PANTERA

Pan European Technology Energy Research Approach

Work Package WP4 "Key Topics and Content Management"

Deliverable D4.4

Assessment of the defined topics: relevance, driving forces and trends

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Abbreviations

Acronym	Meaning
AI	Artificial Intelligence
AMI	Advanced Metering Infrastructure
CEC	Citizens Energy Community
CSA	Coordination and Support Action
DE	Distributed Energy
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EC	European Commission
EIRIE	European Interconnection for Research Innovation & Entrepreneurship platform
ETIP SNET	European Technology and Innovation Platform Smart Networks for Energy Transition
EV	Electric Vehicle
FACTS	Flexible Alternating Current Transmission System
GDPR	General Data Protection Regulation
ICT	Information and Communication Technology
NRA	National Regulating Authority
PV	Photovoltaics
R&D	Research and Development
R&I	Research and Innovation
RE	Renewable Energy
RES	Renewable Energy Sources
RICAP	R&I status and Continuous gAP analysis
TRL	Technology Readiness Level
TSO	Transmission System Operator
TYND	Ten-year Network Development Plan
WP	Work Package

Executive Summary

The document summarises results from "Key topics and content management" activity in H2020 project PANTERA. This is the **fifth in the series of five project reports** in activity "Key topics and content management" (WP4), seeking to carry out the following analysis:

1. The initial definition of the content for dissemination and networking activities (D4.1) [1]
2. 1st Report on Identification of Gaps and Missing Subjects (D4.2) [2]
3. 2nd Report on Identification of Gaps and Missing Subjects (D4.2.2)
4. Final Report on Identification of Gaps and Missing Subjects (D4.3) [3]
5. Assessment of the defined topics, relevance, driving forces and trends (D4.4) (the present document).

The study linked its activities to evolution of the Pan-European regulatory landscape, which has been constantly changing in recent years, focusing on the long-term goals of decarbonising the power sector.

Among the most recent changes the study mentions:

- Communication (2022/230) REPowerEU Plan addressing an unexpected political and economic turmoil caused by the outbreak of the war in Ukraine (May 2022)
- Proposals for electricity market reforms (September 2023)
- Development of Guideline on Demand Response (Ongoing)

The activity created a twofold approach, where the first workflow (RICAP) developed a dedicated process for identification of gaps and missing subjects, while the second concentrated on direct interaction with the stakeholders. The direct interaction is based on more than 30 semi-structured interviews and surveys, which have been accomplished to establish an open dialogue and identify specific stakeholder needs and expectations. Considering that PANTERA as project aims specifically at Smart Grids domain, which is normally associated with distribution part of the grid, the intention was to focus on respondents, which are engaged in and have expertise there. The activity identified the main challenged requiring implementation of Smart Grids Technologies in the focus countries, where the most important were:

- Massive introduction of distributed Renewable Energy Sources (RES)
- Electrification of transport, Electric Vehicles (EVs)
- Growing necessity for consumers' empowerment and engagement
- Economic challenges
- Growing quantity of data from different sources

When it comes to priorities for implementation of Smart Grid Solutions, several respondents indicated three main areas:

- Advanced Metering Infrastructure (AMI)
- Enabling observability and controllability functions for DSOs
- Enabling flexibility and Big Data technologies for enhancing the planning and operation of the grid

Among the nontechnical barriers for more activities in the Smart Grids the study discusses several points, including:

- The role of National Contact Points and potential revision of these
- National Energy and Climate Plans
- Several aspects related to funding procedures for R&I Projects
- Issues related to national regulations

Further the study presents organisation of and results from the Technological Gap Identification Process (RICAP), which made an overview of 409 projects in total, mapping their activities to the different Smart Grid Technologies and defined prevailing focus areas and gaps. The study concludes that these in general comply with the outcomes from direct interactions with the stakeholders, and therefore advises implementation of RICAP functionality into the EIRIE platform, the main outcome of the PANTERA project. Finally, the document discusses possibility for establishing of regional cooperation in the focus countries.

1 Introduction

The work in this report is carried out under the activity "Key topics and content management" (WP4) of the Pan European Technology Energy Research Approach (PANTERA) project.

PANTERA is an EU H2020 project aimed at setting up a European forum composed of Research & Innovation (R&I) stakeholders active in the fields of smart grids, storage and local energy systems, including policymakers, standardisation bodies and experts in both research and academia, representing the EU energy system (for details see [4]).

According to the project's description of work, the main intention of this sub-activity is to maintain throughout the project the significance and value of the operational topics of PANTERA through regular interaction with the stakeholders, following the legislative and political changes related to the EU energy transition (at national or EU level) 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 stakeholders through surveys and individual interviews is used as further validation of the work.

This deliverable is the **fifth and the final in the series of five project reports** in activity "Key topics and content management" (WP4), seeking to carry out the following analysis (see Figure 1):

6. The initial definition of the content for dissemination and networking activities (D4.1) [1]
7. 1st Report on Identification of Gaps and Missing Subjects (D4.2) [2]
8. 2nd Report on Identification of Gaps and Missing Subjects (D4.2.2)
9. Final Report on Identification of Gaps and Missing Subjects (D4.3) [3]
10. Assessment of the defined topics, relevance, driving forces and trends (D4.4) (the present document).

2 Summary and updates of the previous activities

2.1 Overall workflow

The overall workflow within the activity is presented in Figure 1 and includes three sequential steps according to the three sub-activities.

