# PANTERA
# *Pan European Technology Energy Research Approach*

Work Package 6

## Collaboration working groups

Deliverable D6.4

## Catalogue of potential solutions to overcome acceptance barriers for each country

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## Abbreviations

| | |
|---|---|
| CCS-CCU | Carbon Capture and Storage - Carbon Capture and Utilisation |
| CSA | Coordination and Support action |
| DG ENER | Directorate-General for Energy |
| DSO | Distribution System Operator |
| ERDF | European Regional Development Fund |
| EC | European Commission |
| EIRIE | European Interconnection for Research Innovation & Entrepreneurship platform |
| ETIP SNET | European Technology and Innovation Platform Smart Networks for Energy Transition |
| ETS | Emissions Trading System |
| EU | European Union |
| EV | Electric Vehicle |
| GDPR | General Data Protection Regulation |
| HVDC | High Voltage Direct Current |
| IWG | Implementation Working Group |
| KPI | Key Performance Indicator |
| MS | Member State |
| NCP | National Contact Point |
| NECP | National Energy and Climate Plan |
| R&D | Research and Development |
| RD&D | Research, Development and Demonstration |
| R&I | Research and Innovation |
| RES | Renewable Energy Sources |
| RICAP | R&I status and Continuous gAP analysis |
| RRF | Recovery and Resilience Facility |
| SET plan | Strategic Technology plan |
| SME | Small and Medium Enterprise |
| TRL | Technology Readiness Level |
| TSO | Transmission System Operator |
| WP | Work Package |

## 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 report summarizes common activities and the work performed under each Desk individually and discusses possible pathways to facilitate deeper involvement of low activity countries.

PANTERA project activities has showed that collaboration in its various dimensions is the key solution to facilitate R&I activities:

- Communication between national representatives and the EC. Establishing open and effective lines of communication between national representatives and the EC is crucial for promoting the alignment of national policies with European objectives and priorities. Through regular and meaningful dialogue, national representatives can stay informed about EU policies and initiatives, ensuring that national policies are aligned with the broader European framework. This collaborative communication helps to foster a harmonized approach, enabling countries to actively contribute to the European agenda while addressing their specific national interests.
- Regional cooperation plays a pivotal role in fostering the development of both individual countries and the broader region. By joining forces and collaborating on common goals, countries can achieve greater progress and prosperity than they would individually. This cooperation not only benefits the participating countries but also presents valuable opportunities for smaller nations to have their voices heard at the EU level.
- Close cooperation with EU-level initiatives and organizations. Collaborating closely with EU-level initiatives and organizations provides national stakeholders with opportunities to strengthen their position at the EU level and increase their visibility. Active engagement in EU-level initiatives enables national stakeholders to have a greater say in decision-making processes, influence policy developments, and foster partnerships with other European counterparts.
- Effective communication between national bodies and researchers: Ensuring effective communication channels between national bodies and researchers is crucial for supporting proposal preparation and enhancing the quality of research proposals. By facilitating clear and timely communication, national bodies can provide researchers with the necessary guidance, resources, and support to improve the preparation and presentation of their proposals. This targeted communication contributes to the submission of high-quality proposals and enables more efficient allocation of resources to promising projects.
- Cooperation between researcher groups. Collaboration between researcher groups at national, regional, and European levels facilitates the exchange of lessons learned, ideas, and knowledge. By leveraging collective expertise, researchers can enhance the quality of their proposals and increase their prospects of success in funding calls. This gradual process allows them to gain recognition and bolster the position of their respective organizations within the broader EU landscape.

- Collaboration between science and business sectors. The establishment of effective science-business cooperation plays a vital role in the transformation of research outcomes into practical applications and the commercialization of scientific discoveries. By leveraging the strengths of both sectors, this collaborative approach becomes a pivotal aspect in enhancing a country's innovation performance.

Thus, unlocking the full potential of EU funding opportunities is a collaborative effort that requires the active involvement of policymakers, research institutions, businesses, and other stakeholders to create an innovation ecosystem that encourages the translation of research into tangible societal and economic benefits. The EIRIE platform provides necessary tools and functionalities to support this complex but rewarding process.

# 1 Introduction

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.

PANTERA initiative as a coordination and support action (CSA) includes a variety of activities on European and national levels, that may be grouped into three core dimensions:

- the set-up of European Interconnection for Research Innovation and Entrepreneurship (EIRIE), an interactive multidimensional Platform of pan-European status and influence;
- working with regions via Regional Desks aiming to find ways of supporting R&I in energy field, particularly in smart grid, storage and local energy networks;
- joining efforts in supporting R&I through ad hoc Working Teams under the ETIP SNET umbrella.

The WP6 focuses on developing and implementing PANTERA Regional Desk approach (described in next section) aiming at working with countries less involved in EU R&I activities in the Smart Grid domain to identify ways of supporting their wider involvement.

This deliverable is the final deliverable of WP6 that are summarised below for easy reference:

- Stakeholder consultation plans (one for each region/country) (D6.2) [1];
- Review of EU strategic priorities and relevant policy developments (D6.1) [2];
- First version of Consolidated Summary Report of Desk Activities in the Target Regions (D6.3) [3];
- Second version of Consolidated Summary Report of Desk Activities in the Target Regions (D6.5) [4];
- Catalogue of potential solutions to overcome acceptance barriers for each country (D6.4, the present document).

This report summarizes the work performed in all PANTERA target countries separately, briefly discussed centrally implemented actions covering all countries together and provides tentative recommendations in facilitating R&I activities in PANTERA target countries for their deeper involvement in collaborative research in EU level in the field of Smart Grid, storage and local energy systems.

This deliverable D6.4 is structured to cover all aspects of the regional work. It starts with a brief introduction of regional dimension of PANTERA Regional Desk approach in Section 2. Section 3 summarises findings of the work performed centrally, i.e. covering all countries, conducted under WP6 through the entire project timeline. Section 4 looks at each Desk individually, discussing lessons learned from stakeholder interaction, workshops and case-studies. Section 5 includes tentative recommendations for regions and countries. Finally, Section 6 concludes the document. Updated PANTERA country profiles are provided in Annex.

# 2 Regional Desk Approach

PANTERA 6+1 approach, introduced in D6.2 [1] 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.

