line for defining and actuating decarbonisation policies. MITE is in charge of managing a relevant amount of the Italian recovery plan established at EU level to support the EU economy to recover from the COVID-19 pandemic and to increase the EU competitiveness. More in details the Italian plan consist of 6 main missions, 3 of which (covering 40% of total the total budget) are related to fight climate changing. It's in particular Mission 2 "Green energy revolution and ecological transition" with a budget of 59,47 billion of euro are focused the main actions to support the clean evolution of national energy systems. However, as can be seen from the mission names, also Mission 1 and Mission 3 are devoted to topics such as digitalisation and sustainable mobility very much relevant for a real green energy transition.

Figure 15: Missions of the Italian recovery and residence plan

The "Energy Services Manager" (Gestore dei Servizi Energetici – GSE)[21]

The public owned entity "Gestore dei Servizi Energetici – GSE" has been identified by the State to pursue and achieve environmental sustainability through the two pillars of renewable sources and energy efficiency. GSE's work is based on contributing in shaping a more sustainable future for the current and new generations. More in details, GSE in charge, basing of the law, of managing a relevant set of incentives to support the clean energy transition concerning the electro-energetic

[20] www.mite.gov.it
[21] www.gse.it

sector and to foster the modernization of industrial processes. More details about some of the most relevant incentives are reported in the following section.

Italian Regulatory Authority for Energy, Networks and Environment - ARERA

The Italian Regulatory Authority for Energy, Networks and Environment (ARERA) carries out regulatory and supervisory activities in the sectors of electricity, natural gas, water services, waste cycle and district heating. ARERA is an independent administrative authority that operates to ensure the promotion of competition and efficiency in public utility services and protect the interests of users and consumers. These functions are performed by balancing operators' economic and financial objectives with general social objectives, for environmental protection and the efficient use of resources. It also provides advisory services to the Government and the Parliament in matters within its competence, also for the purposes of defining, transposing and implementing EU legislation.

Main incentives and approaches

We report in the following the some of the main measures that are in place to support the Italian clean energy transition.

Energy efficiency related incentives[22]:

- **Energy Efficiency Certificates (White certificates)**[23]
  White certificates, also known as “Energy Efficiency Certificates", give proof of end-use energy savings achieved through projects aimed at increasing energy efficiency in the final uses of energy. The white certificate mechanism, which came into force in 2005, is the main tool for promoting energy efficiency in Italy. White certificates are negotiable securities that certify the achievement of savings in the final uses of energy through interventions and projects to increase energy efficiency. One certificate is equivalent to saving one Ton of Oil Equivalent (TOE). High efficiency co-generator plants (that produces electrical or mechanical energy and heat) could be part of the scheme.
  White certificates cannot be combined with other incentives apart from local (not national level) loans and grants
- **Thermal account**
  The Thermal Account encourages interventions to increase energy efficiency and the production of thermal energy from renewable sources for small plants. The beneficiaries are mainly public administrations, but also companies and individuals, who will be able to access funds for 900 million euros per year, of which 200 for public administrations. Thanks to the Thermal Account it is possible to redevelop your buildings to improve their energy performance, thus reducing consumption costs and quickly recovering part of the costs incurred.
- **Energy requalification program for the central public administration**
  The programme is aimed to requalify of at least 3% per year of the air-conditioned useful covered area of the public building stock. The intervention proposals are eligible for funding according to the order shown in the annual ranking, up to 100% of the expenditure exposed and charged to the proposing Administration, within the limits of the resources available annually and taking into account any co-financing.

The recent developments in the EU legislation has been reflected in the Italian regulatory framework and in particular the following means have been introduced to foster the citizen renewable energy

[22] https://www.gse.it/en/what-we-do/energy-efficiency
[23] www.arera.it

self-consumption[24]

- **Groups of self-consumers and renewable energy communities**
  Final consumers of electricity can group to produce (through renewable sources) and share locally the electricity necessary for their needs. This is thanks to the recently (2020) entry into of a legislative decree and of the related implementing regulation.
  The "shared" electricity (equal to the minimum, on an hourly basis, between the electricity injected into the grid by the production plants and the electricity taken from the consumers who are relevant for the configuration) benefits from an economic contribution following the access to the enhancement and incentive service (different incentive schemes are possible). There are two types of configuration allowed:
  - **Groups of renewable energy self-consumers acting collectively**

  A group of self-consumers represents a set of at least two self-consumers of renewable energy who act collectively under a private agreement and who are located in the same condominium or building. By self-consumer of renewable energy we mean an end customer who, operating in its own sites located within defined borders, produces renewable electricity for its own consumption and can store or sell self-produced renewable electricity provided that, for a renewable energy self-consumer other than households, these activities do not constitute the main commercial or professional activity. The renewable energy self-consumer production plant can be owned by a third party and / or managed by a third party, as long as the third party remains subject to the instructions of the renewable energy consumer.
  - **Renewable energy community**

  A renewable energy community is a legal entity that:
  A. is based on open and voluntary participation, is self-contained and is effectively controlled by shareholders or members who are located in the vicinity of production facilities owned by the renewable energy community;
  B. whose shareholders or members are natural persons, small and medium-sized enterprises (SMEs), territorial bodies or local authorities, including municipal administrations, provided that, for private companies, participation in the renewable energy community does not constitute commercial activity and / or main industrial;
  C. whose primary objective is to provide community-wide environmental, economic or social benefits to its shareholders or members or to the local areas in which it operates, rather than financial profits.
- **Simple production and consumption systems**
  The simple production and consumption systems are electrical systems connected to the public network, characterized by the presence of at least one electricity production plant and a consumption unit (consisting of one or more real estate units) directly connected to each other, within which the transport of electricity is not configured as a transmission and / or distribution activity, but as an energy self-supply activity. This is thanks to the presence of a single final customer and a single producer, in the case represented by corporate groups or cooperatives or consortia or historical ones. The SSPCs are divided into two groups: the historic consortia and cooperatives with their own network and the other simple production and consumption systems.

Analysis and recommendations

We would like to draw some recommendation for the desk 5 countries to support them in boosting R&D EU level activities. Based especially on the discussion that took place during

[24] https://www.gse.it/servizi-per-te/autoconsumo

the workshop organised in Hungary, Croatia and Italy we found that the following recommendations could support the analysis of what actions could be taken in view of increasing the presence of national stakeholders coming from these countries, at EU level R&D project related activities.

The first concluding, recommendation was to encourage a deeper involvement in the SET Plan and in particular in its Implementing Working Groups[25] (IWG). Italy is well involved in the SET Plan, while Hungary and Croatia very much less. In fact, while Italy is participating in all the fourteen IWG and coordinating four of them (namely deep geothermal, ocean energy, energy systems, renewable fuels and bioenergy), Croatia is only participating in the IWGs batteries and nuclear safety. Hungary joined the IWGs batteries, CCU-CCS, nuclear safety and the recently launched IWG on high voltage direct current (HVDC) & direct current (DC) technologies. We believe that participating in the SET Plan IWG is important to both align the domestic research agendas to the EU priorities and also to influence the European research agenda towards research activities that are important for the country. This mutual influence is relevant to build a truly integrated R&D field all over Europe. In fact, the IWGs oversee monitoring and reporting to the SET Plan managing bodies about targets and R&I activities carried out at national and European levels. More in detail, the activities, and targets, published in the working groups' implementation plans, are identified in cooperation with national governments and stakeholders (industry and research bodies). These implementation plans represent the reference document of the SET Plan in each field and ensure that it is aligned with the key industrial development.

Besides the direct participation in the Set Plan IWGs, the meetings concluded in recommending to national stakeholders to be also actively engaged in the European Technology and Innovation Platforms[26] (ETIPs), in particular in the working groups of the ETIP SNET that is dealing with the innovation of the entire energy system. As reported in other deliverables the PANTERA project has strong links with the ETIP SNET and could support the national stakeholders in being actively involved.

In addition to the above, through the IWGs funding initiatives are developed that are specifically supporting the SET Plan implementation. As an example stakeholders were exposed to the European Research Area Networks (ERA-NETs) being anb instrument allowing Member States to support the SET Plan with increased funding for transnational research and R&I Framework Programmes. Following the establishment of Horizon Europe, the ERA-NET Cofund and the European Joint Programme (EJP) Cofund under Horizon 2020 have been replaced by the Co-funded European Partnerships. Considering the energy system, the most relevant field for the PANTERA activities, desk 5 countries (Hungary, Croatia and Italy) are all participating in the CETPartnership (that takes origin from ERA-NET Smart Energy System in which they were involved too). We stressed this need to desk 5 countries stakeholders to consider the possibilities offered by this funding scheme, aimed to support R&D activities with a regional connotation.

Stressing this approach, a lot of effort was exercised by the partners of the PANTERA project, to encourage all stakeholders collaborating with the PANTERA consortium, to look for and participate in the different initiatives aimed to foster the building of a true European R&D field. In fact, during the workshops that were organised, it was highlighted that lack of international cooperation and knowledge sharing play a crucial role in hindering R&D activities and wider participation in EU related projects. The PANTERA consortium, with its activities will strongly

[25] https://setis.ec.europa.eu/implementing-actions_en
[26] https://smart-networks-energy-transition.ec.europa.eu

support all these till the end of the project directly, and indirectly beyond the Summer of 2023, thanks to the established EIRIE platform and the activities planned through it.

3.11 Desk 6 case study Ireland: Identifying Country Specific Barriers and Solutions through Case Studies: Ireland – a Focus on Data Issues

Introduction

The University College Dublin Energy Institute and the International Energy Research Centre are members of the H2020 PANTERA Coordination and Support Action. PANTERA aims to foster research and innovation in smart grids in countries that have below the EU average spending in that area. PANTERA aims to achieve this through regional workshops with relevant stakeholders, and the provision of information and data on an IT platform.