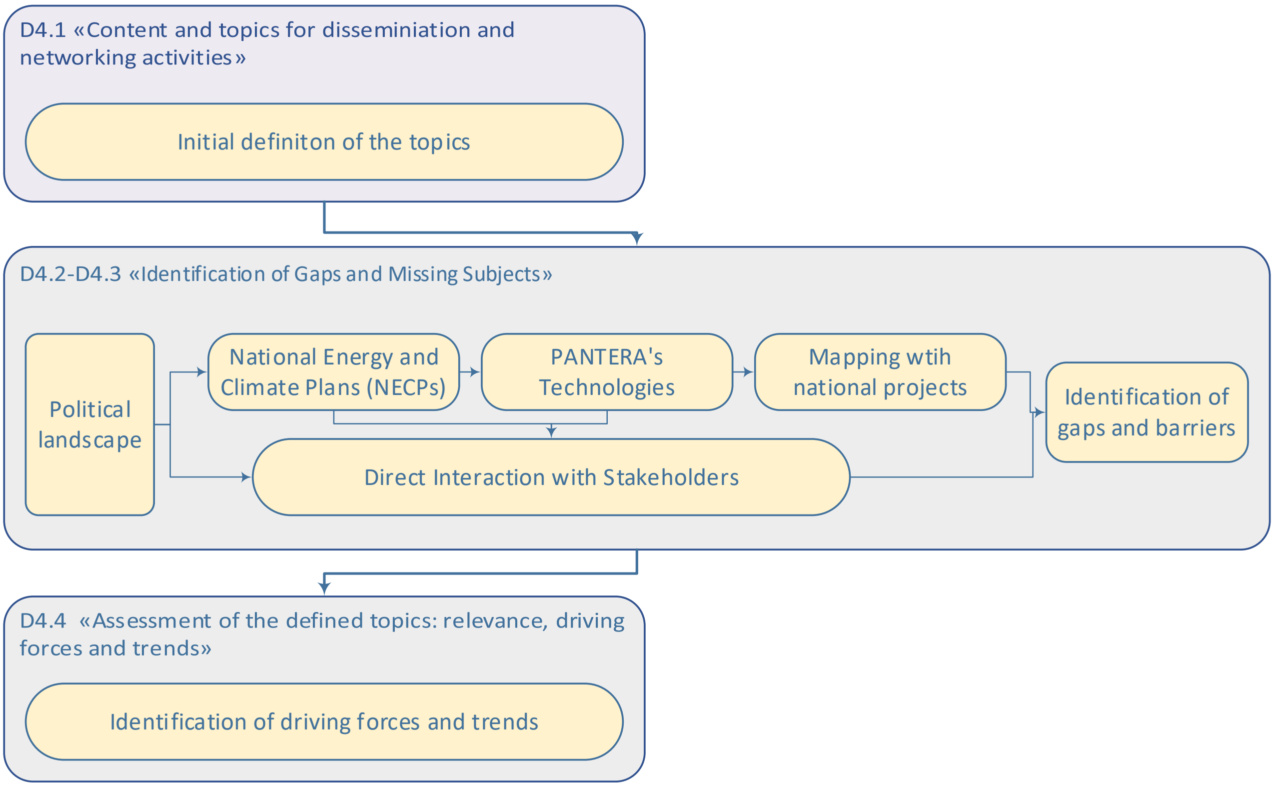

Figure 1 Workflow in "Key topics and content management" activity

2.1.1 Definition of the content for dissemination and working activities

The initiating task created an overall approach for the whole activity. Several initial topics were proposed and tested at the first interactions with stakeholders, the first PANTERA workshop in Sofia in July 2019. The first five interviews were organised there. The feedback from these interviews contributed to the extension of the scope from technical only to both technical and none-technical areas. The latter includes decision-making, political and regulatory topics (for details see [1]). This area was further explored through several studies, dedicated to national decision-making and funding of R&I, where the main processes were mapped (see Figure 2) and the main topics for interaction were suggested.

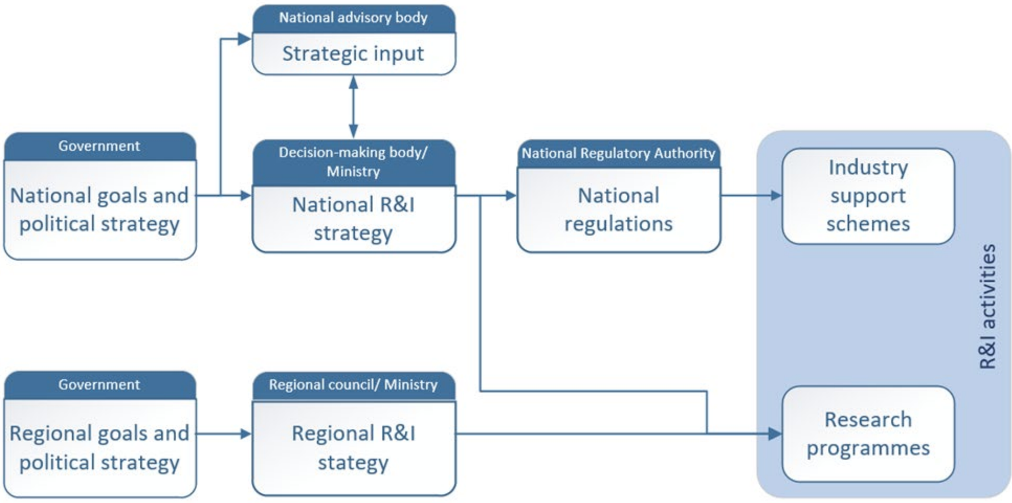

Figure 2 Steps in the decision-making process of funding for R&I activities.

In the meanwhile, the technical area was successfully connected to the functionalities, defined by a taxonomy of Smart Grid technologies, proposed by ETIP SNET in its Integrated Roadmap 2017-2016 [5]

2.1.2 Identification of gaps and missing subjects

The process of identification of gaps and barriers was the main objective in the second task. It included two parallel work streams (see the second step in Figure 1), starting with a reference to the Pan-European Political landscape, defining the main R&I priorities and political targets for the Member States. The Pan-European regulatory landscape has constantly been changing in recent years, focusing on the long-term goals of decarbonising the power sector.

The project is further divided into two parallel streams:

- The upper stream is essentially dedicated to the technical domain of Smart Grids, storage and distributed generation. This process starts with identifying the R&I status by mapping the technologies/systems toward national/EU/International collaborative projects in the target countries. This is followed by an assessment of the National Energy and Climate Plans (NECPs) in the target countries, based on the PANTERA's taxonomy of technologies, in order to identify national R&I technical priorities. Finally, the outcomes are used for the identification of the R&I gaps (see [6]).
- The lower stream has a broader holistic nature based on direct interaction with stakeholders around technical and non-technical areas. The exchanges are made as semi-formal interviews, where the topics are modified according to any changes in the technical stream. This stream results in the definition of the main barriers and gaps whenever it is possible. These conclusions are deliberately not country specific. This has been done to meet the requirements of GDPR and avoid tracing the answers. More importantly, the information about gaps and barriers has been used as input to the main outcome of the PANTERA project - the European Interconnection for Research Innovation & Entrepreneurship platform (EIRIE).

2.1.3 Assessment of the defined topics, relevance, driving forces and trends

The final task makes an evaluation of the identified issues, content and topics. The task identifies the main driving forces and major learning acquired throughout the activity.

2.2 Changes in the Pan-European legislative and regulatory landscape

As it was mentioned in the previous section, the Pan-European landscape evolves quite fast. Considering, many global processes and circumstances during the last two years of the project and similar to the previous reports in the activity, this section intends to update about the most relevant recent changes in the Pan-European regulatory landscape rather than providing a deep and exhaustive description.

The focus is on the changes which may directly influence the related R&I activities in the targeted countries.

The previous deliverables [2] and [3] in this activity outlined the following key documents and strategies:

- The European long-term decarbonisation strategy (LTS) "A Clean Planet for all" aims to make Europe climate-neutral by 2050, with net-zero greenhouse gas emissions. The strategy shows how Europe can find a way to achieve climate neutrality by investing in realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance or research.
- The Strategic Energy Technology (SET) plan defines the main priorities for the European energy ambitions of the energy transition according to the defined 10 Key actions. Several national case studies pointed out that national R&I strategies in the energy field are following the road paved by SET-plan.
- The New Circular Economy strategy is one of the main drivers behind the most recent Green Deal Initiative and is defined as Europe's new agenda for sustainable growth.
- "Clean Energy for All Europeans" package comprises several important documents and, in particular, EC Directive (EU) 2019/944 on common rules for the internal electricity market (IEM) [7] and the corresponding IEM Regulation 2019/943 [8].
- The European Green Deal. The document introduced a visionary and holistic approach to the EU's climate and environmental policy that cuts across policy areas and safeguards and integrates sustainability in further policy design and in the implementation and revision of existing regulations
- For the scope of the present project, it is relevant to mention the EC’s intentions to assess all member states' National Energy and Climate Plans (NECPs) that were completed in 2019. The European Commission decided to assess the level of ambition in the individual plans and the need for further measures if the level of ambition was not sufficient.
- Communication (2022/230) REPowerEU Plan [9] addressing an unexpected political and economic turmoil caused by the outbreak of the war in Ukraine, which resulted in unprecedented energy crises with extremely high prices for electricity in Europe. It proposes to increase the headline 2030 target for renewables from 40% to 45% under the Fit for 55 package [10].
- The European Commission proposes amendments or additions to three Directives: The Renewable Energy Directive (REDII) (2018/2001) [11], the Energy Performance for Buildings (2018/844) [12] and the Energy Efficiency Directives (2018/2002) [13].

In addition to these, the most recent updates of the Pan-European and regulatory landscapes are:

- Proposals for electricity market reforms: In response to the above-mentioned energy crisis, caused by the war in Ukraine, Ursula von der Leyen announced in September 2022 [14] that the European

Commission would work on "a deep and comprehensive reform of the electricity market". Following this several reform proposals have been already mentioned, where proposal from Natalia Fabra is probably the most well-known [15]. The proposed reform should lead to efficient and equitable electricity market outcomes by diversification of contracts according to the generation technologies and time horizons.