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 takes responsibility for the host country of the specific desk and for the neighbouring associated, countries. 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.


*Figure 1: PANTERA 6+1 approach*

The EIRIE regional corner and regional page in Confluence (collaborative working space) is structured in the similar way as a continuous support to the PANTERA process.

## 3 Summary and updates of the WP6 activities covering all Desks

The regional dimension was consistently developed from drafting the approach in consultation plan D6.2 [1] setting framework for analysing situation related to energy policy and energy R&I at national level by creating a first version of so-called country profiles in the frame of policy review D6.1 1 [2] and taking corrective measures after the first project year considering results of workshops and analysis D6.3 [3] and D6.5 [4]. This section summarizes the work performed and provides general insights and results coveting all involved countries.

### 3.1 Stakeholder engagement in building EU policy

At the very beginning of the project, we tried to understand how stakeholders are engaged in the EU policy making processes in energy sector. This study was described in detail in D6.1 [2]. The analysis of stakeholder engagement in the legislative process included analysis of participation in the public consultation in the 2030 energy framework and new energy market design, and on the European Parliament level as analysis of selected stakeholders' amendment papers on the proposal for the Electricity market directive.

Analysis of public consultations uncovered that stakeholders from PANTERA target countries appear to be less active in contributing to the EU policy formulation process both directly by submitting their contribution to EC and indirectly via participating in the EU level organisations. Meanwhile analysis of position papers showed that well-known organisations' views are heard at EU level. Common trend is that individual stakeholders (organizations at national level and citizens) seemed to be less active than EU-level stakeholders, and, as a result, national interests may be less visible than EU-wide sectoral interests.

In addition to analyses described in D6.1 [2], below we provide an overview of the PANTERA target countries participation in the SET Plan. As seen in Table 1: PANTERA target countries' representation in the SET plan Italy is participating in all Implementation working groups and is the chair of IWG5 on Ocean energy and co-chair of IWG4 (Deep geothermal energy), IWG8 (Energy Systems). IWG12 (Renewable fuels and bioenergy), meanwhile Cyprus and Portugal participate in ten IWGs and Ireland in eight IWGs. Other PANTERA countries are less active and have limited representation in SET Plan IWGs. Notably, only four of PANTERA target countries (Latvia, Cyprus, Italy, Ireland) are involved in the Energy Systems IWG, which is directly linked to Smart Grid.

*Table 1: PANTERA target countries' representation in the SET Plan*

| IWG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Latvia | | | | | | | X | X | X | X | X | | | |
| Lithuania | | | | | | X | | | | | X | | | X |
| Estonia | | | | | | | | | | | X | | | X |
| Bulgaria | | | | | | | | | | | | | | X |
| Romania | | | | | | X | X | | | | X | | | X |
| Greece | | X | X | | | | | | | | X | | | |
| Cyprus | X | X | | X | X | X | X | X | | X | X | X | | |
| Malta | | | | | | | | | | | X | | | |
| Poland | | | | | | | X | | | X | X | X | | X |
| Czechia | | | | | | X | X | | | X | X | | X | X |
| Slovakia | | | | | | | | | | X | X | | | X |
| Hungary | | | | | | X | | | | | X | | X | X |
| Croatia | | | | | | | | | | | X | | | X |
| Italy | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Ireland | | | X | X | X | X | | X | X | X | X | | | |
| Portugal | | X | X | X | X | X | X | | X | X | X | X | | |

*Table 2: SET Plan IWGs*

| # | Title |
|---|---|

| | |
|---|---|
| IWG1 | Solar photovoltaics |
| IWG2 | Concentrated solar power/Solar thermal electricity |
| IWG3 | Offshore wind energy |
| IWG4 | Deep geothermal energy |
| IWG5 | Ocean energy |
| IWG6 | High Voltage Direct Current (HVDC) |
| IWG7 | Positive energy districts |
| IWG8 | Energy systems |
| IWG9 | Energy efficiency in buildings |
| IWG10 | Energy efficiency in industry |
| IWG11 | Batteries |
| IWG12 | Renewable fuels and bioenergy |
| IWG13 | Carbon Capture and Storage - Carbon Capture and Utilisation (CCS-CCU) |
| IWG14 | Nuclear safety |

Hence, close cooperation with EU level initiatives and organizations promoted by PANTERA is helpful for national level stakeholders in strengthening their position at EU level. To more effectively address this issue PANTERA has joined forces with SUPEERA[1] project and organised multiple joint workshops.

### 3.2 Barriers hindering wider participation in EU programmes

In order to better understand stakeholder needs and expectations we performed a dedicated stakeholder consultation (PANTERA Desk survey) in the form of closed survey with carefully selected experienced stakeholders from target countries, but not limited to these. As part of Best Practise Desk activities, the survey was circulated within the Nordic countries' stakeholders, which allowed to see the difference between advanced and less active countries. The process is described in detail in D6.3 [3]. Furthermore, the results were presented in Powertech2021 conference [5].

We tried to acknowledge the main challenges and barriers in project preparation, success and access to finance. The results showed that different issues related to the project proposal and consortium building are considered as major barriers for success. For respondents from Academia/Research category both areas have approximately equal significance while consortium building is mentioned a bit more often. Respondents from SME/Industry category more often mention issues related to project proposal, e.g., resource- and time-consuming proposal preparation process. DSOs and TSOs do not refer to any issues with consortium building and solely refer to complicated project proposal preparation process. Other issues are related to insufficient support from national organisations, lack of information, bureaucracy and other.

Furthermore, the respondents were asked to rate the supportive activities provided at national level by local institutions and organisations. This exercise (Figure 2) clearly indicated the lack of support in target countries for all stakeholder categories and the difference in satisfaction levels between target and more advanced countries (specific case of the Nordic countries considered). Moreover, almost one third of respondents from target countries indicated that they have not received any national support. An alarming trend is that only 20% of representatives from SME/Industry category

[1] https://www.supeera.eu/

and 30% of representatives from Academia/Research organisation category are satisfied with support provided locally. Stakeholders indicated that in most cases the support activities are limited to providing very general information without focusing on details and expected assistance through the proposal preparation process. The uncovered trend indicates the need to strengthen support measures, such as for example, a system of National Contact Points (NCP). As for DSO and TSO representatives, it seems that they receive better support than other actors, which might be justified with the fact that usually grid development is tightly interlinked with political objectives and might be lobbied by authorities.