Digitalisation is one of the key components of the future clean energy system in the implementation of any Smart Grid. Hence measuring, monitoring, managing, and analysing big data in decision making, control and management of smart grid operation are vital. The resulting data needs to be managed in compliance with the European regulations on General Data Protection to protect the privacy of the individual, and to ensure commercial sensitivities and the grid infrastructure are maintained securely. However, sharing data is equally important to help fast track research through to implementation and business as usual. Digitalisation enables new services for Integrated Energy Systems. Digitalisation is noted as one of the required functionalities of the future integrated energy system and is listed as F6 Digitalisation Integrating digitalisation services (including data privacy, cyber security) in [55].

Figure 1 shows the ETIP SNET smart grid layers. Data is generated by the physical components of the system and measured by a variety of field devices, sensors, such as Advanced Metering Infrastructure (AMI) - smart meters, power management units (PMUs), supervisory control and data acquisition (SCADA) systems, and frequency disturbance recorders (FDRs). The data include customer usage data and various power quality data that are needed to control and operate the grid securely. These data are also used to manage the business/market interactions in various management systems ranging from customer relationship management to customer billing and credit control; to outage management systems, wide-area monitoring systems (WAMS), and control systems on the grid.

The data may be processed at the Digital Infrastructure layer to reduce the volume of data and ensure appropriate access is provided via the Communications layer. Thus, ensuring privacy, cyber security and regulatory compliance. The communication layer integrates the complete power network while partitioning the data in compliance with regulatory and market requirements. The data can be classed as “Big Data” given its volume, variety, velocity, and potential value.

This data offers potential value and many opportunities to support the clean energy transition. However, there are significant challenges including interoperability and data standards, protecting the privacy of natural persons, cyber security of the system, and concerns about who benefits when unlocking the data value chain – monetising the data is seen as an opportunity for Smart Grid actors who may be reluctant to share access to data either for fear of violating GDPR requirements, or potentially giving access to a valuable revenue source and forsaking Intellectual Property.

Significant works have been carried out on Smart Grid data interoperability and standards [56], As

noted in [57] “standardisation would identify minimum performance standards for the digital equipment involved and provide rules for how these components interact and share information, thus eliminating differences that inhibit the flow of information and data. Currently, there is insufficient standardisation to achieve a decarbonised energy system, lacking in the interoperability of technologies. With a range of technologies and systems being developed throughout Europe, the lack of standardisation means that there is an issue with compatibility.”
The role of big data in smart grids is explored in [58, 59].

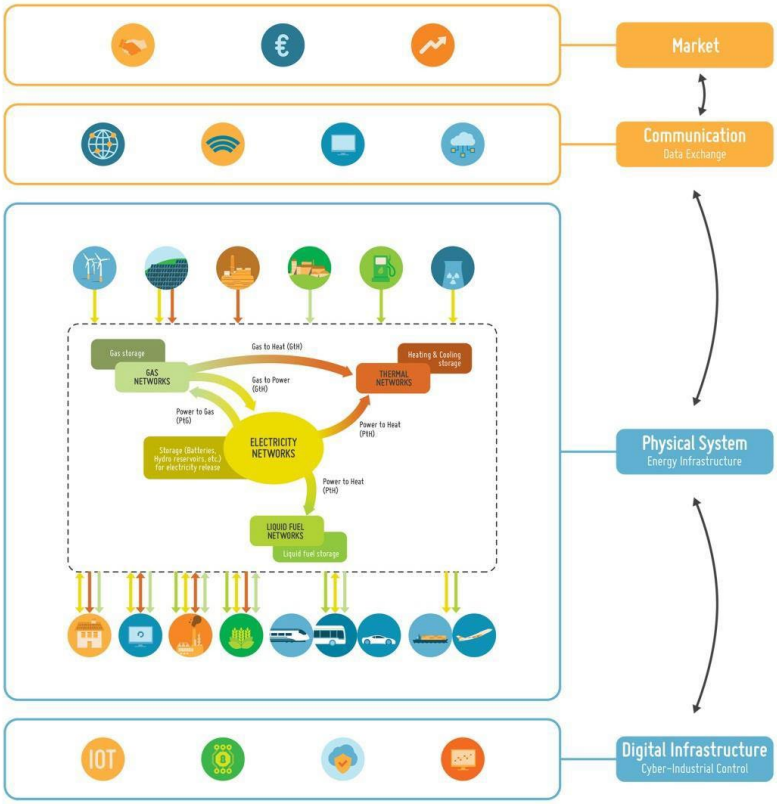


Figure 16: EU ETIPSNET smart grid layers

Figure 17 shows the Gartner Analytics Ascendency model. Different types of business and data analytics are used to extract different levels of business understanding and insight depending on the analytics approach. Simple traditional descriptive statistics and analytics can be applied to “In-House” Enterprise Resource Planning data to conduct “rear-view” assessments of what happened. The analytics ascendancy model applies equally to Smart Grid data and modelling approaches.

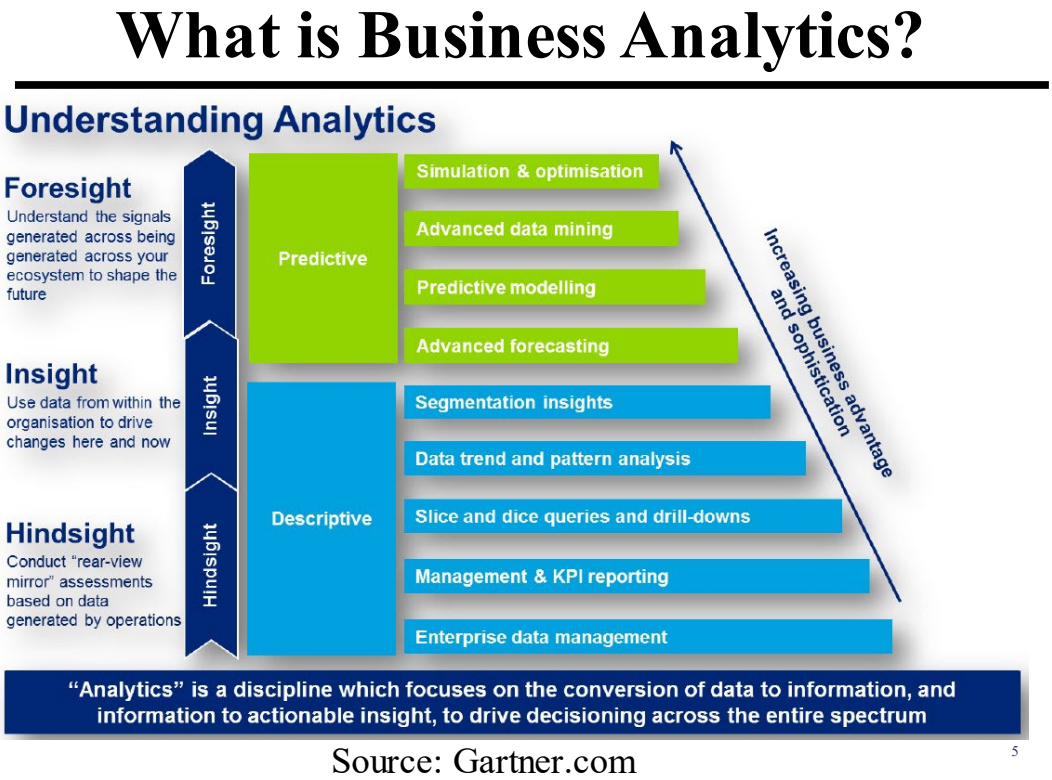


Figure 17: Gartner's Analytics Ascendency Model

Aims

This paper outlines two case studies of data-centric smart grid research projects in Ireland. Low carbon technologies and their placement in distribution networks offer potential solutions to decarbonisation. The consumer is at the heart of the energy transition and thus their active participation in all spaces of energy from generation, consumption, energy sharing, participation in energy markets are also changing the flow of energy from uni to multi-directional. Hence, these adoptions will have a significant impact on the operation and management of the grid, particularly in the low voltage distribution network. This case study aims to highlight the challenges, costs and importance of high-quality data to achieve energy transition targets. With a focus on Ireland (similar case can be found in other countries), we aim to explore the role of data, and the move to open data in smart grid research, particularly research funded by the Sustainable Energy Authority of Ireland under its National Energy Research Development and Demonstration (RD&D) Funding Programme. We summarise the data policy and demonstrate the case by examples arising in the electrification of the heating sector and the adoption of heat pumps, and participation of active consumers/prosumers in the energy trading mechanism by designing the local energy market models.

Method

This paper uses a case study approach to highlight the role of data as a critical topic linked to increasing national R&I activity in smart grids.

Focusing on a case study in the heating sector where Ireland has a target to have 600,000 heat pumps installed by 2030, starting from a base of 44,000 installed [60], we describe the data

requirements of the smart grid research project, the challenges of field trials, and the solution approach. Another case study example is from an ongoing project, “Blockchain-based electricity trading for the integration of National and Decentralized local markets (BEYOND)”. The availability of smart meter and network data play a significant role in the successful outcome of the project.
An analysis of the national funding landscape shows the sources of smart grid R&I [61]. The Sustainable Energy Authority of Ireland (SEAI) funds research and innovation through their RD&D programme. Each call specifies an open strand for applicants to propose projects within SEAI’s legal remit, and a topic strand for applicants to submit proposals that address the requirements of specified project topics. The heat pump case study was funded under the SEAI RDD programme: RDD2018 led by Principal Investigator Paula Carroll with the DSO in Ireland (ESBN) acting as a stakeholder under the topic strand. This project is “Exploration of Air Source Heat Pumps for Ireland’s Residential Heating Needs”. (BEYOND)” is led by Principal Investigator Shafi Khadem and is funded by SEAI under the ERA-NET SES 2018 programme (Project no: 19/RDD/578).