- Development of Guideline on Demand Response: The major difference for this Guideline is that it will be elaborated by EU DSO entity and will apply essentially to the distribution grid, where the main part of the Smart Grid domain resides. Therefore, it is difficult to underestimate significance of the presented ACER's Framework Guideline on Demand Response [16], which presents an outline for the main subjects to be stipulated in the forthcoming Guideline on Demand Response. It refers to several topics, which seem to be pivotal for the Smart Grids domain:
    - Storage ownership
    - Responsibilities and data exchange between Transmission System Operators (TSOs) and Distribution System Operators (DSOs) in planning:
    - Markets flexibility resources can participate in
    - Definition of rules for the local markets emphasising free access and transparency.

The above-mentioned changes in the Pan-European regulatory landscape reaffirm the previously committed decarbonisation targets and indicate that we are stepping into a decisive phase of energy transition in Europe. Furthermore, the outlined actions will inevitably strengthen the necessity for implementing Smart Grid technology and make the outcomes of the PANTERA project more relevant and timelier.

3 Organisation of interactions with stakeholder in the target countries

This section represents the main part of the feedback from stakeholders which was received during interviews and surveys with the stakeholders. Following the description of work and feedback from the stakeholders, the project group recognised the necessity to establish a direct interaction with various groups of stakeholders in order to obtain interdisciplinary feedback allowing to uncover gaps, barriers and in some cases best local practices.

3.1 The main interaction: Interviews and surveys

The interaction started at the first workshop in Sofia in 2019, when the first physical interviews were conducted. Based on this first interaction some modifications were made:

Modifications of the content:

- Several questions were reformulated and merged in order to avoid duplications.
- The area of none-technical questions, related to financing and decision-making was added.
- Instead selecting prioritised technologies from the list, the respondents were asked to formulate the answer freely and indicated the desired priority (sequence) in implementation of technologies.

Modifications of the approach:

- The necessity to make actual recording of the interviews was recognised to secure the conveyed information from the stakeholders.
- Introduction of COVID restrictions limited the possibility for physical interviews, therefore new modifications were made, and the project group continued with interactive web-based interviews. This

proved to function much better than physical interviews, especially since it was much easier to find suitable timeslots for the interaction and achieve sufficient technical quality of the recorded materials.

At the moment of writing, more than 30 semi-structured interviews and surveys have been accomplished in order to establish an open dialogue and identify specific stakeholder needs and expectations. Considering that PANTERA as project aims specifically at Smart Grids domain, which is normally associated with the distribution part of the grid, the intention was to focus on respondents, which are engaged in and have expertise there. However, considering the interdependencies and in particular the growing interaction between distribution and transmission networks (see Figure 3) broader groups of stakeholders were considered. In general, it can be summarised that the expertise, represented in the study covered the whole value chain from final customers to transmission, with main focus on distribution network.

Arranging the interviews proved to be quite time-consuming with fairly high drop-off rate from the candidates. In addition, in order to maintain high quality of the outcomes, the project group cancelled interaction with some of the candidates, which were not qualified for the task.

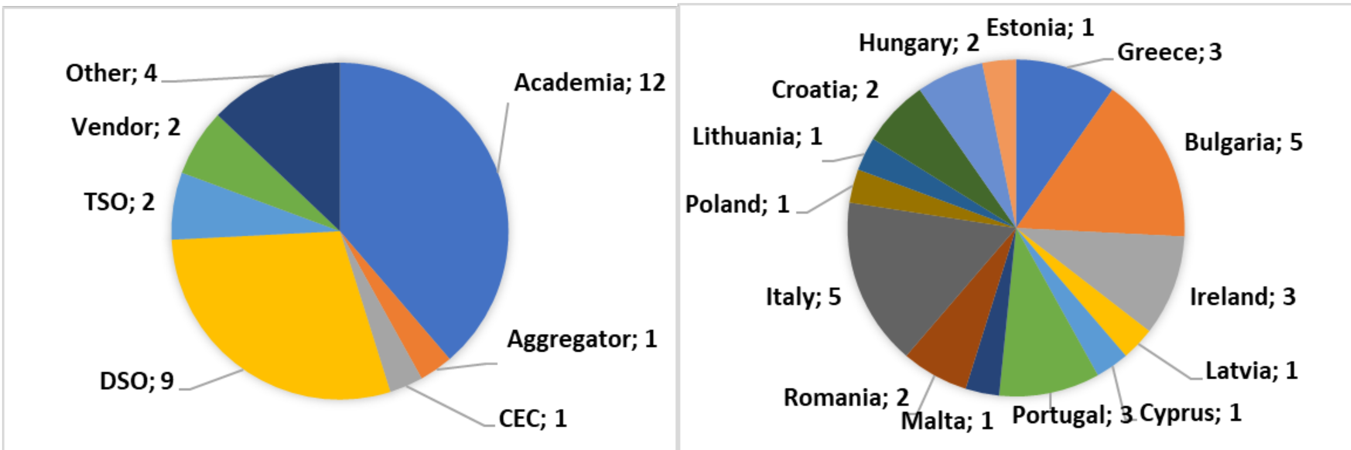

Figure 3 Interviews conducted by the project by March 2023.

The interviews included persons representing key stakeholders such as DSOs, TSOs, vendors, academia, citizens energy communities (CECs) and aggregators, as presented in Figure 3. Category "other" included representatives from Energy Community, Consulting, National Interest Organisation and Contract Research company.

It has also been observed that several respondents have worked in several types of organisations throughout their carrier and accumulated different experiences and tend to present a consolidated view rather than representing the most recent affiliation.

Throughout the project an online survey similar to the interview guide was available, and several stakeholders preferred to submit their feedback in written. There were several cases, when the respondents provided their replies in written and further elaborated them during interviews.

3.2 Additional interactions

In addition to the above-mentioned interviews, in October-November 2021 the activity arranged three separate group interactions with:

- Two stakeholders from Latvia (academia)
- Two stakeholders from Romania (academia)
- One stakeholder from Ireland (other)

During these interactions the project groups presented the current status for the work, preliminary conclusions and received feedback from the participants. These interactions were done as clearing of the project's official milestone MS4 ensuring that the milestone had been achieved. Furthermore, these interactions were used as additional feedback channel from the stakeholders in the target countries.

3.3 Limitations of the method

The following limitations of the method can be marked and were taken into account when performing analysis of the results:

- The selected approach presents rather indicative than precise results, showing the most obvious gaps and shortages.
- The interviewed and surveyed stakeholders represent different actors and various fields of expertise belonging to the SmartGrid domain, and their views and opinions vary accordingly.
- There is a certain level of subjective personal opinions, which are presented at the interviews.
- Since the number of interviews is limited, applying statistical methods for data analysis is impossible.

Interactions with the stakeholders were conducted throughout the whole project. Several global events have happened during this period, including COVID19, gradual recovery from it and the energy crisis starting from 2022. All these changes have influenced responses from the stakeholders, especially the last one. Starting from the second part of 2022, several respondents started to emphasise the importance of security of supply.

4 The technical part

All interviews were carried out according to General Data Protection Regulation (GDPR) requirements and organised as semi-structured interviews with rather qualitative results. Following GDPR, results of the interviews should not be traced to the respondents, therefore the results are mostly presented in consolidated form with exception of technical topics, which are presented in country-specific manner (see Table 9.1 and Table 9.2 in the Annex).

4.1 Summary of challenges requiring implementation of Smart Grid Technologies

It is a common understanding that Smart Grid technologies are not an ultimate goal by itself, but rather a combination of technologies, functioning as a tool allowing to resolve certain problems and issues in a cost-efficient way. Therefore, respondents were asked to indicate what challenges do they see today, or 5-10 years, which require implementation of Smart Grid Technologies.