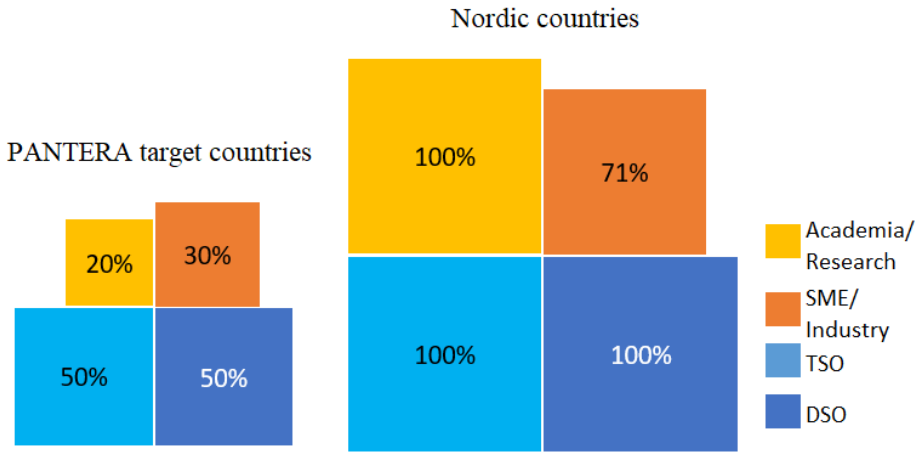


*Figure 2: Results from PATERA Desk survey. Share of respondents rating national support on a score four and five*

This issue was included in questions used for live interaction with stakeholders during PANTERA workshops and interviews performed under WP4.

### 3.3 General country indicators and trends in PANTERA country profiles

The framework for PANTERA country profile is aligned with the review of 2030/2050 climate and energy framework, relevant policies and five dimensions of the Energy Union (i.e., energy security, solidarity and trust; the internal energy market; energy efficiency as a contribution to the moderation of energy demand; decarbonisation of the economy; and research, innovation and competitiveness). It aims at monitoring the progress of the target countries towards the EU objectives, reflected in national 2020/2030 targets, and structure countries' specific information from such sources as EC country reports, Eurostat, National Energy Climate Plans (NECPs) and other.

Furthermore, continuously updating PANTERA country profiles aims at:

- identifying countries' specific gaps for further detailed analysis of causes of insufficient performance to determine PANTERA desks' activities;
- providing input for preparing PANTERA workshops;
- supporting the envisaged regional area of EIRIE platform;
- supporting PANTERA recommendations.

PANTERA country profiles were updated during the preparation of this Deliverable and are published in EIRIE country pages. These are provided in Annex 1.

Below we provide a very brief overview of PANTERA target countries performance in the light of EU 2020 targets, with deeper focus on R&I intensity.

Most of PANTERA countries have met their 2020 energy and climate targets with few exceptions. GHG emission reduction target (without use of flexibilities and/or statistical transfers) was missed by Bulgaria, Cyprus, Malta and Ireland. RES target was missed by Ireland. As for energy efficiency, Lithuania has missed its final energy consumption target, Poland has been slightly below its primary energy consumption target and Bulgaria has missed both.

As for total R&D intensity, only three from PANTERA countries have reached their national goals – Cyprus, Greece and Italy. However, it shall be noted that countries had very different level of ambition in setting their national 2020 total R&D expenditure targets, i.e. from 0.5% of GDP for Cyprus to 3% of GDP aligned with EU wide target in case of Estonia. In six of PANTERA countries R&D intensity level is below 1%. These are Latvia, Bulgaria, Romania, Malta, Slovakia and Cyprus. An interesting fact is, that Cyprus despite having a relatively low R&D intensity is very successful in H2020 and has improved its innovation joining the group of Strong Innovators according to EU innovation Scoreboard [6]. At the same time, its R&D intensity doubled from 0.44% of GDP in 2010 to 0.87% in 2021 (Cyprus target for 2023 is reaching R&D intensity of 1.5% of GDP). In most countries R&D level is increasing with different pace. Information on national R&D intensity targets for 2030 is not available for all PANTERA countries. Czechia has the highest R&D intensity from PANTERA countries (2% of GDP), however it didn't meet its target expressed in public R&D expenditure - 1% (public expenditure in 2021 constituted 0.74% of GDP). Table 1 summaries data on R&D intensity in PANTERA countries.

*Table 3: R&D intensity in PANTERA countries*

| **Country** | **Total R&I intensity 2017, % of GDP** | **Total R&I intensity 2021, % of GDP** | **R&I intensity 5-year growth, %** | **2020 target, % of GDP** | **2030 target, % of GDP** | **Innovation performance** |
|---|---|---|---|---|---|---|
| Latvia | 0.51 | 0.69 | 35 | 1.5 | 1/1.5 (2024/2027) | Emerging |
| Lithuania | 0.9 | 1.11 | 23 | 1.9 | 2 | Moderate |
| Estonia | 1.28 | 1.75 | 37 | 3 | 3 | Moderate |
| Bulgaria | 0.74 | 0.77 | 4 | 1.5 | 2.5 | Emerging |
| Romania | 0.5 | 0.47 | -6 | 2 | n.a. | Emerging |
| Greece | 1.15 | 1.45 | 26 | 1.3 | n.a. | Moderate |
| Cyprus | 0.54 | 0.87 | 61 | 0.5 | 1.5 (2023) | Strong |
| Malta | 0.55 | 0.63 | 15 | 2 | n.a. | Moderate |
| Poland | 1.03 | 1.44 | 40 | 1.7 | 2.5 | Emerging |
| Slovakia | 0.88 | 0.93 | 6 | 1.2 | n.a. | Moderate |
| Czechia | 1.77 | 2 | | 1 (public) | n.a. | Moderate |
| Hungary | 1.32 | 1.65 | 25 | 1.8 | n.a. | Emerging |
| Croatia | 0.85 | 1.24 | 46 | 1.53 | n.a. | Emerging |
| Italy | 1.37 | 1.49 | 9 | 1.4 | n.a. | Moderate |
| Ireland | 1.25 | 1.06 | -15 | 2.5 | n.a. | Strong |
| Portugal | 1.32 | 1.66 | 26 | 1.8 | 3 | Moderate |

The EU's €723.9 billion Recovery and Resilience Facility fund (RRF), set up in 2021 to help member states recover from the social and economic impact of COVID-19, will direct huge sums of money to research and development in the coming years. As a result, member states have set varying levels of focus on research, development and innovation, which is tracked through the Recovery and Resilience Scoreboard (see Figure 3).