Results: Smart Grid Data - Ireland

A PANTERA Regional workshop was held in UCD, Dublin in December 2019. Attended by representatives from industry national funding agency Enterprise Ireland, and academia. Interviews were conducted with representatives from the DSO, TSO, new entrants and academia. Open discussion with all participants was also used to identify key challenges for smart grid research and innovation.
Access to data emerged as a significant challenge. Speakers noted that lags in data sharing will impact the timeliness of decarbonisation and highlighted that there are opportunities for new services in the electrification of transport and heating. New entrants emphasised the importance of extracting value from existing assets in the system through smart efficient usage which can be leveraged through data analysis.

Speakers noted that historically focus for energy innovation was on the TSO, but with the emergence of the smart grid, more emphasis are being placed on the DSO to facilitate innovation. Much of this innovation will require interaction with end-user consumers and will have to address the social challenges of decarbonisation. The challenges for the low voltage network to achieve the Climate Action Plan of 840,000 electric vehicles and 600,000 Heat Pumps [62] will require enhancement of the LV network. Monitoring and controlling small-scale renewables and low carbon technologies will be the most critical challenge within the next 5-10 years. Along with these, consumer awareness and their active participation, acceptance in implementing smart meters and sharing the anonymous data (maintaining GDPR issues) are needed. Missing these issues will create a serious threat to secure grid operation and a problem for the grid with a high share of renewable. This issue is closely interrelated with the observability and controllability of the grid, especially at lower voltage levels. In addition, it also raises the necessity of improved utilisation of the potential for the existing distribution and transmission assets instead of the traditional focus on the expansion of the grid.

The challenges of the Smart Grid Research Data workshop were further explored in an online webinar in February 2021. Participants explored how to share research data, ensure GDPR compliance, reduce the risk of divulging potential innovation insights, and related issues. The webinar focused on how different stakeholders such as governments, industry and local energy communities can share and organise their data respecting the privacy of users and citizens. The discussion touched on who owns smart meter data, and how it can be accessed by researchers. An example of weather data was addressed noting that in a decentralised data structure, Distributed

Ledger Technology (DLT) for example, there is no such thing as ownership of data, but there are agreements for data sharing.

Weather data is available from weather data API service providers and is chargeable. Such services are used in Germany in smart grid development works. On whether Irish authorities are going to license these types of services, speakers noted that there are public and private players in the provision of weather data. The Irish open gov initiative offers access to free data under the cc by 4 licences [63]. Commercial providers will have commercial agreements and sometimes non-commercial agreements for university researchers.

SEAI webinar speaker Jim Scheer described a project that accessed and assessed electricity and gas billing data to evaluate a home retrofit scheme. He noted that the data was acquired prior to the current GDPR regime, but that it was used to extract insights and create an evidence base for further policy design. He noted that researchers are providing insight to the government through their research and during consultation processes, and this informs future policies and standards. The latest finding call stipulates open data deliverables

The recent specification of the SEAI National Energy RD&D Funding Programme in 2021 specifies open data requirements. The 2021 call states "Impact – Data Management and Open Access Strategy: Project teams are encouraged to work with open access tools and to make project outputs/models/assumptions available to interested stakeholders to facilitate follow-on studies and reduce duplication of research. Projects should aim to follow the FAIR principles, making research data findable, accessible, interoperable and re-usable[27]". For specific topics the data requirements are more specific. For example, "Topic 13 Indoor air quality, ventilation and occupant comfort in non-domestic buildings pre and post deep energy renovations" specifies that "The research project outcomes should include the following, among others: Anonymised and GDPR-compliant datasets of monitored data for online publication". The SEAI RD&D calls prior to 2021 specified open access data requirements for some specific projects, but not a high-level open-access requirement for all submissions. This is an example where the funding requirements will lead the way to the availability of open data for smart grid researchers.

Case Study 1: Exploration of Air Source Heat Pumps

This project aimed to review the status of the research literature on the use of air source heat pumps (ASHPs) and their operation in temperate climates like Ireland. We identified a gap in the research literature on the efficient operation of ASHPs in the field with little publicly available empirical data to assess the operation of ASHPs in situ. We conducted a systematic literature review to create a taxonomy of the available ASHP literature, data and models [64]. We intended to conduct a field study of ASHPs in use in the residential sector to gather ASHP operational data. We planned to use the empirical data to assess any gap between the observed data and that suggested by the manufacturers' technical operating sheets and create statistical models to explain this gap. We summarised the study outputs in academic papers and a final report with recommendations on installation and user operation guidelines.

We encountered challenges such as the cost of research-grade rather than billing grade electricity

[27] https://www.seai.ie/grants/research-funding/research-development-and-demonstration-fund/SEAI-RDD-Call-Document.pdf

monitoring equipment. ESBN identified another research performing organisation working on related projects. We were able to successfully collaborate and leverage additional value from the Superhomes field trial which had been conducted by the Limerick Institute of Technology [65]. The combination of electricity and heat data from the Superhomes field trial and publicly available weather data from the meteorological service in Ireland allowed us to estimate the Coefficient of Performance, Seasonal Performance Facto, and Heating Season Performance Factor [66, 67].

Case Study 2: Beyond

This project aims to design different local-to-regional electricity markets that will be studied to propose and define country-specific alternatives that are in line with the requirements and scenarios. A secure, automatized and decentralized local electricity market (LEM) model will be designed and tested for three countries (Austria, Ireland and Norway) based on smart contracts and blockchain technologies. The project will further analyze the impact of these designs as well as elaborate on new ideas and commercialization. The project will also provide regulatory and policy recommendations for the implementation of local-to-regional markets.

In the Irish part, the team is working to (i) analyze different local energy market designs for the Dingle community to benefit the local actors, (ii) Identify the route from local to regional/national market, (iii) Identify the best possible solution considering the Irish Grid Code, regulations, etc. (iv) Identify the barriers and recommend the possible changes needed to implement the best market design solutions.

Two use cases (UCs) will be demonstrated in a real-time simulation environment: (i) LEM aimed at local balancing – maximize local consumption of locally generated electricity, (ii) LEM interacting with the wholesale market – demonstrate the market participation mechanisms for buying or selling of deficit/surplus energy of local energy community in the wholesale market.

Existing research and demonstration works suggest that apart from the empowerment of con/prosumers with more active participation, LEM also comes up with multi-benefits, e.g. efficient utilisation of DERs, local consumption of locally generated green electricity, economic savings etc [68]. However, trading electricity is mainly transported through the physical electrical networks, and therefore requires to respect network constraints, such as reliability and voltage levels, frequency balancing, congestion management etc. Hence, it is very important to investigate the impact of LEM on network operational performance [69]. [70] shows the role of energy storage in self-consumption and collective consumption based LEM model and their impact on the distribution network. All these studies suggest that the successful control, operation and management of LEM high depend on the data availability and most importantly the real-time/time series smart meter data for consumer consumption, self-generation and storage etc as well as network parameters for modelling and analysis of the impact of LEM on the network. The assets that participate in the LEM also vary from location to location and network to network. ESB Networks (Irish DSO) is now establishing a platform to collect all the necessary data for detailed analysis of a network towards the development of the Dingle smart energy community.

Discussion

An issue that quickly became apparent in both case studies was the reliance on authenticated high-quality data to allow the research questions to be answered with high reliability. Research grade

meter equipment can cost in the order of €1,000 – 1,500 per installation and is more difficult to configure given that each installation has its own characteristics. The Communication layer of the ETIP SNET SG architecture is prone to failures as each instance may be only be required for a short-term project. In the case of AMI, the installation processes are standardised hence the smart meter configuration tends to be more reliable, and the data are required for billing purposes albeit at a different accuracy than a research project.

The research data need to be carefully managed to ensure GDPR compliance, and that the data are shared according to the project collaboration agreement. The ASHP data were acceded in two different ways: via 2G wi-fi networks and by collecting data on SD cards. Both options have strengths and weaknesses. The DSO stakeholder strictly complies with all data sharing requirements and maintain high security levels on its IT platforms. Once data sharing agreements are in place, data can be made available to research partners for specific research purposes. In contrast, collecting the data on SD cards offers more control to the research partners but is more time consuming and can be subject to failures of the IT equipment. It is also more intrusive for the home owner. In the case of the ASHP project, significant time was required to collate and prepare the data sets before the analysis and modelling could be implemented.

Similar types of experiences are gaining in the BEYOND project. Data that have been used so far for the analysis were collected previously for another project “StoreNet”. Data collection interval and synchronisation are also very important to get reliable and good quality data.

Recommendations

The UCD Energy Institute and the IERC share common interests in Smart Grid research to facilitate the clean energy transition. There are opportunities for enhanced collaboration through the sharing or pooling of smart grid data. The SEAI RDD open data requirements from 2021 onwards will facilitate further collaboration. Sample data sharing mechanisms could be developed to address this challenge which currently acts as a bottleneck to Smartgrid R&I. The success of future smart grids depends on the availability of high-quality data availability, firstly for research and subsequently for sustainability of the innovation.

There are implications for energy transition policies. PANTERA could contribute by supporting further training for smart grid researchers on data issues. We note the issues raised at the Dublin nano-workshop on IP protection and GDPR. The case studies point to the need to design a data sharing agreement as part of the Grant Agreement, and that meaningful Data Management Plans can help identify suitable open data, and identify a repository for data storage and archiving.

3.12 Desk 6 case study Portugal: How R&I collaboration can be impactful for energy transition goals of the power industry

Introduction

R&D density in the country is way behind the national target. The same holds for the share of RES energy in the total energy mix where industry is expected to play a leading role in integrating properly the distributed resources. This Case Study will try to link the needs of the NECPs with the R&I capital supporting them through the appropriate industrial players to overcome the identified challenges.