There is a variety of feedbacks related to the challenges, varying by countries and affiliations of the specific stakeholders (see Table 9.1). The following selection is representative:

- **Massive introduction of distributed Renewable Energy Sources (RES):** The main challenge is high variability in production and limited controllability of electricity based on renewables. Massive and fast deployment of RES during the recent years was not neither foreseen nor followed by development of the grid. Conventional development of the distribution network has an investment cycle for new components and lines in that can be up to five years, while installation of PVs from decision-making to commissioning takes few months. Smart Grid technologies allow to narrow the gap between these two.

- **Electrification of transport, Electric Vehicles (EVs):** Different types of respondents from various countries mentioned the expected deployment of electric mobility as a huge challenge, especially in the major European cities, requiring intervention of Smart Grids technologies in order to avoid lengthy and extremely expensive upgrade of the grids. Some of the respondents indicated that electrification of transport is more urgent and demanding issue than deployment of PVs.
- **Growing necessity for consumers' empowerment and engagement**. Customers are gradually becoming prosumers both through ownership of distributed generation and provision of demand response services. Smart grids require acceptance from the end-users, some poor experience with projects, when end-users dislike the new technologies. The role of the customers is very important in a decentralised system.
- **Economic challenges:** It is a clear necessity to improve the economics within the power sector, making it more targeted, and to facilitate reliability and security of energy supply. This requires an optimal use of the existing assets and even more importantly avoiding stranded assets.
- **Growing quantity of data from different sources,** such as EVs, RES, AMI etc. which will need processing, understanding and utilizing in order to be useful in building new tools/models and efficient operation of the system.

Specific challenges were also mentioned, related to certain countries as:

- **Isolated systems:** Difficulties in operation of none-interconnected power systems at islands or need for increase of system's flexibility due to limited interconnection to other countries.
- **Legacies from the past:** Power systems in several focus countries, were initially developed as consistent parts of bigger energy systems, therefore there are several inherent shortcomings in the existing topologies of the power grids.

It is necessary to mention that some of the answers were based on real experiences, but mostly on expectations of the forthcoming changes. Nevertheless, there are surprisingly many commonalities among replies from the focus countries.

4.2 Additional points and barriers

Standardisation: Among the technical issues, different aspects of standardisation, including interoperability and legacy problems (products, services and technologies) were mentioned as pre-dominant technical barriers for development in the Smart Grids domain. This issue is so urgent that it calls for necessary actions from the regulatory part. It was also mentioned that this, apart from the electricity sector, also acts as a barrier for the sector coupling process.

Lack of technical expertise: One of the feedback items pointed out that there is a very strong focus on ICT-related expertise in education, so we may lack specialists with expertise in electric power engineering in few years. Another respondent mentioned that some national experts left the country due to the growing internationalisation and involvement in European projects.

4.3 Priority areas for implementation of Smart Grids solutions

An overview of the received feedback related to national priorities for the implementation of Smart Grid technologies is presented in Table 9.2.

The table presents a compilation of replies, where in some countries, more than one interview has been conducted.

A summary of the answers in Annex;

- The first technological priority is Advanced Metering Infrastructure (AMI), as a mandatory enabler of the next steps. However, proper utilisation of its potential requires a set of actions, including standardisation, and regulatory and administrative conditions, allowing to use and exploit the data. Installation of AMI is not a one-time action but a continuous stepwise improvement.
- The second technological priority is related to enabling observability and controllability functions for DSOs which allow handling RES and the deployment of EVs without compromising the overall reliability of the system.
- The third priority points towards enabling flexibility and Big Data technologies for enhancing the planning and operation of the grid, and handling the data protection issues, which will arrive simultaneously.
- Development of tools for smart use of resources ensuring efficient and reliable operation of the system, including automatization of the grid operation and data management. System adequacy and system reliability and stability are the most important keystones. Smart Grid can be used to ensure these parameters.

In addition, the feedback underlines the importance of timely knowledge transfer from the countries which were forerunners in implementing new technologies, for example, Italy in the case of AMI, to the following countries.

Based on the provided overview two important things can be observed:

- There is a striking similarity in technological priorities, even though the answers are provided from different countries and different stakeholder groups.
- What is more interesting is that the feedback complements an additional level of details across countries.

5 The non-technical part: barriers for more activities in the SmartGrids domain

The importance of the non-technical aspects was raised already during the first interaction at Sofia workshop, where it was pointed out the necessity to extend the scope of the topics. The question about additional barriers was not divided into technical or non-technical areas. This was rather an attempt to collect complementary feedback from both sides. Several topics were stated as barriers for more activities in the Smart Grid domain and are described as follows.

5.1 The role of the National Contact Points

Initially interactions with the stakeholders did not include any questions about the National Contact Points

(NCPs). This became an additional point based on the first feedback and the preliminary learnings from the first two workshops.

According to the European Commission, “the network of National Contact Points (NCPs) is the main structure to provide guidance, practical information and assistance on all aspects of participation in the Horizon Europe program. NCPs are also established in many non-EU and non-associated countries ("third countries")”. The European Commission defines a set of minimum standards for the NCPs [17] giving freedom to adapt and extend the NCPs role according to the national circumstances.

Touching the issue of NCPs, it is necessary to mention that none of the interviewed mentioned that NCPs’ work is poor. The general feedback is that NCPs carry out activities according to their mandates, and the activities include workshops, “match-making” events, information etc. Several concerns were however raised by the stakeholders: it seems like NCPs in general focus exclusively on support related to preparation of proposals and initiation of projects, while the project work and successful accomplishment and achieving of the expected results gets very little attention.

This further relates to two following issues:

- Administrative and reporting tasks throughout implementation of European projects can be very demanding for inexperienced organisations. This creates additional costs or in some cases even financial losses due to non-compliance with rules.
- Successful achievement of the project results also requires adequate professional expertise and financial solidness of the involved project partners. This has to be considered before facilitation of contacts among potential partners.
- Research organisations, such as universities often have sufficient expertise in development and submission of project proposal, so for them the regular NCP services are often unnecessary.

Revision of NCPs’ tasks and duties: It was also commented that the existing scope of support services from NCPs should be revised and more pro-active involvement in initiation of projects should be considered. From the replies it appears that several NCPs are sufficiently skilled for providing these services.

As it has been mentioned, the European framework encourages the Member States to shape the NCP services according to the local needs and priorities, so such modifications may allow to improve some of R&I areas, which seem to be under prioritised today.

Finally, NCPs will function much better if they are duly and constantly updated about the ongoing status R&I activities in the members states, gaps and shortcomings. Therefore, the activity proposed to launch a specific section at EIRIE i.e. “The NCPs’ corner” which will support their activities.

5.2 National Energy and Climate Plans

Mandatory development of the National Energy and Climate Plans (NECPs) for the period 2021-2030 was introduced by the European Commission in 2018 as part of Clean Energy for All Europeans package [18] and [19]. This is another question that was added after assessment of outcomes from the first interaction with the stakeholders, to find whether the respondents were aware of the existence and content of NECPSs

Firm connection of NCPs and R&I priorities is needed: It appears that in practice all respondents were aware of such national plans, while some of the respondents demonstrated detailed knowledge of the documents for their respective countries. The received feedback does not indicate that the national NECPS deviate from the Pan-European and national goals. However, some of the respondents indicated a missing link between NECPs and specific priority areas for national R&I activities, allowing to close any open gaps.

5.3 Change of mindset both on the industry and customer sides

In several cases, DSOs instead of deployment of Smart Grids choose to use conventional solutions, even though they are more expensive. It is necessary to convey to the industrial actors that Smart Grids actually work and apply targeted support schemes.

Smart Grids is more a philosophical concept than a technical concept, allowing active involvement of citizens. However, citizens are not familiar with the Smart Grid concept. Smart Grids can be a useful tool for introduction of ICTs to the end-users.

5.4 Funding procedures for R&I Projects

This part combines different issues, which are directly related to various aspects of the national funding of R&I projects.