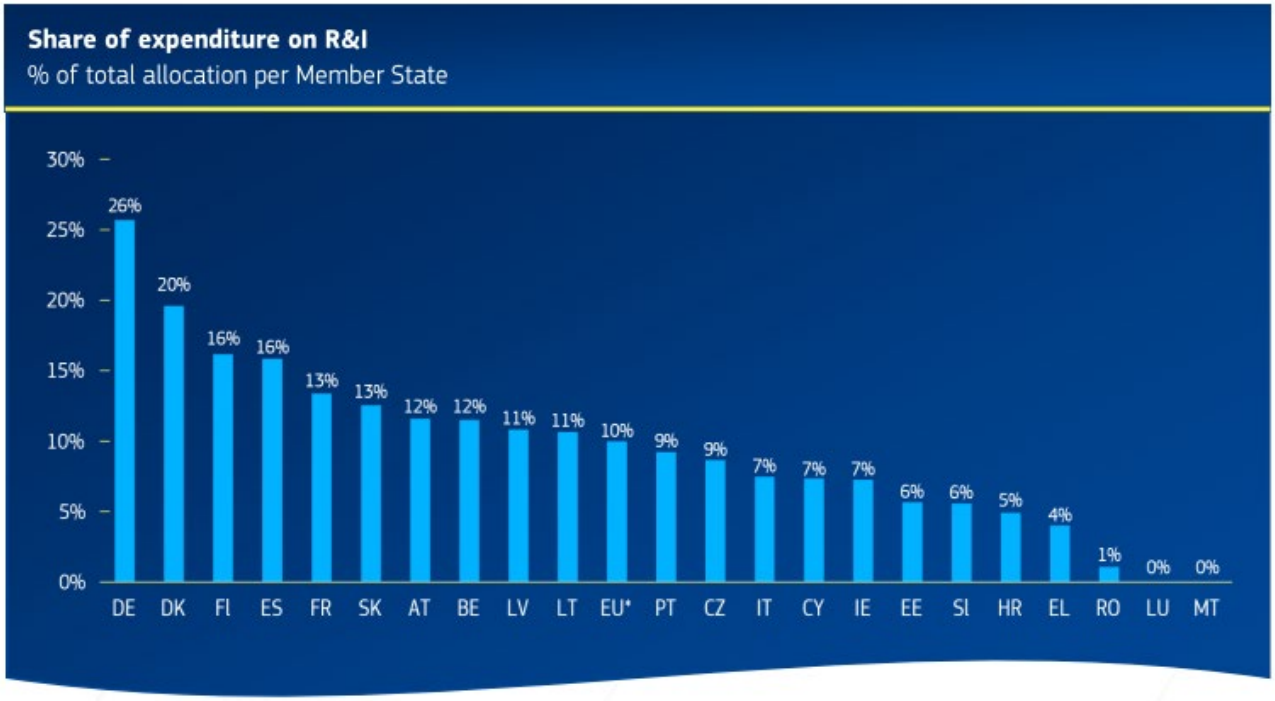


*Figure 3: Proportion of RRF expenditure dedicated to R&I activities [7]*

Several countries also included investments to support Horizon Europe Partnerships and the funding of projects receiving a Seal of Excellence.

For lagging countries RRF can be instrumental in the development of their R&I systems with a real transformative effect in case combined with adequate policy measures.

### 3.4 Exploring Best Practices

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 serve as a reference and be replicated in other countries. The general approach is that the PANTERA consortium does not advice other countries to specific actions but provides a selection of alternatives, which proved to work.

The first list of best practices was presented in deliverable D6.3 [3] and included the topics listed below.

**Funding schemes:**

- Common industrial funding of R&D projects: practices of pooling resources from multiple industrial organizations to address specific challenges usually at high TRL levels. One advantage of common financing is that it involves different actors in projects, leading to more interdisciplinary results that can be replicated and scaled. However, a limitation is that since these projects are industry-funded and often have a high TRL, the results may not be publicly

accessible.

- Mixed funding of R&D projects: for broader R&I topics involving fundamental research, additional funding from national agencies, i.e. public funding, could be necessary. Public funding typically assumes that the project results are fully or partially available to the public. The involvement of industrial partners goes beyond financing and serves as a crucial mechanism to ensure that the project remains relevant to the industry and generates useful and applicable outcomes.

**Creation of financial incentives:**

- Tax exemptions: Tax exemptions or tax credits are commonly used as financial incentives to encourage involvement in R&I projects, allowing companies to reduce their tax burden when investing in R&D. However, tax exemptions have limited impact and are not a substitute for funding, and organizations must meet certain requirements to qualify for them.
- Regulation of DSOs: National regulation plays a crucial role in the deployment of Smart Grid. However, many countries treat R&I activities and pilots as regular costs without specific compensation for the risks involved. Several good practices exist and are described in [8].

**Regional cooperation**

Regional cooperation has proven to be efficient (specific case of Nordic countries was discussed) for addressing region-specific challenges and enabling the fast deployment of innovative results across multiple countries. However, funding for such cooperation is typically limited, and establishing such collaboration requires common regional challenges and strong political commitment.

In D6.5 best practices were enhanced by the **case-study on regulatory sandboxes**. Regulatory sandboxes provide a space for experimentation and collaboration between regulators, utilities, and technology providers to explore and evaluate the potential benefits, risks, and impacts of new technologies. By granting temporary regulatory flexibility, sandboxes promote innovation, facilitate market entry for new players, and help regulators understand the implications of emerging technologies before implementing them on a larger scale. PANTERA project received feedback from several stakeholders, that lack of sandboxes is one of the barriers for implementation of Smart Grid technologies.