The approach will be a collaboration establishment among the following organizations aiming to get funded by local power industries:

- INESC Porto, Portugal
- TUS, Sofia, Bulgaria
- FOSS, UCY, Cyprus

Aims

The case study aims to provide support to researchers of these three countries for pursuing the following:

- Strengthen their network of national cooperation through the collaboration with the industry providing meaningful support
- Find channel of cooperation with other institutes in terms of research collaboration and data sharing around Europe,
- Have access to R&I infrastructure and validation cases through the industry
- Through this case study, we intend as PANTERA to identify good practices and lessons learned on
- Raising funding from industry to do impactful research
- Collaborating with other EU institutes to provide complementary expertise and building links.

Method

The method that will followed consists of the following steps:

- Identify the research needs and endeavours coupled with the NECP plans and the industrial players (bilateral meetings/non-structured interview)
- Identify time plan and way of collaboration
- Connect appropriate institutions (DSOs and Universities) together and discuss the collaboration opportunities and the funding scheme or the support scheme (INESC/UCY/ EAC/EDP/TUS)
- Implementation and development of our proposal.
- In case needed, common proposal preparation under ERIGRID2.0
- Building questionnaire to have feedback and establish a good practice.

Results

The technical needs that are co-shaped by the consortium to serve also each country national energy goals:

- Technical and Business challenges and research questions to be identified
- INESC focus on the integration part of RES and the inverters to serve the proper integration
- TUS focus on the market aspects and how the inverters are providing appropriate signals and reaction e.g. to market tariffs.
- FOSS closely cooperate with EAC for data, insight and validation of research results
- EDP and Bulgarian DSO can fund this type of research

Based on the above approach, we can identify an important addition that has given added value to the work promoted through the EIRIE platform and be the first result of this case study. This is the extension of collaborative work between FOSS of Cyprus and TUS of Sofia

bringing in INESC TEC of Porto Portugal, hence building a new platform for cooperation.

Using the successful implementation of the case study selected for Malta and Cyprus we extended it to Portugal as well, bringing in R&I partners from INESC TEC university in Porto, inviting them to work with our successful mode of working to build stronger research opportunities for all three groups of R&I experts. This was done in close collaboration with another partner of PANTERA, Technical University of Sofia, thus bringing altogether three collaborating partners coming from Cyprus, Bulgaria and Portugal. Together we have identified areas of common interest and identified researchers from all three groups to build the agreed collaboration areas. A first noted success story of this approach is the successful submission of a paper to the conference IEEE PES SyNERGYMED22 in Thessaloniki organised on the 17th and 18th of November 2022. The paper approved is the following:

Title: A new controller for Dump Load Active Power Management of Hydraulic Generator Unit Authors: Asenov, Tsvetomir (1); Stanev, Rad (1); Viglov, Kostadin (1); Lopes, João Peças (2); Efthymiou, Venizelos (3); Fernandes, Francisco (2); Charalambous, Chrysanthos (3); Bracho, Jorge (3) Organization(s): 1: Technical University of Sofia, Bulgaria; 2: Faculty of Engineering, INESC TEC, University of Porto, Portugal; 3: FOSS Research Centre for Sustainable Energy University of Cyprus, Nicosia, Cyprus

Discussion

Due to lack of time, the pursue of other activities was not possible, but the commitment is there and collaboration has set its first roots with the understanding that more will follow. The three entities have already set up working relations through identified task objectives, and thus in the future more successes will be registered in the benefit of all connected stakeholders.

Recommendations

It is clear from the above experience in building trust and interest between consortia of Cyprus, Sofia and Portugal positive results were achieved giving valuable results to the stakeholders of the electricity grid in the three countries. The successful submission of a paper to SyNERGYMED22 conference, give the evidence that collaboration work through the EIRIE platform can generate benefits to the entities involved. This will be highly utilised as a best practice approach for the R&I community to learn and use in their future endeavours.

Another lesson learned through this process, is the importance of keeping truck of targeted objectives with the stakeholders involved constantly updated. Final results achieved should be suitably disseminated to all stakeholders contributing to the fruition of the effort. Equally important is to keep truck of achieved results and future steps clearly identified for all parties involved.

4 Other activities performed and results achieved within PANTERA Desks

4.1 Desk 1 (Latvia, Lithuania, Estonia)

Stakeholder engagement

Stakeholder engagement in Desk 1 followed two main dimensions, identifying and engaging contact persons from associated countries Estonia and Lithuania, and extensive networking activities, including multiple face-to-face meetings in the host country, Latvia. Links with contact persons were successfully established and first results of collaboration already achieved. These include publishing PANTERA related article in Lithuania, engaging speakers for the envisaged Riga workshop and identifying additional potential stakeholders.

As for Latvia, thanks to vast personal experience in both academic work and research activities it was possible to establish links and organise face-to-face meetings with stakeholders from different categories, including not only academia and/or research organisations, but also TSO, DSO, Ministry of Education and Science and Ministry of Economics. As a result, main lines and thematic for Riga workshop were identified and high-level speakers were invited. Moreover, analysis of views and opinions received led to an idea of a consultation within all Desks aiming at clarifying stakeholder needs and searching for additional ideas on how PANTERA might support certain stakeholder categories.

Dissemination activities

Regional Workshop within Desk 1 activities 'Energy Transition in the Baltic States: Funding Opportunities for Smart Energy Research and Innovation' was scheduled on 26th March 2020. All preparations took place as planned but due to risks and limitations resulted from COVID-19 pandemic it was postponed and finally took place in April 2022 with the different title ("International research collaboration opportunities fostering EU Clean Energy transition in Baltic States") and in cooperation with another CSA SUPEERA having similar objectives. It was held in a hybrid mode: 25 participants were present physically and 56 participants connected remotely. The audience highly rated the quality of online streaming and appreciated possibility to ask questions. Totally 38 questions were received and almost all of them discussed during the event. The workshop incorporated multiple presentations of experts presenting their experience in collaborative R&I activities as well as intensive panel table discussions. The workshop was supported by Latvian Ministry of Economy, Latvian Council of Science, Lithuanian Ministry of Energy and European Commission. Additionally, to workshop summary report and videos[28], a local article in professional journal "Energija&Pasaule" (Latvia) was published.

As for publications, as a result of close cooperation with Latvian professional journal 'Enerģija un Pasaule' two articles were published. First article devoted to R&I role in energy system transformation is available also online[29]. Another one, about international initiatives is available only in paper version. Both articles published in Latvian language. Both articles include information on PANTERA project and benefits it provides for the stakeholders.

Another success is a publication in Lithuanian scientific journal in energy field, 'ENERGETIKA' with

[28]https://pantera-platform.eu/watch-pantera-and-supeera-joint-workshop-international-research-collaboration-opportunities-fostering-eu-clean-energy-transition-in-baltic-states-on-demand/)
[29] http://www.energijaunpasaule.lv/wp-content/uploads/2019/10/EP.pdf

the additional focus on Lithuanian situation. The article 'Facilitating research and innovation for energy transition' is published in English and available online[30].

To cover all countries, IPE team prepared and published article in Estonian professional journal (in Estonian).

Table 16: Dissemination activities within Desk 1

Activity	Country	Status	Comments
PANTERA workshop in Riga			
International research collaboration opportunities fostering EU Clean Energy transition in Baltic States	LV LT EE NO	Done April 2022	Initially planned for 20th March 2020, the workshop was postponed multiple times and finally took place in March 2022 in Riga, organised in cooperation with SUPEERA 25 participants were present physically, 56 participants connected remotely Experts from Latvia, Estonia, Lithuania and Norway shared their experience and participated in vivid panel discussions
Publications			
Articles in professional journal Enerģija un Pasaule:	LV		Close collaboration with journal is established.
1. Pētījumu un inovāciju loma Eiropas Savienības enerģētikas attīstībā (R&I role in EU energy system development)		Done December 2019	In this article a brief review of EU energy policies is performed and the role of Smart Grids R&I in energy system development and climate goals achievement is discussed. Then PANTERA project is introduced. Focus is given on Latvian situation and benefits PANTERA can provide to local stakeholders.
2. Tīras enerģētikas pētniecības un inovācijas virzienu noteicošas iniciatīvas (Main Initiatives Guiding Clean Energy R&I)		Done March 2020	This article briefly introduces such initiatives as SET plan, EERA, ETIP SNET, Mission Innovation and PANTERA. Each description is supported with a representative opinion presented in interview like style.
3 Aizvadīts seminārs par sadarbību enerģētikas pētniecībā un inovācijās (Summary on the workshop on collaboration in the field of clean energy R&I)		Done May 2022	
Article in ENERGETIKA Facilitating research and innovation for energy transition	LT	Done June 2020	Publication completed with the support of Lithuanian contact person for PANTERA At first a brief review of latest EU energy policies is given. Then PANTERA objectives, main elements and methodology with special attention on Regional Desks

[30] https://www.lmaleidykla.lt/ojs/index.php/energetika/article/view/4250/3240

			concept is described. Additionally, highlights on Lithuanian energy policy are given. Finally, collaboration opportunities with Lithuanian stakeholders are discussed.
Article in Elekrijaala Energiapöörde mõjuvõimu suurendamine Eestis (Empowering energy transition in Estonia)	EE	Done January 2021	Publication completed with the support of Lithuanian contact person for PANTERA Highlights of Estonian energy policy along with EU energy policy are presented, PANTEA project is presented and possibilities to foster R&I are discussed

4.2 Desk 2 (Bulgaria, Romania, Greece)

Stakeholder engagement in Desk 2 is based on identifying and engaging selected contact persons from the associated countries Greece and Romania who are interested and able to support the PANTERA activities, and also extensive networking activities, including multiple face-to-face meetings, conference presentations, regional workshops and nano workshop in the host country, Bulgaria. A successful collaboration was established with a PANTERA Stakeholders from Varna, Bulgaria who actively supported the PANTERA Regional Desk processes in Northeast Bulgaria. Links with contact persons were successfully established and the first results from this collaboration are already present. These include publishing PANTERA related articles in Bulgaria, involvement of the relevant stakeholders in the Regional workshops in Sofia, Bulgaria and Athens, Greece as well as nano workshop in Varna, Bulgaria.