Lack of targeted funding: Lack of targeted funding towards Smart Grids was mentioned as the main barrier and showstopper for many R&I activities. Several respondents pointed out that incentives should be focusing on specific topics to encourage progress in the R&I activities. Part of turnover at System Operators should be used for the development of Smart Grid solutions.

Too much focus on high TRL projects: The recent Pan-European programs tend to assign very high TRL requirements to the announced Calls, which are related to the Smart Grids domain, ignoring the need for some basic research activities in this domain.

Demanding application procedures at national levels: Countries may have several national funding agencies with different requirements, especially for paperwork. It is very difficult to obtain a clear overview and follow different rules and requirements. Harmonisation of the application process, at least at the national level, can be a solution.

5.5 Issues related to national regulations

Several mentioned issues can be connected to the national regulations. Addressing regulatory shortcomings can be a very lengthy and demanding process. However, this can be significantly accelerated by introduction of new methods and in particular regulatory sandboxes.

The necessity for creation of national regulatory sandboxes: Regulatory sandboxes are an important tool, which enables a real-life environment for testing of innovative technologies, products, services or approaches, which are not fully compliant with the existing legal and regulatory framework. They are operated for a limited time and in a limited part of a sector or area. The regulatory sandboxes are essential for assessment of potential innovations, requiring changes in the regulatory framework and brining this to the next level of development.

Common Pan-European guidelines for Regulatory Sandboxes: The necessity of sandboxes was not in the focus for interaction but was mentioned by several respondents. More specifically, reference was made to the importance for creation of sandboxes. According to the provided feedback, in some of the countries there was not existing practice or legal framework for creation of sandboxes. Other respondents pointed out that the National Regulators are not necessarily negative to these, but the process for obtaining the necessary permissions was very lengthy and time-consuming. It appears that the target countries have quite variable national practices related to Regulatory Sandboxes.

Following this, a case study was conducted for improving the formal procedures, which is presented in D6.4 [20]. In general, the case study concluded positive results for the creation of the regulatory sandboxes and necessity to streamline the bureaucratic procedures for granting permissions to specific project and initiation of sandboxes.

Shortcomings of the legislation: Different aspects of national legislation, including the slow transposing of European Directives into national legislation and the consequences of this, were mentioned as a barrier. This delays the implementation of several changes regarding the evolution of different roles and responsibilities in the energy sector. There are several open questions about which actor in the power industry does what. This is the first thing to be done i.e., a clear market role model should be defined.

Obsolete market design: Several respondents mentioned the organisation of markets as a barrier, such as:

- Many of the present market mechanisms are specific to certain technology and can act as a barrier to the entrance and implementation of new technologies. This applies, for example, to markets for ancillary services, which were initially designed for thermal energy, and do not allow the use of alternative technologies such as storage.
- The present market design for electricity trading is based on marginal production costs. This has not changed much in the last 30 years and is becoming obsolete nowadays when RES production costs are close to zero.
- Market design for "flexibility" products is still missing.

This issue should be approached as a common approach from the Pan-European level because solving it in a single country should be linked to and be justified by the common Pan-European approach.

6 Technological Gap Identification Process

PANTERA has already developed a universal methodology for evaluating the national and EU projects and their contribution to analysing the maturity of PANTERA-defined “Smart Grid technologies/systems” and the ETIP SNET-defined “FUNCTIONALITIES” to achieve the decarbonisation of integrated energy system target as outlined by the ETIP SNET Vision 2050 [21]. The evaluation methodology is known as PANTERA proposed RICAP (R&I status and Continuous gAP analysis) process, and the details of this can be obtained in D3.1 (see [22]) and [6]. This report does not include the maturity index calculation and findings since the task is still ongoing and its final outcomes will be reported in a dedicated report [23].

The RICAP process creates a technology/system mapping under the five dimensions shown in Table 1:

- Integrated Grid
- Customers and Markets
- Storage
- Generation
- Digitalisation, Communication and Data.

Figure 4 shows the evaluation methodology of RICAP.

RICAP process takes input as “smart grid project info”, where some specific pieces of project information are extracted from the deliverables/publications. This is then fed into the “smart grid technologies/systems block. As a part of the process, R&I status is analysed here at a national level. Smart grid technologies/systems information is then transferred to the NECP block where the R&I priorities are extracted from the national plan document. “Identification of R&I needs” is the final block of this dynamic process where the final status, priority, technological maturity, gaps are analysed. Final outcomes are planned to feed to the EIRIE (European Interconnection for Research Innovation & Entrepreneurship) platform.

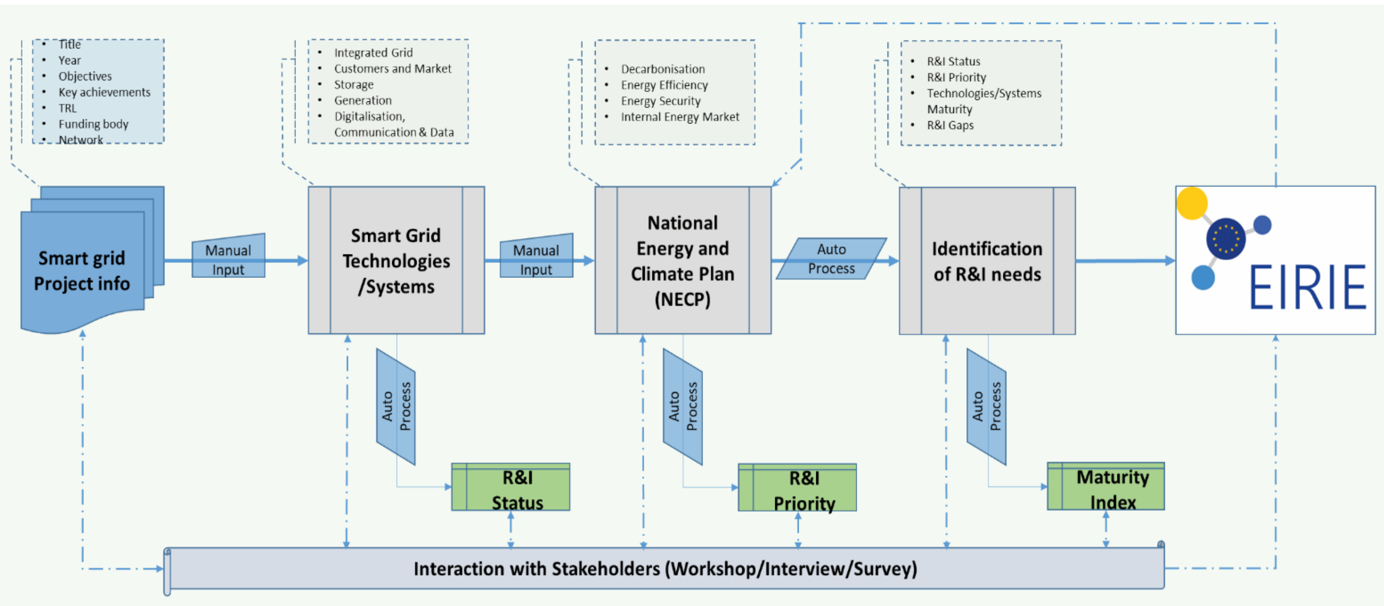

Figure 4 RICAP process

The PANTERA team has also identified the R&I priorities for 2020 – 2030 as defined in the NECPs (at the national level) and its link with the “Smart Grid technologies/systems” and “FUNCTIONALITIES”. This further helps to identify the R&I needs at the national and EU level. The selected approach presents somewhat more indicative than precise results, showing the most obvious gaps and shortages.