# 4 Lessons learned per country/per Desk

## 4.1 Desk 1 (Latvia, Estonia, Lithuania)

### 4.1.1 Lessons learned from workshops and other interactions with stakeholders

In the specific case of Desk 1, the term "region" in PANTERA refers to the geographical area where all three countries share not only common borders but also close historical, political, cultural, and business ties. These countries joined the EU after 2004 and are classified as widening countries under the Horizon 2020 framework. Main activities over these years included 2 workshops: one in Riga and one in Lithuania, both organised jointly with SUPEERA. Latvian workshop involved speakers and stakeholders from all three Baltic States but also broader Nordic region.

These activities have led to a clear conclusion that in all countries, stakeholders involved in energy consider R&I to be crucial in achieving the long-term goals of energy transition. Moreover, it is widely agreed that there is a necessity for greater collaboration among the Baltic States to overcome existing barriers and ensure their voices are heard at the EU level.

The Latvian workshop was held in Riga, with 25 physical attendees, and also featured high-quality online streaming, which attracted 56 attendees who actively took the opportunity to ask questions online.

Representatives of state institutions (Jānis Ancāns (Head of National Contact Point (NCP) for Horizon Europe, Latvian Council of Science), Einārs Cilinskis (Senior Expert, Department of Sustainable Energy Policy, Ministry of Economics of Latvia), Daumantas Kerezis (Adviser at the Innovation Group of the Ministry of Energy of the Republic of Lithuania) and the Commission (Aleksandra Kronberga (Policy Officer at New Energy Technologies' Unit, DG Energy, European Commission) opened the workshop) presented their views on how to foster R&I activities. The PANTERA consortium received significant guidance from key policy stakeholders during their interactions, which helped to shape the consortium's work in this area.

At the same time, research community representatives from Estonia, Lithuania and Norway and TSO representative from Latvia shared their experience in collaborative project implementation, success stories and challenges in proposal preparation. Their interaction unveiled strengths and weaknesses of R&I ecosystem in their home counties.

Furthermore, speakers participated in two panel discussions under headlines:

- Opportunities to increase participation in join R&I activities;
- Experience and benefits from the participation in the energy international networks, including the SET plan.

Discussions raise several important related themes:

- Education is essential to upskill the current workforce through continuing professional development, particularly to help them comprehend national and EU policies. Additionally, new programs are needed to attract young students to this area and build a pipeline of skilled workers who can contribute to the energy transition. There is also a need to educate and communicate with citizens, enabling them to understand the opportunities and challenges of the energy transition, such as the selection of low-carbon technologies, and how government energy policies support the achievement of national energy and climate targets.
- To improve national funding for R&I, call designs must bridge the gap between theory and practice and consider local and national needs. The panel recommends the development of more tailored calls to promote local solutions. Pilot and demonstration projects were also highlighted as having high visibility in addressing consumer education and connecting theory to practice. Multi- and interdisciplinary calls are necessary to encourage cooperation with social science, and more dialogue among national agencies and ministries is required to ensure that calls connect technical and social science disciplines. It is also important to provide support to improve the quality of Horizon submissions. While teams may have technical expertise and their submission may be highly ranked, weak presentation can lead to failed submissions.
- Experts discussed the need for alignment between policy and strategy across different domains. For example, TSOs must prioritize addressing transmission system technical problems due to regulatory requirements. Additionally, decisions on grid tariffs to maintain the grid should be made concurrently with the development of energy communities to ensure that the core network is adequately funded. To achieve long-term clean energy objectives, it is crucial to address community opposition to infrastructure projects and enable the

realization of ambitious projects within short timelines. The energy community must remain steadfast in the face of current geopolitical tensions and the spotlight on energy independence.

- Although membership in an international association can lead to increased project activity, institutions in the Baltic countries still face challenges in achieving prominence on a European level. One solution proposed is to encourage greater regional cooperation within the Baltics.
- Experts emphasised the significance of promoting collaboration and constructive communication between policymakers at the national level and the European Commission. It is crucial to engage in a productive dialogue that allows for mutual understanding of the needs and concerns of both parties. This approach can facilitate the development of effective policies and initiatives that better serve the interests of all stakeholders involved. Moreover, it can enhance the coherence and alignment of national and EU policies towards shared objectives, such as energy transition and climate change mitigation.

In order to reach broader audience, the workshop outcomes were additionally presented in Latvian Energy Journal.

In 2023, another workshop took place in Vilnius. The event brought together experts from academia, industry, and government sectors in a hybrid format, with 26 participants onsite at the Lithuania Academy of Sciences and 19 participants joining online. The participants discussed several topics, with many of them emphasizing the significance of collaboration and networking. While the Baltic countries have often been viewed as a strong and homogenous region, there are variations in national priorities within the energy sector. Nevertheless, the main takeaway from the workshop could is the need for collective action for the benefit of the countries and the region.

During both workshops the audience was kindly invited to participate in online interaction by answering the following two simple questions:

*1. What do you think is the most important reasons for low R&I activity in your country in smart grids, storage and local energy systems? Choose three of the following reasons that suit best your case:*

- *No adequate funds under national calls*
- *Low priority in our country policies in the specific themes*
- *Lack of country or region-specific themes enriching country and region competitive advantage*
- *Lack of research facilities in the specific themes*
- *Our country is not active in the Clean Energy Transition Public Private Partnership*
- *Horizon Europe is too competitive and more advance countries have advantage*
- *No access to match making platforms to promote our competences the audience will be the falling:*
- *other*

*2. Are there any mechanisms supporting the initiation and completion of R&I projects funded under EU or joint national programmes (such as information services, workshops for partner search etc.) organized by national institutions? How do you rate support services provided by national institutions / agencies?*

*1. Extremely helpful*
*2. Very helpful*
*3. Somewhat helpful*

*4. Not very helpful*
*5. Not at all helpful*

In both workshops similar results were obtained. The majority of respondents answered that Horizon is too competitive and more advanced countries have an advantage, and that the support provided by national funding agencies was just sufficient – participants rated that as “neither good nor bad”.

### 4.1.2 Lessons learned from case studies

According to PANTERA Desk survey (summarised in the Section 3.2 of this report and discussed in detail in [3], [5]), issues in project proposal preparation process are indicated as the most important barrier in project success and thus increasing R&I activities. Meanwhile, PANTERA workshops pointed out the need for closer regional cooperation between Baltic States. Considering the above, a common case study for all three Desk 1 countries was carried out. It focused on analysing organisation of the Baltic Research Programme which is one of good examples of cooperation between Baltic and Nordic countries. The case study aimed at identifying particular gaps in the call organisation process and at uncovering differences in project application organising practises in Latvia, Estonia and Lithuania.