As for Bulgaria, thanks to the experience in the academic work, research activities and the industry relations built, it was possible to establish links and organise face-to-face meetings with selected stakeholders from different categories, including not only academia and/or research organisations, but also TSO, DSO, Industry, Energy Traders, Electric Vehicle Cluster, Equipment Manufacturers, Ministry of Energy, Ministry of Education and Science. These Stakeholders took part as high-level keynote speakers and participants in the first PANTERA Workshop in Sofia, Bulgaria. The collaborative stakeholder engagement activities in the host country resulted in high participation of the Bulgarian stakeholders on the PANTERA Regional Workshop in Athens Greece, despite of the financial struggles which these Stakeholders are facing.

Dissemination activities

The desks' Regional Workshop in Sofia entitled 'Pan European Research and Innovation activities for Smart Grids, Energy Storage and Local Energy Systems', was held on 02 July 2019. Being the first PANTERA regional event the workshop included panel presentation session, teamwork brainstorming session in small groups, discussion session and interviews with selected stakeholders [more information available at *https://pantera-platform.eu/pantera-workshop-an-innovative-approach-towards-unified-pan-european-research-innovation-efforts-in-the-energy-sector-balkan-series-sofia-bg-2-july-2019/*]. The analysis showed that the most valuable results from this event originated from the roundtable discussions, teamwork in small groups and the interviews. Thus, the following dissemination activities were focused on more personally oriented stakeholder interaction.

A nano- workshop was organised on the 13th of September 2019 in Varna, Bulgaria within the

BULEF scientific conference. The event results showed that the nano workshop concept is very promising and highly productive.

The PANTERA Athens Regional Workshop entitled 'Green Islands as a driver for the Energy Transition – Going Renewable and Smart', Athens, took place on 13 February 2020 and considered important country and region-specific R&I needs and opportunities [more information available at *https://pantera-platform.eu/pantera-workshop-green-islands-as-a-driver-for-the-energy-transition-going-renewable-and-smart-athens-gr-13-february-2020/].* Few of accompanying faces to face meetings and interviews were organised to maximise the benefits of the event.

An article in Power Industry Bulgaria Journal and announcement for the PANTERA Regional Workshop in Sofia, Bulgaria was published in Bulgarian language prior to the event.

A paper entitled 'PAN European Approach for Strengthening Research and Innovation in Smart Grids, Energy Storage and Local Energy Systems' was published on the 11th Scientific IEEE Conference BULEF 2019, Varna, Bulgaria.

Table 17: Dissemination activities within Desk 2

Activity	***Country***	***Date***	***Comments***
Events			
BFIEC Conference: Climate, Energy and Environment	BG	14 March 2019	General presentation on the PANTERA project, Sofia Workshop Announcement, Flyers
ELMA International conference Varna, Bulgaria	BG, GR, RO	06-08 June 2019	General presentation (on screen), Sofia Workshop Announcement, Flyers, Poster
Climate-Friendly Energy & Industry, Converting Challenges to Opportunities Sofia, Bulgaria	BG	06 June 2019	Sofia Workshop Announcement, Flyers, Poster
ERIGrid Summer School on Advanced Operation and Control of Active Distribution Networks Athens, Greece	GR, BG, RO, other	10-14 June	Poster, Sofia Workshop Announcement, Flyers
PANTERA regional workshop Sofia, Bulgaria	BG, RO, GR	01-02 July 2019	Presentations, Flyers, Poster
PANTERA nano workshop, Varna, Bulgaria	BG	13 September 2019	Presentation, Discussion, Brainstorming, Flyers, Poster
PANTERA regional workshop, Athens	GR, BG	13-14 February 2020	Presentations, Flyers, Poster
Final Conference of the EUKI-project ALLIES	BG, RO, GR, other	26 May 2020	PANTERA presentation, Stakeholder interaction
"The key role of the R&I unified approach across EU for boosting smart grids	GR, BG, RO	9 July 2021	PANTERA presentation, EIRIE presentation, Stakeholder interaction

investments: The EIRIE platform" nano workshop at the 5th Cretan Energy Conference, online & Crete (GR)			
PANTERA Regional Workshop "Research and Innovation activities for Smart Grids, Energy Storage and Local Energy Systems", Varna, Bulgaria.	BG, GR, other	3 August 202	PANTERA presentation, EIRIE presentation, Stakeholder interaction
International research collaboration opportunities fostering EU Clean Energy transition in Bulgaria, SUPEERA / PANTERA joint workshop, Sofia, Bulgaria.	BG, GR, other	25th of May, 2022	PANTERA presentation, EIRIE presentation, Stakeholder interaction
	BG, GR, other		PANTERA presentation, EIRIE presentation, Stakeholder inter
PANTERA workshop "Boosting the R&I activity on Smart Grid Technologies: Empowering Energy Citizens and Communities to actively contribute to the Energy Transition. Country: Greece	BG, GR, other	18 October 2022	PANTERA presentation, EIRIE presentation, Stakeholder inter
Publications			
Article in Power Industry Bulgaria Journal	BG	27 June 2019	Article and Announcement for PANTERA regional workshop in Sofia, Bulgaria
Conference paper:			
PAN European Approach for Strengthening Research and Innovation in Smart Grids, Energy Storage and Local Energy Systems, 11th Scientific IEEE Conference BULEF 2019, Varna, Bulgaria	BG, EU	13 September 2019	PANTERA presentation

4.3 Desk 3 (Cyprus, Malta)

Stakeholder engagement activities

Regarding the collaboration practices, the PANTERA partners tried to reach the regional stakeholders that serve the triangle of knowledge and fall under the targeted stakeholders PANTERA categories: academia, industry and research & innovation. They have also tried to reach the institutional national contact points for energy-related issues i.e. ministries and Smart Specialisation representatives

As an overall evaluation of the Regional Desk 3 activities, Cyprus has developed active engagement

in the PANTERA process although it is considered that more targeted activities and innovative tools can be employed for improved results. Malta also showed adequate interest, and worked closely with the stakeholders of Cyprus building good examples of research activity and deployment of projects.

In both Cyprus and Malta, the contact persons have responded to the outreach and a face-to face meeting has been organized with the related Ministry and Smart Specialisation representative. Through these contacts, the following have been identified:

- The needs and challenges for engaging in regional activities. It seems that both human and economic resources are low and these two hinder the consistent working relations with many initiatives. Also, the administrative structure can delay the stakeholders' reaction.
- The main expectations from PANTERA Regional Desk for the benefit of the regional stakeholders (DSO, TSO of Cyprus, Energy Office, OEB representing the local industry in Cyprus, ETEK representing the Cyprus professionals etc) for participating in the PANTERA process through workshops, consultations etc. Moreover, strengthen the networking possibilities, facilitate access to valuable data in support of their R&I activities and build close working regional relations for mutual benefit.

Stakeholders and PANTERA partners have agreed to be in contact and try to build a constant and rolling plan of different activities that serve both parties.

The close collaboration between stakeholders of Cyprus and Malta has indicated strong successful opportunities that are reflected through the activities reported under the case studies for the two countries.

Dissemination activities

As seen in the table below different dissemination activities were performed till today.

Table 4 Dissemination activities within Desk 3

Dissemination activities	***Country***	***Status***	***Comments***
Publications			
Article through the University press	CY	Done	good working relations
Article for Low Spending Countries evaluation	ALL	In process	Will be presented in the MEDPOWER conference 2020 in Paphos , Cyprus
PANTERA workshop			
Paphos regional workshop as a plenary session under the MEDPOWER conference	ALL	Complete	The conference is organized to take place on November 9-12 2020 in Paphos, Cyprus
Workshop related dissemination activities			
MEDPOWER website, University dissemination channels	ALL	In process	may be used for further dissemination activities
Presentation of PANTERA in other events			

Participation in the Final Conference of our ALLIES project (virtual event)	South-East Europe, especially from Croatia, Bulgaria, Rumania and Italy	Complete	participated in the Mediterranean countries' session talking about the regional desks setup and make a follow up to the interested stakeholders post event
Meeting on 27 of September 2021 with Maltese and Cypriot stakeholders	CY and MA	Complete	A physical meeting at the UCY with Maltese and Cypriot colleagues. We agreed on the common ground and activities as they are part of the NEEMO project. We have agreed that Maltese colleagues could give us feedback on the Malta island profile regarding the R&D funding at national level (Del4.3)and that they would share their training material (NEEMO project outcome)
SUPEERA-EERA AISBL	CY and MA	Complete	Ivan Matejak- SETPLAN objectives and the low spending countries. This collaboration and consultation that has been started in Medpower 2020 shall be continued throughout the project.
Malta and Cyprus stakeholders organised a virtual workshop in support of the PANTERA process	CY and MA	Complete	NEEMO Workshop 1: Examining Transport Energy Pathways in the Mediterranean Public Policies Towards Electric Mobility
FOSS has given interview to SUPEERA for its success story	CY	Complete	Networking and dissemination for the Cyprus case and FOSS success story
IEEE ISC2 2022 - 8th IEEE International Smart Cities conference 2022 -	CY	Complete	With the participation of the Ministry of Energy, CERA, TSOC and DSO - EU was present with an expert from ETIP SNET.
MEDPOWER 2022 conference in Valetta Malta with a workshop session of the PANTERA project	CY and MA	7 to 9 November 2022	Local stakeholders participating including the common paper prepared by experts from Malta and Cyprus.