Table 1 Smart Grid Technologies/Systems

Integrated Grid (IG)		Customers and Market (CM)	
IG1	Flexible ac transmission systems (FACTS)	CM12	Distributed flexibility, load, forecasting,
IG2	Models, Tools, Systems for the operation	CM13	Smart appliances
IG3	HVDC	CM14	Building control, automation and energy
IG4	Forecasting (RES)	CM15	Electric vehicles
IG5	Asset management	CM16	Energy communities
IG6	Outage management, fault finding and associated	CM17	Lighting
IG7	Equipment and apparatus of the integrated grid	CM18	Electricity market
IG8	Equipment, sensing, monitoring, measuring for	**Storage (St)**	
IG9	Advanced distributed control	St19	Electric Storage
IG10	Feeder auto-restoration / self-healing	St20	Thermal Storage
IG11	Smart metering infrastructure	St21	Power to X
Generation (Ge)		St22	Pumped storage
Ge24	Flexible generation	St23	Other Storage
Ge25	Solar including PV & Concentrated Solar Power	**Digitalisation, Communication and Data (DCD)**	
Ge26	Wind	DCD30	Communication networks including devices and
Ge27	Hydropower	DCD31	Digital Twins
Ge28	Hydrogen & sustainable gases	DCD32	Artificial intelligence
Ge29	Other generation	DCD33	Data and cyber security including repositories

In total, 409 projects have been analysed in this report, as shown in Figure 5, and around 30% of these projects have at least two of target countries in collaboration. Details of the types of projects, fundings, technologies, analysis are available in deliverable D4.3 (see [3]). In most cases, the contribution from each participating partner/country in a specific technology/system is not available; thus, it is very difficult to identify the individual contribution. Nevertheless, based on the available information, this study is a very high-level indication of the R&I status, priorities, and gaps in smart grid technologies/systems. These findings may change with the increase in the number of projects assessed and detailed information on the considered technologies. Thus, it is imperative to get the national expert/resources/sources to be involved in the PANTERA-developed RICAP process to fine-tune the “R&I status” of the countries. Smart grid stakeholders at the national level joining PANTERA regional Desks and Working Teams could effectively support these activities.

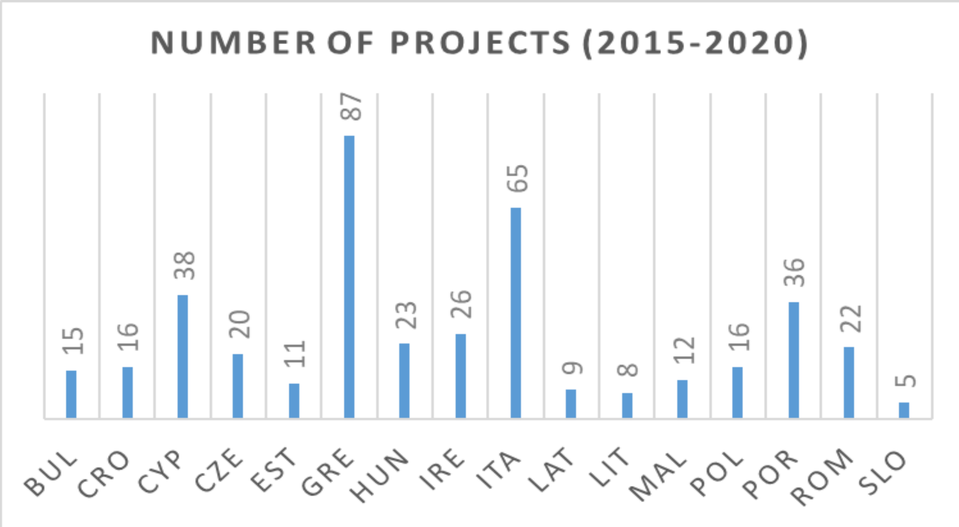

Figure 5 Number of RICAP analysed projects for each country.

Based on all this high-level information on R&I dimensions and our mapping with smart grid technologies, it appears that most of the countries still have big gaps in R&I status and specially in the technologies/systems under the "integrated grid" and "customers and market" technologies, as shown in Figure 6. All these countries mostly focus on:

- IG08 - Equipment, sensing, monitoring, measuring for analysis and solutions and control
- IG11 - Smart metering infrastructure
- CM12- Distributed flexibility, load, forecasting, management & control and demand response including end devices, communication infrastructure and systems
- CM14- Building control, automation and energy management systems
- CM15-Electric Vehicles
- CM18-Electricity market

It is expected and reasonable that all countries will focus more on all technologies/systems considered under the "Integrated Grid" and "Customers and Market" groups. These are very much aligned with their 2030 NECP targets.

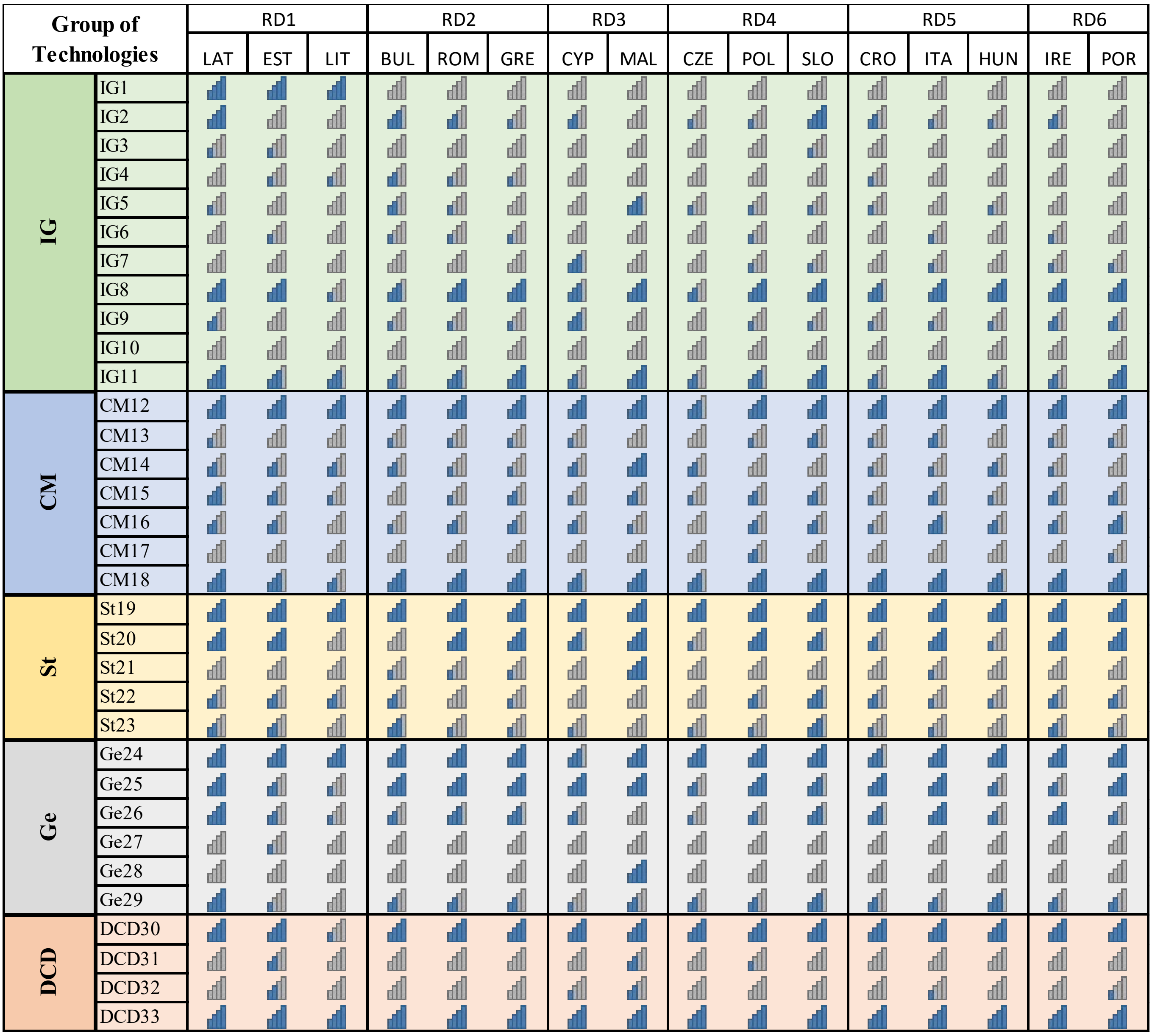

Figure 6 R&I status and gaps analysis under the RICAP process

One of the core parts of the advancement and development of the smart grid electricity grid and active customers' participation in the electricity market is to develop the digitalisation infrastructure, including advances in communication, big data analysis and cybersecurity systems. Thus, the technologies/systems under the "digitalisation, communication and data" group are equally important for all countries. Clear gaps appear for:

- DCC31-digital twins and
- DCC32-artificial intelligence technologies/systems.