The case study was carried out by analysing documents of three calls (2018 call coordinated by Estonia, 2020 call coordinated by Lithuania and 2020 call coordinated by Latvia) 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. 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. The details of the study are included in D6.5 [4].

Below we provide the main findings of the study:

- All three calls showed a significant level of competition. A success rate in Estonian and Latvian call was 6% and 10% accordingly, which is lower than Horizon 2020 average success rate (12%).
- The criteria for the calls were described in a general manner, which could lead to subjective evaluations of proposals due to the broad definition of the evaluation criteria and challenges associated with the calls. This is because experts may be more knowledgeable and passionate about certain specific topics.
- Due to the size of the countries involved and thus limited number of institutions working in the same thematic direction, the number of unique consortia combinations was quite small.
- The Latvian call stands out for its highly demanding requirements and greater amount of paperwork, which has resulted in a clear need to attract administrative resources. As a result, leading researchers often become overwhelmed with administrative tasks, including accounting, which takes away from their research time.
- 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)). 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 were quite high in all three 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.

As seen from performed analysis, different gaps exist in all stages of the process. In order to benchmark the findings, the case study additionally included an overview of Joint Call 2020 Digital Transformation for Green Energy Transition (MICALL20) organised by European Research Area Network Smart Energy Systems (ERA-Net SES).

Finally, the following recommendations were summarised:

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

Collaboration between R&I entities can thrive and enable learning from the experience gained and thus increase chances of creating high quality proposal and getting funds for research. For this reason, the case study was published on the provided collaboration area CONFLUENCE (Figure 4).


*Figure 4: Desk 1 CONFLUENCE page, information on the case study*

## 4.2 Desk 2 (Bulgaria, Romania, Greece)

### 4.2.1 Lessons learned from workshops and other interactions with stakeholders

Dedicated to the countries with lowest Research and Innovation (R&I) activities and funding in the smart grid, flexibility, local energy systems and storage domains Regional Desk 2 performed intensive supportive collaboration organizing the following workshops and R&I supporting events:

- PAN European Research and Innovation Activities for Smart Grids, Energy Storage and Local Energy Systems, 02 July 2019, Sofia, Bulgaria
- Regional Workshop Green Islands as a driver for the Energy Transition – Going Renewable

and Smart 13th of February 2020, Athens, Greece, N.J.V. Athens Plaza Hotel, Syntagma Square

- International research collaboration opportunities fostering EU Clean Energy transition in Romania PANTERA / SUPEERA joint workshop, Date: Thursday, 23 March 2023, Time: 14:00 - 18:30 EET, Location: Bucharest, Faculty of Electrical Engineering, Mode: Hybrid
- Nano Workshop “Smart Grids Research and Innovation Status in Bulgaria: gap analysis, opportunities and needs”, within the BULEF scientific conference, 13th of September 2019 in Varna, Bulgaria
- Nano Workshop Regional Research and Innovation activities for Smart Grids, Energy Storage and Local Energy Systems, 03 August 2021, Varna, Bulgaria
- PANTERA REGIONAL VIRTUAL WORKSHOP, “Energy transition through optimal use of the rich Renewable Energy Resources, of the Mediterranean basin”, at MedPower 2020, 10th and 11th November 2020
- Workshop in Cretan Energy Conferences, “The key role of the R&I unified approach across EU for boosting smart grids, investments: The EIRIE platform”, International Conference and Exhibition 9th July, 2021
- PANTERA Session, Boosting the R&I activity on Smart Grid Technologies, Empowering the R&I community to actively contribute to the Energy Transition, Country: Greece, Thessaloniki, Session Co-chairs: Dr Venizelos Efthymiou and Dr Rad Stanev, SyNERGY MED 2022 – 18th of October 2022 from 14:00 to 15:30 hrs EEST
- International research collaboration opportunities fostering EU Clean Energy transition in Bulgaria – SUPEERA/ PANTERA joint workshop Date:25 May2022 Time:09:00 -14:30 EESTLocation:Bulevard "Sveti Kliment Ohridski" 8, 1756 Studentski Kompleks, Sofia, Bulgaria, Bl. 2, Library Building

As a result, the activities showed that despite the difficulties in these countries the interest of the local stakeholders to build sustainable and successful R&I in the field of smart grids which are supporting the way towards the energy transition is significant. The fact that the events collected the highest level of the TSOs, DSOs, academia, ministries and research representatives witness the significant will for change towards achieving better R&I status in these countries.

The first workshop PAN European Research and Innovation Activities for Smart Grids, Energy Storage and Local Energy Systems, 02 July 2019, Sofia, Bulgaria allowed wide stakeholder interaction providing valuable feedback:

**Veneta Tsvetkova** from the Ministry of Energy of Bulgaria noted that considering the energy policies and energy transition of Bulgaria some major challenges exist requiring fast and important next steps for fulfilling the Bulgarian commitments towards the EU:
The development of renewable energy in Bulgaria grows rapidly, increasing the installed capacities and the production of solar and wind power. The volatile and highly dependent on meteorological conditions electricity production from photovoltaic and wind power plants is creating a need for grid modernization.
Hence, investments are needed for further development of electricity grids and implementation of new technologies: smart metering and smart grids.

**Dimitar Zarchev (ESO, BG),** noted the present state of the art situation of the power system of Bulgaria, giving some of the major gaps, problems and critical R&I topics which need to be faced in

closest future. A special emphasis was given to the importance of the emerging R&I needs in the region for maintaining the integrity of the entire continental Europe power system especially concerning the overhead power lines capacity and the power balancing in a system with high RES penetration.

**Mihai Mladin (CRE, RO)**, outlined success stories and good R&I practices in Romania giving a special focus on the following key topics:

- deployment and integration of distributed generation, including renewable energy, incorporation of demand response, demand-side resources and energy-efficiency resources,
- integration of smart technologies for metering and monitoring energy use, and of smart appliances for the grid management;
- deployment of advanced electricity storage and peak-shaving technologies, including plug-in electric vehicles and thermal-storage air conditioning;
- development of standards for grid communication and interoperability.