4.4 Desk 4 (Poland, Slovakia, Czechia)

In 2022 PANTERA successfully organised and held physical workshop "Capacity building on R&I in Smart Grids, Storage and Local Energy Systems " in Czechia in the frame of 22nd International Scientific Conference on Electric Power Engineering (EPE) Kouty nad Desnou. The conference attracted many local stakeholders from academia and industry. This gave PANTERA team an opportunity to establish contacts with stakeholders from Czechia and neighbouring countries (Poland). The workshop aimed at facilitating knowledge exchange and showcasing best practices of how international networking and cooperation between national stakeholders and key international associations and organisations can be beneficial for establishing long-lasting interactions and fostering joint R&I activities. Moreover, PANTERA team members participated in the scientific part of the conference and presented two papers.

S. Khadem et al., "A Dynamic Process to Identify the National Smart Grid Research &Innovation Status and Priorities," 2022 22nd International Scientific Conference on Electric Power Engineering (EPE), 2022, pp. 1-6, doi: 10.1109/EPE54603.2022.9814119.

M. Bahloul, S. Khadem, A. Nouri, P. Carroll, C. Papadimitriou and V. Efthymiou, "Integration of Distributed

Energy Generation in Energy Citizen side: Key Barriers and Enablers," 2022 22nd International Scientific Conference on Electric Power Engineering (EPE), 2022, pp. 1-6, doi: 10.1109/EPE54603.2022.9814138.

4.5 Desk 5 (Hungary, Croatia, Italy)

The first approach was to send out the questionnaire prepared in the framework of Work Package 2 (WP 2). The replies received through this have indicated some barriers that, according to the view of local stakeholders, hinder the development of R&I activities in these countries.

- Lack of responsive networking facilities;
- lack of access to reliable information/data to facilitate R&I activity;
- limited human resources;

are among the most important limits to be removed. In this view it is important to note that PANTERA could actually help with its activities at least in lowering the effect of 'lack of access to reliable information/data to facilitate R&I activity'.

Apart from information exchange, local stakeholders consider that the PANTERA project would be very helpful in fostering R&I activities giving the possibility to enlarge their networking potential.

These points are in line with the Regional Desk approach that tries to involve local stakeholders through meetings, direct contacts and information exchange.

Regarding the overall status of Desk activities, good progress has been made especially in contacting and establishing relations with different stakeholders. Different interviews, as reported under WP4 have been obtained thanks to the effort of contacting stakeholders both remotely by targeted e-mails and both at physical events like the ENLIT conference.

Moreover, a workshop within the SpiTech Croatian conference has been organised aiming to discuss and raise attention on gaps and barriers that limit the R&I activities in the energy sector and especially hinder a true integration of Croatian R&I stakeholders at EU level. The SpliTech conference was an excellent occasion to organise a side event for the PANETRA project being an IEEE conference dealing with "Smart and sustainable technologies" thus collecting a good participation from the energy field stakeholder from the R&I field, first stakeholders of the PANTERA project. The event has also been the occasion to present the EIRIE platform highlight its role in supporting the R&I unified approach across Europe aiming to act as a single stop-shop for searching and finding information related to project on smart grids and the energy system at large. At the workshop where invited project stakeholders from the countries neighbouring Croatia following an approach perfectly in line with the PANTERA regional approach. Moreover, the joint organisation with the SUPEERA projects, that shares with PANTERA different key objectives, allowed to foster stakeholder participation and to enhance the discussion in the panels.

A workshop has been organised also in Italy within the MELECON 2022 conference held in Palermo in June 2022. Also, in this case the workshop gave the opportunity to gather local stakeholders and discuss about the topics of storage and electromobility as a huge opportunity to enhance system flexibility and about the role of policies in fostering the deployment of innovative solutions with a special attention on recent development in the renewable energy communities field.

More details about the workshops are reported under the WP5.

Finally, it is worth to report that two events are planned to be held in Hungary. One will take place on October 26th and it will be organised together with the SUPEERA projects, while a second one will be organised within the CANDO EPE 2022 conference at the end of November 2022. Both the

events will give the opportunity to get in contact with local stakeholders and will foster the engagement of them in the PANTERA project.

4.6 Desk 6 (Ireland, Portugal)

IERC and UCD engage with stakeholders in the energy sector in the Republic of Ireland across multiple funded projects including PANTERA. This gives opportunities to advertise PANTERA and to identify potential content from other Smart Grid projects that could be made available on the EIRIE platform.

Actors in the Irish energy sector were invited to complete the PANTERA questionnaire in early 2019 and sign up as a stakeholder. Likewise, invitations were sent to actors in Portugal.

UCD and IERC jointly organised a PANTERA regional workshop in December 2019 to facilitate the exchange of best practices and information among R&I experts and policymakers in Ireland, and foster links with EU-level initiatives. The workshop aimed to highlight how the PANTERA project could address the energy transition challenges at the regional and EU level through the prism of smart grid R&I. Sessions explored the opportunities and challenges for research and innovation in Smart Grids, Energy Storage and Local Energy Systems in Ireland. Speakers from the DSO, TSO, New Entrant and academia presented their perspectives. Representatives from all major Smart Grid stakeholders attended the Dublin Workshop and indicated positive support for PANTERA and positive interest in the type of content proposed on the EIRIE Platform.

With the help and support of the rest of the consortium, UCD ran a webinar, in the form of a nano-workshop, to address the theme of Smart Grid Research Data - how to share research data, ensure GDPR compliance, reduce the risk of divulging potential innovation insights, and related issues. The webinar focused on "how different stakeholders such as governments, industry and local energy communities can share and organise their data respecting the privacy of users and citizens". Fu

UCD initiated and led a research activity inside the consortium to highlight the coordination and support actions to increase activity in smart grid research, demonstration, and innovation in the EU. A paper was published based on the results of the collaboration and was presented at the 2021 9th International Conference on Smart Grid (icSmartGrid) held in Portugal. A review of regulations, codes and standards in the EU conducted by the PANTERA project was presented where the focus was on the development of Network Codes by looking at a specific case study of a research and demonstration project in Ireland. The opportunities to foster smart grid RD&I through a shared understanding of insights available on the PANTERA platform were also highlighted.

P. Carroll et al., "Development of Network Codes to Facilitate the Energy Transition," 2021 9th International Conference on Smart Grid (icSmartGrid), 2021, pp. 63-67, doi: 10.1109/icSmartGrid52357.2021.9551230.

5 Identification of best practices

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. Starting from the very first PANTERA workshop in Sofia (BG) in July 2019, WP4 arranged a set of individual interviews with several stakeholders from the target countries representing different sectors e.g., TSO, DSO, hard- and software vendors and academia (see the latest status for the interviews in Section 3 . The intention of the interviews was to validate some initial hypothesis and establish an overview of thematic areas for interaction and knowledge transfer i.e., best practices to increase national R&I activities in Smart Grid domain. During the interviews it was received strong feedback from the stakeholders asking to include several topics, where the most important one was **organisation of regulatory and decision-making processes.** Several transformation processes in today's power sector are driven by the overarching political goals related to the global climate challenges. Therefore, the national regulatory and decision-making part is an important trigger for targeted R&I activities. It was specifically mentioned that long-term alignment and coordination of R&I efforts within the research community on national level will support meeting the overall targets for implementation of Smart Grids technologies.

5.1 Importance of best practices for R&I and EIRIE Platform

One of the main tasks of "Best Practice Desk" is to explore and identify different well-functioning mechanisms, which contribute to increased R&I activities, so this experience can be considered and replicated in other countries. The general approach is that the project group does not advice other countries to specific actions but provides a selection of alternatives, which had been proved to work. The continuous interview process supports maintaining sufficient level of Research and Innovation (R&I) activities on national level with focus on the Smart Grid domain. The main goal has been to create and configure a dedicated “Best Practice” part at EIRIE platform, populate it with several examples of best practices and further facilitate continuous update of the section.

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).

Development of Smart Grid solutions as any other technical field follows the general Technology Readiness Level (TRL) ladder going through Basic Technology Research to Operation. Development and implementation of novel technical solutions requires an unbroken chain of R&D activities corresponding the whole TRL scale or the final part of it, in case of replicability and technology transfer from another country. This means that support mechanisms should be applied at different TRL levels in a balanced and coordinated manner in order to avoid segmentation of results.

In addition, the process should involve various types of organisations on different stages of technology development, starting from basic research organisations (in case of novel technology development) to industrial partners deploying the actual technology. A coordinated involvement of

all necessary types of organisations into this process requires different facilitation and support mechanisms.

The first list of best practices was presented in deliverable D6.3 [71] of the present project and included:

- Funding schemes
  - Common industrial funding of R&D projects
  - Mixed funding of R&D projects
- Creation of financial incentives
  - Tax exemptions
  - Regulation of DSOs
- Regional cooperation

This section presents an update of best practices, based on the most recent outcomes from interviews with the stakeholder. In order to uncover more details this was done as a case study.

5.2 Best practice: Regulatory sandboxes in Europe

According to a report published by CERRE [72], European DSOs want their NRAs to make good incentives and regulatory support for innovation. Regulatory sandboxes were mentioned by several DSOs as a tool to foster innovation but should be used more often or be easier to use.

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.

Purpose of the case study

PANTERA project received feedback from several stakeholders, that lack of functional sandboxes is one of the barriers for implementation of Smart Grid Technologies. Therefore, it could be useful for the PANTERA-project to investigate how sandboxes have been implemented in European countries and their results. Several programs for establishing sandboxes are operational in Europe today. ISGAN has made an overview of some of the programs that are either upcoming, in progress or completed over the last decade [73]. However, we think that a case study that focuses on specific projects within a sandbox is beneficial to find some best practises that may further make it easier for stakeholders to establish and develop new sandboxes or projects in their respective countries. In order to make a case study it needs consensus both from the project and the stakeholders that a case study on regulatory sandboxes is feasible and useful. Additionally, it will demand some contributions from the stakeholders to provide the information and data that is needed to conduct the study.