Thus, we expect that all countries will focus more on these technologies/systems in their R&I priorities and will also participate in projects accordingly.

Depending on the geographical locations and resource availability, the technologies under the "generation" and "storage" groups can differ.

It is very much true that all countries are expected to give more priorities in exploring:

- GE27 - hydropower
- GE28 - hydrogen and sustainable gases
- GE29 - other generations.

Similarly, under the energy "storage" technologies/systems group, more priorities are expected in:

- St21 – power to x,
- St22 - pumped storage and
- St23 - all storages other than electric and thermal storages.

In general, these findings comply with the feedback, collected from the direct interaction with stakeholders in the focus countries, both with regard to the challenges, requiring implementation of Smart Grids technologies (see Section 4.1) and priority areas for implementation of Smart Grids (see Section 4.3). Such as massive introduction of distributed RES, electrification of transport, EVs, consumers engagement require more focus/advancement on all the technologies under the "integrated grid, customer and markets" along with "digitalisation, communication and data" technologies. This proves that the developed RICAP process can give a reliable information about status for R&I activity in a given country, and thus serve as an important supporting tool for different stakeholders, and in particular for the national decision-makers.

7 Processes and trends: discussion

7.1 Slow Transposition Processes

During the recent year the European Commission has introduced several very ambitious targets (see Section 2.2) and pivotal documents e.g., Directive 2019/944 [7], which have been gradually increasing the Pan-European environmental goals.

One of main issues, which was mentioned repeatedly by the stakeholders was the mismatch between the Pan-European regulatory documents i.e., Directives and national legislation in the target countries. It can be several reasons for this, several respondents mentioned very lengthy national transposition processes in some of the European Member States. Transposition is the process of incorporating EU directives into the national laws of EU Member States [24].

Apart from Directives themselves, the delayed introduction of new processes, as for example electrification of the transport and mechanisms enabling countries to achieve this. This may gradually bring several unfortunate consequences for some of the Member States, and result in decoupling of the Pan-European R&I needs and priorities with the national. This brings several concerns to the focus countries:

- Focusing on somewhat outdated R&I priorities in the national funding programs will result in stagnating national R&I expertise in the potentially critical and challenging areas. Following the same trend, this also results in outdated education of the young specialists.
- The decoupled R&I needs discourage national industrial actors to get involved into R&I activities at both national and European levels. At the very same time research organisations willing to obtain external funding and getting Involved in the European projects, develop products and expertise, which cannot be

properly exploited under the domestic conditions, where the Pan-Europeans level challenges have not fully emerged yet.

The challenge is that the emerging gaps may grow even bigger due to ever increasing environmental goals from one side and self-accelerating stagnation on the other side.

7.2 Geographic proximity alone is not enough for regional cooperation

This issue was presented and discussed before (see [25]). The general observation so far is that there are normally two layers of research programmes and operating funding agencies: national and Pan-European. In some areas, as for example the Nordic region there is however a long-term tradition of having regional cooperation, functioning as an additional intermediate level. This cooperation functions in particular in the energy field, probably due to common synchronous energy system, previously known as NORDEL. This type of cooperation proved to be very efficient and fruitful for many years, especially when it comes to replicability and fast deployment of innovative results across several countries.

The question of regional cooperation was discussed during the interviews, and apparently this practice seems to be more or less unknown in the target countries. Establishing regional cooperation is not impossible, but rather difficult due to many reasons:

- Historical legacies in configuration of the local energy systems, resulting in different challenges
- Different level for transposition of the European Directives and accordingly somewhat different goals
- No previous experience in regional cooperation, including bilateral contacts between decision-makers
- No incentives for creation of such cooperation coming from the national governments

Referring to the experience of fruitful regional cooperation in Nordic countries, mentioned as an example of best practices in [25], it seems like establishment of such cooperation requires presence of common regional challenges and strong political will and engagement. In case of Nordic countries, it is the Nordic Council of Ministers, the official body for inter-governmental co-operation in the Nordic Region. It seeks Nordic solutions wherever and whenever the countries can achieve more together than by working on their own.

8 Conclusions

The document summarises results from "Key topics and content management" activity in H2020 project PANTERA. The activity created a twofold approach, where the first workflow (RICAP) developed a dedicated process for identification of gaps and missing subjects, while the second concentrated on direct interaction with the stakeholders. These two activities functioned in a complementary way throughout the project to define the operational topics of PANTERA through regular interaction with the stakeholders, following the legislative and political changes related to the EU energy transition (at national or EU level) 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.

Results from the direct interaction with stakeholders highlighted importance of the none-technical aspects and indicated several barriers, preventing development of Smart Grids Technologies in the target countries. Among these, the activity recognises the importance of NCPs' activities and proposes several modifications of their roles and responsibilities. Furthermore, the EIRIE platform can be a useful support for NCPs.

Therefore, the activity suggested to introduce a dedicated “NCP Corner” in EIRIE.

Several topics are related to shortcomings of the existing regulations in the target countries. Addressing regulatory limitations can be a very lengthy and demanding process, as for example the introduction of new electricity market designs. However, this can be significantly accelerated by introduction of new methods and in particular by using regulatory sandboxes. Harmonised Pan-European approach should support creation of national regulatory sandboxes in the focus countries.

The study defined several technical issues, which require implementation of the Smart Grids technologies in the focus countries. Despite several similarities as the introduction of RES and the forthcoming electrification of transport, some countries may have specific challenges related to their legacies in configuration of power systems, their geographic locations or some other properties. Smart Grids is a powerful tool combining multiple technologies and the study has emphasised the importance of a harmonised deployment of the technologies in a correct sequence in order to maximise the positive effects and minimise costs related to stranded assets.

Slow transposition of the Pan-European regulatory acts into the national legislations is one of the main concerns for the stakeholders in the target countries. Considering the steady growing Pan-European targets it may further increase the existing R&I gaps.

In addition to this, feedback from the interaction supported refining of the RICAP tool and served as a verification for it. Based on this, the activity concludes that RICAP can be a useful supporting tool for a wide range of national stakeholders, including decision makers. The activity advises integration of the tool into EIRIE platform.

9 Annex

Table 9.1 Indicated challenges today or 5-10 years, which require implementation of Smart Grid Technologies.