**Rad Stanev (TU-Sofia, BG)** gave a perspective of the status of smart grid evolution in the region that generate open R&I needs, analyzing the main political, technology-related, market and social driving forces. A specific need for advancing the R&I level in the countries from the region towards the following prospective areas was given:

- Self- healing nano, mini and micro grids with prosumer centric behavior, environmentally friendly grid support action, increased DC / decreased AC power share;
- Stability of systems with reduced inertia;
- Flexibility as cost efficient storage;
- Self- establishing real time minimum data electricity markets;
- Establishment of a holistic power system architecture (as described in ETIP SNET vision) as a key factor related to the electricity producers, storage, grid, customer plants, and electricity market.

To allow maximal involvement of all stakeholders, a bottom up approach was implemented and the workshop participants were divided small working groups and an interactive SWOT analysis was performed in order to identify the main gaps and R&I areas of actions where next steps need to be organized (Figure 5).


*Figure 5: One of the working groups in Sofia. Weaknesses pinboard*

The proactive work of the stakeholders brought many findings. Some of the most important are the following:

**STRENGTHS**

Knowledge in EU should be extensive and accessible:

- A lot of knowledge and experience around the EU
- Good networking synergies
- Easy access to knowledge & resources
- Networking activities

R & I family is strong in numbers and quality and well connected to EU networks

- High-level researchers linked to R&I at EU level
- Projects under implementation could give best practice examples
- A lot of R&D is already performed from EU projects
- The potential for knowledge transfer between R&I and industry is high
- The strong interest of ERA-NET family to link with low spending counties is supporting

Regulation promotes RES & energy efficiency

- Incentives for PV rooftops & energy efficient buildings
- New regulations focusing on social acceptance and consumer engagement
- Regulation for energy communities is under consideration

A lot was done in infrastructure and technology evolution

- There is a good EU grid infrastructure
- Good working relations between different stakeholders
- Extended integration of RES through new regulatory framework
- Some of the main issues in the energy field are addressed

**WEAKNESSES**

Project results are not always adequately utilized

- R&D results are not well communicated
- Lack of access to project results & knowledge
- Lack of demonstration of projects
- Lack of information about the possible coupling of instruments/supplementary funding

Weak industry involvement

- Cannot convince the industry to invest
- High investment cost of new technologies restricts the deployment of innovative technologies
- Missing business case
- Missing leadership
- Long decision process
- No clear market specification
- EU industry is not competitive (e.g. PV and storage)

Slow regulation adaptation compared to technology evolution and system needs

- The regulation is so slow to peak up with the technology evolution
- No regulation about synergistic approaches and sector coupling
- Lack of understanding the urgency of energy shift at the policy level
- TSO & DSO don’t want to change

Weak in communication of achieved knowledge, results and solutions

- Lack of communication between projects/partners
- Lack of communication between project applications
- Data exchange is difficult among stakeholders which leads to reinventing the wheel
- Lack of networking & synergies
- Scientific results are not connected with each other

Low involvement of stakeholders

- Lack of understanding of regulation & policy by the end users
- Customers are not ready or educated enough for smart grids
- Limited involvement of some stakeholders

Slow technology penetration

- Technology penetration is slower than it should be (e.g. Smart meters)
- The area that is rich in renewables have weak access to the grid

**OPPORTUNITIES**

High potential for renewable energy resources

- Local renewable energy resources can meet the EU energy needs
- The potential of hydro infrastructure is good

Education

- Educate students in schools on energy sustainability

Low cost of ICT hardware infrastructure is present

EU funds

- Funding available on the European level
- Providing information on funding opportunities is essential

Job opportunity

- More jobs opportunities
- More energy experts

Energy active citizens

Opening of the energy market

Collaboration of stakeholders from other associated projects

Investment possibilities for creating potential companies to invest in new projects

**THREATS**

Data handling

- Security and personal data handling
- Social acceptance

Bureaucracy

- Bureaucratic legislation from each country
- In some countries regulatory bodies have inertia on fulfilling EU recommendations

Funds

- Insufficient national funds
- EC sponsors projects with more than one country involved

Action is needed from outside EU- If all countries in the World do not take action, the EU actions cannot change the global situation.

**Taking into account all of the Stakeholder interactions the main outcomes and lessons learned can be summarized as follows:**

- Stakeholders of the Balkan region interacted with the PANTERA initiative and further

involvement can be established for achieving a “win–win” situation

- Stakeholders have a principal role into the PANTERA process and thus ways on their involvement were discussed through the PANTERA (regional) desks, ad hoc working groups and participation in targeted workshops.
- SWOT analysis highlighted the strongest shaping factors (mainly Strengths and Weaknesses and identified opportunities and threats that are of critical importance to know and adapt accordingly) on how PANTERA needs to act and move forward with the support of the stakeholders from the Balkan region.
- Main challenges and prevailing barriers were identified that form a great constructive feedback for the next workshops to be organised by PANTERA
- PANTERA initiative has the full support of EC on delivering the promised vision with close collaboration with existing EU tools.
- PANTERA initiative can have a constructive and fruitful cooperation with other pan-European associations such as EERA AISBL / JP4SG / Storage, ETIP SNET, ERANET Smart Energy Systems etc. to support the energy transition, leverage the smart grids investments and maximize their impact.

**The 3rd Regional Pantera Workshop – Green Islands as a driver for the Energy Transition – Going Renewable and Smart**

The PANTERA workshop, held in Athens Greece, focused on the challenges, barriers, best practices, and future steps towards transforming geographical islands into 100% renewable energy systems using technologies that enable their smart autonomous operation. The workshop had five keynote presentations from major stakeholders of the Greek Energy Market, which were followed by facilitated Q&A/discussions. Parallel interviews were conducted as a means of stakeholders’ consultation, and the feedback from the interviewed stakeholders indicated that PANTERA’s approach and vision can be helpful and effective.

**Professor Nikos Hatziargyriou** discussed research and innovation priorities for facilitating the energy transition and the realization of future smart island energy systems. The presentation covered the R&I priorities for smart energy transition, including input on H2020 activities from ETIP SNET, and the organization of Working Group 5. The presentation also discussed the vision for 2050, which aims to establish a low carbon, secure, reliable, and pan-European integrated system for a fully CO2-neutral and circular economy. Additionally, the energy island framework was discussed, with pending issues related to energy production from renewable energy sources.