5.2.1 Key performance indicators (KPIs)

To conduct such a case study, it is necessary to define various Key Performance Indicators (KPIs) to compare the various sandboxes. KPIs are the critical indicators of progress towards an intended result. In the following paragraphs some suggested KPIs are described.

Duration

When a sandbox is to be designed and opened, it is important to evaluate the duration of the derogations or exemptions. There are different pros and cons to be aware of regarding the length of a sandbox. A shorter duration will ensure that e.g., the distortion of the market from the project is limited. In addition, it can contribute with quick learning and a potentially faster adaption of the regulation. If the project is lasting over a longer period, the results may be more robust, and it will become easier to decide on implementing the new regulations or not. This, however, may compromise with the goal of a fast implementation of new regulations but in many situations, it is necessary to have a robust basis for decision-making. Another time perspective is to establish permanent sandboxes, where it is possible to continually try out new exemptions and the area can be regarded more as a test site. This, however, must be in a designated area where it is purposeful to establish this, and that the inhabitants are willingly to contribute.

Scope

The scope of the sandbox can be defined as which parts of the investigated system that are tested or impacted. Aiming at different levels of operations or different parts of the value chain. A suitable framework to evaluate the scope of the sandboxes may be the five-layer Smart Grid Architecture Model (SGAM) framework [74]. This framework describes the interoperability in the context of smart grids in terms of *Business, Function, Information, Communication and Components*. An overview of the layers presented in [74] can be seen in Figure 18. In a sandbox, derogations may be applied in one or more of these layers and the impact is monitored subsequently.

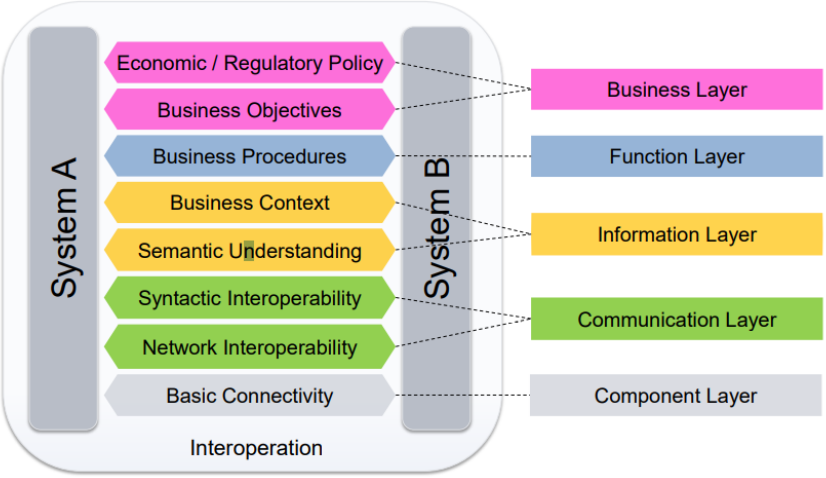


Figure 18: Overview of layers in the SGAM framework.

Scale

In addition to the scope, the size of the sandbox is of relevance. Since the sandboxes are of different sizes, the number of affected will vary and thus the robustness of the results is varying. A possible description of the scale is to define a sandbox as local, national, regional, continental, or worldwide.

Number of projects in a sandbox

Each sandbox can contain one or several projects that are distorting the system. A single project sandbox may be easier to establish due to less coordination and it may be less resource intensive. This is naturally varying from project to project. With more projects collaborating in the same sandbox, it is possible to evaluate the impacts in a greater extent and to maximise synergies between the different projects. According to ISGAN [73], regulatory experiments are more powerful, the more a broad range of actors get involved as well as orchestrated. However, this requires each

involvement from the stakeholders to be explicitly organised.

Exemptions in a technical or economical part

The sandboxes are targeted at various types of exemptions that can be categorised as either technical or economical. E.g., if a project wants to try a new technology or a new business model this may lead to difficulties to comply with a set of technical requirements such as voltage or frequency limits. Alternatively, a new business model is proposed but is not accepted within today's regulations due to e.g., rules of competition, an exemption can be made to investigate the effects.

Replicability and scalability of the results

The replicability and scalability of the results must be considered. How transparent are the sandboxes? To what extent are the results shared publicly within the sector and not only solely an advantage for the involved participants in the project. The replicability of the projects is of importance to set up new sandboxes and use the results in other areas than the investigated system.
Replicability denotes the property of a system that allows it to be duplicated at another location or time [75]. Additionally, it is important to evaluate the scalability of each sandbox and thus, useful for more than the involved participants in the project.

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand. A system is understood as a set of interacting elements with similar boundary conditions [75].

Scalability and replicability are the preliminary requisite to perform scaling-up and replication successfully; therefore, scalability and replicability allow for or at least reduce barriers for the growth and reuse of the results of R&D and demonstration projects. Depending on the projects it is not given that a concept that succeeds on a small scale will have the same impact or the desired impact when it is fully scaled to a regional or national level. Therefore, the sandboxes must be properly designed to create as precise and beneficial results as possible. An advantage of having a smaller sandbox is that it is not as resource-intensive and thus easier to implement and investigate. This may lead to achieving results faster which again leads to faster implementation of new regulations if the sandbox project succeeded.

5.2.2 A brief example of a project in a sandbox

To give a brief example of sandbox, the pilot project eFleks [76] will be presented. This was a project lasting from 2019 to 2020, where the Norwegian TSO, Statnett, in collaboration with pilot partners, Tibber and Entelios, investigated a new approach to offer more flexible resources to the manual Frequency Restoration Reserve (mFRR) market. To test the approach a temporary sandbox was created. In the sandbox, Statnett was granted an exemption from the regulations on system responsibility to deviate from the requirement of a minimum bid size of 10 MW. This to allow bid sizes down to 1 MW. By allowing a reduced bid size it allows Tibber and Entelios to act as aggregators and offer flexible resources by aggregating loads from end-users. Tibber aggregated loads from electric vehicle chargers and panel heaters in domestic homes, while Entelios aggregated loads from industrial and commercial buildings. Additionally, a second goal was to step closer to more automatic value chains by develop and implement new systems that would decrease the response time for activating the offered flexibility resources. The exemptions were granted for a limited period of 10 weeks in the second half of 2020. The pilot project showed promising results and the systems will be developed further and it is open for other market players to participate. It is expected that the minimum bid size will be reduced to 1 MW during 2023 but no formal decisions

are made yet. In Table 18, a summary of the indicators is given for the presented project.

Table 18: Overview of indicators for the eFleks-project

KPI	Comment
Duration	10 weeks
Scope	The project was directly affecting several layers in the SGAM framework Communication - The project introduced new software that was able to automatically respond offers made and thus reducing the response time from when the bid was activated. Business - The project tested a new bid size to the mFRR that allowed new market players to participate. The aggregators can more easily utilise smaller end-user loads to offer flexibility resources.
Number of projects in the sandbox	There was only 1 project in the sandbox, which was created especially for this pilot project.
Exemptions in a technical or economical part	Technical: Reducing the minimum size of bids in the mFRR market from 10 MW to 1 MW.
Replicability and scalability	The project is easily scalable in both the number of aggregators as market players and the number of end-users that are used by each aggregator. Due to how the Nordic countries are having similar market structures, this project is possibly easily reproduceable in the other Nordic countries, both locally, nationally, and regionally. However, due to the market structure it is not necessary easily adapted to other countries in Europe due to different market structures. This must be investigated further to give a clear answer.

5.2.3 How NRA facilitates the process: application procedure

To create sandboxes which will have configuration necessary for specific projects, it is necessary to have an established framework for application procedures and communication with applicants. Earlier, no defined framework existed explicitly for applying for exemptions from regulatory terms and conditions, since it was very few of these projects. However, the Norwegian NRA has become more open and supportive towards innovation and testing new technologies and business models. During earlier application processes it has been long dialogues between applying projects and the NRA to define and ensure that the applications include the relevant and necessary information for justifying exemptions from a current regulation.

As the desire for more innovative projects has become stronger, an application procedure has been established to make it easier for both the NRA and the projects. The procedure ensures that NRA receives from applicants the information that they consider necessary. This means that the proportion of high-quality applications increases. In addition, it also makes it more straightforward for potential projects to create applications as they know what is expected of documentation from them. All information about the application process can be found on the NRA's website "Pilot and Demonstration Projects" [77]. This includes application format, evaluation criteria, terms for dispensation, and a list of previous granted dispensations.
A summary of the content that should be included in the application is given below:

- An overview of the project containing

  - Description of the purpose and goal.
  - What is innovative with the project?
  - Expected effects from the projects. If possible, specify which relevant areas/groups that will be affected, e.g., customers, development of technology, better grid operation, competition.
  - The project's maturity.
  - Description of eventual collaborators. Do the end-users participate voluntarily and/or is there a reservation option of not participating?
- Why is it necessary to apply for an exemption? Which regulations? Describe why the project cannot be done with current regulations. The duration of the dispensation.
- How are costs distributed in the project and how are they registered?
- How will the project be completed after the expiry of the dispensation?

There are some mandatory terms and conditions for being granted a dispensation that are present:

- Each project must be time-limited, typically 1-3 years with a maximum of 5 years.
- If the project needs to build facilities, it may be required to remove these after the exemption period is over.
- Publication of project goals and results.
- Requirements for reporting to the NRA may apply. Depending on the project in can be required to report directly to the NRA during and at the end of the project.

5.2.4 Experiences with creation of sandboxes (based on interview)

This specific experience is based on several pilot projects over a period of 10-20 years, which tested new configurations of distribution network tariffs and demand response in Norway.