Country	Indicated challenges
Bulgaria (5)	(The first interview, this question was not asked)
Ireland (3)	• Improved utilisation of the existing distribution and transmission assets, so the existing assets can be utilised better. • Distribution system is as huge challenge, need for small low-cost devices for control and metering. How we can statistically make forecast of aggregated DR, not individual devices. • Monitoring and controllability of small-scale renewables is the most critical challenge in the closest future (example of Australia, having 65% of non-synchronous generation). • The challenge is to apply the new tools and methods instead setting a new wire into operation. • Electrification in general and in especially the growing number of electrical vehicles is going to be a huge challenge.
Romania (2)	• New goal of 55% RES in 2030. • Dissemination of research results within CRE members and other industry partners, due to some reluctance to change their business model. • Charging infrastructure for electric vehicles. • Integration of renewable and distributed generation. • Advanced metering infrastructure.
Latvia (1)	• Accommodate the increased share of renewables. • Change the customers' present mindset. • Smart grids require acceptance from end-users. The customers' role is important in a decentralised system.
Italy (5)	• The energy transition/decarbonisation as a paramount challenge • The electric mobility creates a lot of problems, especially in the major cities • Smart Grids is more a philosophic than technical concept, allowing involvement of citizens. Citizens are not familiar with the Smart Grid concept. • Flexibility and SmartGrids are needed to manage the load and keep the tariffs and reasonable level. • Flexibility to manage the load and keep tariffs at a reasonable level. • Ever increasing abundance of distributed generation, especially wind and PV plants in distribution network. • Phase-out of coal power plants (app. 10) in Italy, which should be phased out by 2025. These are major suppliers of flexibility and must be substituted. • Market and regulatory framework for delivery of flexibility services. • Difficulties with expending the traditional grid - difficult to deploy the traditional infrastructure. This requires an optimal use of existing assets and avoid stranded assets. • It is necessary to keep the quality of services for the existing customers • Some of the societal aspects as for example Sustainable Energy Goals (SDG) are difficult

	to address and solve as for example energy poverty. We need a more in-depth connection with the society and involve users into the power market.
Poland (1)	• High variation in renewable generation. • Voltage stability problems in the north where the grid is less developed and wind production is located. Can be solved with FACTS, but difficult to justify cost. • Balancing issues together with some technical limitations to import/export.
Lithuania (1)	• Digitalisation, control solutions and effectiveness. • District heating.
Greece (3)	• Improve the operation of non-interconnected islands. • Deployment of EVs and related infrastructure. • Need for storage to meet the goals for renewable energy.
Hungary (2)	• Requirements from business requiring a holistic and cross-sectoral approach for operation. • Coordination between requirements, the necessary technologies and interoperability. • Smart Grids are necessary to serve the variable demand and meet the variable generation from the renewables.
Estonia (1)	• Due to historical legacy (very sparse grid) requires deployment of grid automation instead of network expansion • Cybersecurity due to substantial increase of prosumers, where many of them use inverters with Chinese origin • Security of supply due to disruption of natural gas supplies
Portugal (3)	• Portugal and Spain have limited connection to the rest of Europe. How to manage this link in cost-efficient manner to maximise the value of the asset. Use of FACTS will allow to maximise the already installed assets. • Customers' ability to participate actively on a market side. • Further installation of Smart meters. allowing more participation and differentiation of services. • Portugal is experiencing energy poverty, low energy efficiency in the building sector, and high energy tariffs on the end-user side. Many of the recent SmartGrid solutions can help to improve the situation. • The energy transition will lead to a much more distributed world, where the balanced participation of supply and demand should be coordinated with the operation of the networks and the system itself. • The need to improve observability and control, flexibility and interaction with stakeholders, as well as the digitalisation process and data handling are just a few examples of the areas to be addressed from a technological point of view.
Croatia (2)	• Disintegrated data sources with the system operators, making interactive data exchange and coordination very challenging. • Multiple "sources of truth" with the system operators, hindering integration of new data sources (such as EVs, DR etc.) • A large share of low carbon technologies is being integrated, especially on the user side, behind-the-meter, in a poorly observable low voltage network. • A large quantity of data that will need processing, understanding, and utilizing to be useful in building new tools/models.

	• Distributed energy supply will probably pose challenges to the current grids due to big potential for PVs in Croatia. • The SmartGrids will probably improve flexibility of the system. • Balancing supply and demand of seasonal levels by using heat pumps and increasing of the electricity demands. • The grid initially was developed as a part of a bigger country, so some of the connections are weak. • Smart heating grids can be very beneficial in the urban areas, which are currently relying on natural gas.
Malta (2)	• Electric mobility in the LV network (very crude network) is the biggest challenge, more than PVs.
Cyprus (1)	• Financing, available statistical data, lack of information in general on national or local level

Table 9.2 National priorities for the deployment of SmartGrid Technologies (the brackets show number of responses pr. country)

Country	Indicated priorities
Bulgaria (5)	(The first interview, where this question was not asked, technologies were selected from a list) • Advanced metering as key enabler • Active demand response schemes
Ireland (3)	(The second interviews, where this question was not asked, technologies were selected from a list) • Grid observability and controllability is the most important topic. • Market-grid operation • Monitoring and control • Cybersecurity, also as a new area related to IoT • Infrastructure to host EV • Smart Metering is happening anyway • New planning approaches and tools • Enhanced ancillary services • Smart Asset Management
Romania (2)	• Advanced metering infrastructure. • Operational improvement for safe and secure supply. • Extension of metrological metering within balancing market products. • Design of developed Big Data systems. • Integration of renewable and distributed generation. • Charging infrastructure for electric vehicles.
Latvia (1)	• Prepare the T&D grids for smart grid solutions through e.g., standards and connection requirements. • Data protection. • Regulatory framework for how the available infrastructure should be shared between

	the actors. • Clear rules for billing and settlement of active customers that will not have demotivating effect.
Italy (5)	• Observability provided by advanced metering functionality and sufficient settlement. The first generation of smart meters has already been deployed. • Infrastructure for Smart Charging of electric vehicles or even vehicle to grid (several) • Flexibility capability i.e., demand-side response management capability. • Controllability: develop tools for smarter use of resources in the grid, e.g., better utilisation of smart metering. • Establish advanced services for the demand side. • Creating new business models, regulations, and market actors to fully exploit the available data and new functionalities. • Significant level of bureaucracy in Italy, requiring obtaining a lot of permissions. • Much more attention should be given to regulatory issues for deployment of Smart Grid technologies. • Building of a network for interconnected expertise is necessary for Smart Grid implementation.
Poland (1)	• Smart metering • Observability • Better use of flexible resources
Lithuania (1)	• System adequacy • System reliability • System stability
Greece (3)	• Roll-out of Smart Meters for all consumers, including LV residential. (Currently most MV and big LV customers) • Efficient proceeding of metered data • Improved observability for DSOs • Application of controllability of production based on renewables and increase of hosting capacity. • Digitalisation of network operation, planning and licensing procedures (connection of PV to a LV network takes several months at the moment). • Introduction of flexibility markets
Hungary (2)	• To use the already existing Smart Meters as statistical source to improve the knowledge and observability of the grid • Sensoring to improve observability of the grid to get even more data in real-time (requires telecommunication development) • Control capability of the SCADA system can be used • Storage, demand response and introduction of Energy Communities
Estonia (1)	• Estonia is already far ahead in sense of Smart Metering implementation. • Automatization of the grid operation should be the next step and data management.

Portugal (3)	• The smart meters are the starting point for many other developments. It should go quicker and deeper. • Many times, the problem is not the technology, but regulatory and administrative issues, which are not prepared for this. The administrative infrastructure does not allow to use technologies. • Tools to cope with the new realities as stochastic analysis e.g., grid conditions. Increasing the overall smartness level • Facilitating the smart use of resources • Smart metering • Grid observability and control • Flexibility • Local energy system and smart cities • Data handling and digitalisation, smart grids deployment, interaction between system operators • Solve regulatory and administrative issues that are not prepared for technological development. Most technologies are ready, while the framework around them is not.
Croatia (2)	• Improvement of observability, especially in LV networks. • Improve data processing (collecting, processing, coordinating/exchanging, utilizing for different applications) • Improve the controllability of the network by either installing new smart components or by digitalizing and unlocking the controllability/automation of the existing equipment • Create a framework to get customers to go from passive to active participants in the power system. • Energy storage and smart grid management
Malta (2)	• Trying to deploy more intelligence in the consumption e.g. IoT • Making the network more autonomous • Development of the market aspects • Facilitation of smarter use of resources
Cyprus (1)	• To establish an electric vehicle facilitating system, fully functional on national level with live monitoring and data provision

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