Regulation of DSOs in Norway focuses on income regulation, and the overall principles and structure of distribution network tariffs are defined by national regulation. When evaluating alternative tariff models, it is important to assess and test how these will affect both the power system and customers. Although one can gain a lot of knowledge from simulations, it is important to test out in real life with the actual power system and real customers, to study how the customers change their electricity consumption due to the new tariff models, and also how the customers evaluate the tariff models. Today DSOs have limited experience with incentivising implicit flexibility by distribution network tariffs among customers in their grid, and therefore pilot projects are needed to gain such knowledge.
In Norway, the regulation states that there must be non-discriminatory conditions for all customers connected to the grid, which means that customers must always have access to the same tariffs. Because of this, it is necessary to apply for an exemption from this regulation, for customers participating in a pilot project. Recruitment of customers can be done by selecting all customers connected downstream of a given substation (with the possibility to opt-out), or customers enter into the project (opt-in) via invitation letter from the DSO, information on the website or via the local newspaper.

An experienced barrier for initiating pilot projects on network tariffs has been to have various types of customers wanting to participate. Often, it is no problem to include first-movers as they are positive to new technological changes and are willingly to participate (opt-in). However, by only including first-movers, the results from the pilot projects are not as realistic as it would be in a greater view, as a fair share of customers are reluctant to do changes. The diversity among customers is also a

reason for why pilot projects are important. Therefore, it is important to find ways and methods to encourage the whole group more reluctant customers to participate in order to get a more diverse customer group.

However, this is often difficult since the present regulations may prevent the DSOs from investigating alternative tariff models. The pilot projects were performed before today's system for accepting pilot project. Therefore, during these pilot projects, exceptions from the current regulations have been granted by the Norwegian Regulator, mainly based on letter-based correspondence describing the different pilot projects (objectives, type of tariff model, how to engage customers etc.). This was quite time- and labour-consuming for the applying projects and probably for the Regulator as well. The process has been significantly improved, when the above-mentioned application procedure has been introduced by the Regulator.

The typical project regarding testing alternative network tariffs is lasting at least for one year. The main reason for this is that new network tariff models typically are calculated based on standard energy tariffs, and the yearly income to the DSOs should be equal when changing to a new tariff model. The tariff costs with new models can vary during the year. This makes it reasonable to investigate tariffs both in the winter and the summer seasons, in addition to the fact that the demand is higher during the winter and lower in the summer.

6 EIRIE Regional corner development

The key and important deliverable of the PANTERA project is the EIRIE platform. It incorporates specific pages related to regional activities, so called Regional Corner. This section describes in brief the structure and features of the Regional Corner.

The Regional Corner is structured according to PANTERA 6+1 approach, i.e., incorporating Desks and distinct country working spaces.

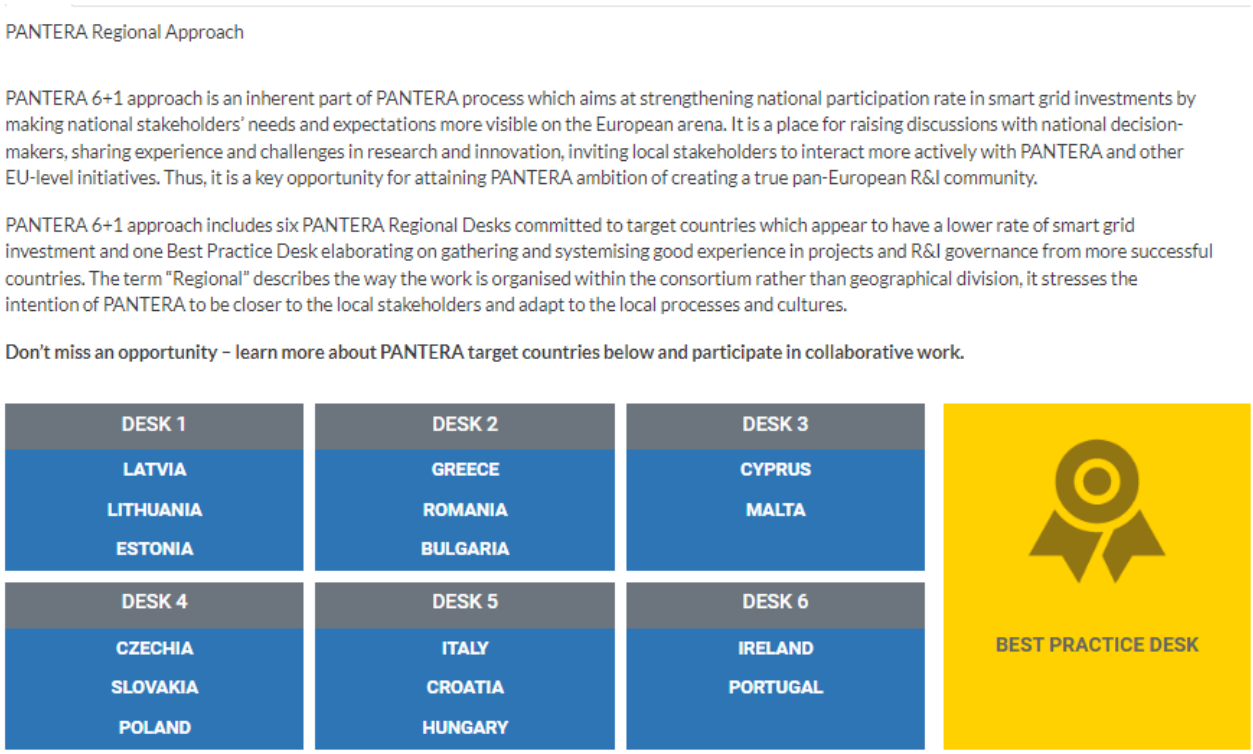


Figure 19: EIRIE Regional corner

Combining countries under six PANTERA Desks (Desk 1 – Desk 6) serves primarily for sharing responsibilities between PANTERA partners and doesn't necessarily correspond to geographical regions. Therefore, more attention is given to countries. To ensure sustainability, the possibility to add/change counties belonging to the Desk is foreseen.

Each country page is built in a flexible way with the possibility to add different kind of static information: news, reports, useful links, images, etc. The information is arranged in "boxes" for better visual representation. At the time of submitting this report IPE team has uploaded information on PANTERA workshops for all countries. Additionally, we have prepared country specific highlights on GHG emission trends and performance in Horizon 2020. The future plans include updating and customising PANTERA country profiles to be effectively published on Desks pages. The content manager of the EIRIE can add/change "boxes" as needed, the number of these is not limited.

Figure 20: EIRIE country page - example of Latvia

Collaboration is fundamental in the existence of the EIRIE platform for team building in related activities and knowledge creation. Confluence is a team workspace where knowledge and collaboration can flourish by creating, collaborating, and getting organized in one place. Dynamic pages give the EIRIE team a place to create, capture, and collaborate on any project or idea. Spaces help the EIRIE team to structure, organise, and share work, so every team member has visibility into institutional knowledge and access to the information they need to enrich and raise the quality of their work. Confluence is for teams of any size and type, from those with mission-critical, high-stakes projects that need rigor behind their practices, to those that are looking for a space to build team culture and engage with one another in a more open and authentic way.

All content lives in pages – classified as living documents on EIRIE Confluence site. Various different types of pages can be created such as project plans, meeting notes, troubleshooting guides, policies, and more. Confluence comes bundled with templates that can be used as a basis for almost any kind of content. In case none of the existing templates can be used for a specific type of content you want to create, a blank page can be used and adjusted accordingly.

Pages are stored in spaces – workspaces where teams can collaborate on work and keep all content organised. All EIRIE content is grouped together in the same space. Each space comes with an

overview (or homepage) and a blog, so it's easy to share updates and announcements with the whole team. Space content is organised with a hierarchical page tree that makes finding work quick and easy.

All countries and Desks have relevant collaboration spaces in Confluence. A dedicated confluence page has been created also for Regional corner collaboration under which members of all desks and the rest of Europe can collaborate together to create content.

7 Conclusions

All of the key pillars of PANTERA Desks (discussed in Section 2) – supporting actions, continued stakeholder engagement, case studies and development of EIRIE – are covered within Task 6.2 and include actions organised centrally and for each individual country. These are closely interlinked and provide inputs to each other.

To identify critical topics PANTERA partners performed European and national policy analysis and stakeholder consultations. Based on the results, the common workshop format was created and then tuned individually to answer the specific country needs. Each workshop was made as interactive as possible to encourage active participation of audience. Feedback received was then used to identify possible case studies and adjust further questions used for surveys, pools and interviews. Moreover, workshops provided possibility to establish closer contact with stakeholders, invite them for interviews and in some cases launch joint activities, e.g., working on common project applications. Where possible, the results of policy analysis, surveys and workshops were disseminated more broadly through popular articles or scientific papers.

The case studies included in this report uncover the variety of challenges stakeholders are facing and lay out possible options to facilitate R&I by utilising strengths and overcoming potential gaps. For instance, one of the solutions to investigate the decisive role of policies and regulations on R&I performance of companies– regulatory sandboxes – is studied more deeply within the Best Practice Desk. The considered cases are planned to be discussed with the relevant stakeholders in the course of preparing country-specific recommendations.

Moreover, the regional Corner of EIRIE was launched and collaboration spaces in Confluence prepared for each country and Desk. A dedicated Confluence page has been created also for Regional corner collaboration under which members of all Desks and the rest of the Europe can collaborate together to create content. The EIRIE Regional Corner has been designed to hold different types of static content and allow modifications in structure for sustainability. It has been gradually filled in with new content.

Finally, it can be noted that considering the variety of envisaged approaches and positive results, Regional Desks of PANTERA and their key pillars could be promoted as an instrument facilitating R&I activities. Whereas the overarching objective of the remaining project months, is to facilitate collaboration through Confluence and strengthen the linking of stakeholders with EIRIE harnessing all embedded benefits.

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9 Annex

9.1 List of Figures

9.2 List of Tables