Some key lessons that can be inferred are that collaboration and innovation are crucial for the successful transition to a sustainable energy system. Working together across sectors and disciplines can help to identify and address key challenges. What is more, the energy transition requires a long-term vision and commitment. Overall, the development of smart island energy systems can be a useful testbed for implementing and evaluating new energy technologies and systems, with the potential to inform wider energy transition efforts.

The PANTERA project aims to bridge gaps in member states to support the energy transition vision and engage stakeholders in the process.

**Dr. Venizelos Efthymiou** of FOSS Research Center, discussed the objectives and the approach of the PANTERA project, including the availability of use cases and scenarios, regional work, and the use of working teams to generate valuable information for all users. The PANTERA process seeks to identify the strengths of each region and support actions

for a sustainable future in compliance with Vision 2050.
Mohamed Shalaby from DERlab provided feedback on the PANTERA process and suggested improvements to support EU investments in smart grids and R&I. This laid the foundation for Mario Dionisio, the representative of the European Commission, to speak further on the topic.

**Mr. Mario Dionisio of DG ENER (EC)** and Project Officer of PANTERA project discussed the EC R&I policy, trends, and challenges related to EU Energy Policy. The key takeaways from his presentation are the importance of modernizing the economy, boosting competitiveness, and creating growth and job opportunities. He also emphasized the significance of Horizon Europe and the need for gathering in Athens to discuss the R&I agenda in Europe and how the Commission, through PANTERA, can boost the process. The goals include framing the status of EU grids, disseminating EU R&I activities on grid modernization for the energy system transition, raising awareness on possible applications and replications throughout the EU, exchanging experiences, knowledge, and use cases, and moving towards greening geographical islands with the support of technologies that enable their smart autonomous operation.
It was interesting to see the evolution of the Clean Energy for EU Islands Initiative and the progress made on Kythnos as a smart island. The interactive approach of the workshop was also praised, as it allowed for discussions and hands-on experience. Additionally, it was noteworthy that even countries without geographical islands face similar challenges in their power systems.

**Professor Stanev** emphasized the need for a new holistic perception and architecture for the energy transition, with a Macrogrid composed of partially or fully autonomous Micro, Mini, and Nanogrids. He also stressed the importance of knowledge sharing, collaborative research, and education in this process. Finally, the attendees identified economic aspects, lack of financing, and regulatory framework and policies as the biggest barriers/challenges to having green geographical islands based on 100% RES & smart grid technology.
Collaboration and coordination between different organizations, governments, and local communities are key factors in achieving this goal. The attendees' recommendations include investments in education, pilot projects, and state-of-the-art technologies, as well as incentives for local communities to accept new technology and regulations. The introduction of new regulatory schemes and government incentives for promoting relevant activities is also suggested. Overall, it is essential to continue working towards a sustainable future by investing in clean energy and smart grid technologies and fostering collaboration and communication between stakeholders.

**Mr. Georgios Messinis** from Ariadne Interconnection discussed the role of interconnections in achieving the energy transition, focusing on the case of Greek islands. He highlighted the main challenges for interconnecting the islands to the transmission system, such as interconnection lengths, reliability, and the surrounding environment. He offered solutions such as cable technologies, advanced control centers, and protection schemes for hybrid AC/DC systems. Mr. Messinis also emphasized the importance of conforming these solutions with respect to the surrounding environment of each island. Professor Dimo Stoilov from the Bulgarian Academy of Sciences presented his case on the lack of resources in the research domain in Bulgaria and how it can be beneficial for every region to share findings in the energy sector. He listed the challenges faced by the Bulgarian energy sector, including high

energy intensiveness, dependence on a single supplier, and insufficiently coordinated structural economic reforms.

**Mr. Dimitris Kitsikopoulos** discussed the importance of developing energy communities to increase social acceptance towards the energy transition. He highlighted several challenges that need to be addressed in building energy communities, such as policies/regulations gaps, lack of awareness, and financing tools, among others. To tackle these challenges, he suggested policy-making actions, workshops, research, networking, and mobilizing conventional and cooperative banks to develop a community energy financing tool. Professor Milena Ivanova suggested initiating pilot projects with small groups of consumers to increase social acceptance. During a discussion on means to engage society and end customers in the energy transition, attendees suggested various solutions, including monetary incentives, education, showcasing success stories, and local energy community seminars.

**Professor Metody Georgiev** from Technical University of Sofia gave a keynote presentation on “Digitalization as an enabler for the energy transition” and identified the main challenges and barriers of digitalization. He also pointed out the essential gaps and challenges in resources, governance, regulations, and networking. The gaps in resources relate to a lack of skilled personnel, demographic crisis, low societal and financial respect for the energy sector, and a lack of related educational programs at middle schools. The main challenges in governance relate to financing, lack of innovation project management skills, and lack of collaboration between market actors for the definition of new business models and the provision of novel energy services. The gaps in networking relate to reduced visibility of R&I results towards external actors, the need to promote collaborations with business and industry, and the need for national coordination towards the organization of the participation of local R&I actors in EU organized events. The gaps in regulations relate to the need to adjust the national legal framework for new technologies and incentives for the penetration of such new technologies. He concluded his presentation by presenting his expectations from the PANTERA project and ways to drive the energy sector towards decarbonization.
In conclusion, the workshop has indicated significant challenges, such as enhancing energy efficiency, increasing the integration of renewable energy sources, and bolstering the digitalization of energy systems. Furthermore, it was emphasized that collaborative efforts between different stakeholders are crucial for accomplishing a successful transition to sustainable energy systems.

**The joint PANTERA / SUPEERA workshop “International research collaboration opportunities fostering EU Clean Energy transition in Romania”**

The SUPEERA and PANTERA projects organized a joint workshop to promote knowledge exchange and best practices and to increase the involvement of Romanian Research and Technology Organizations (RTOs) in research and innovation (R&I) activities. The workshop focused on the Romanian energy sector, its energy mix and dependencies, Romania's participation in the SET Plan and the Clean Energy Transition (CET), and its engagement in H2020. The PANTERA project's findings and activities were presented, highlighting the regional desk approach to address EU countries less involved in EU-level activities, local stakeholder engagement, and the importance of networking and R&I facilities. The EIRE platform, an open tool for collaboration among stakeholders in the energy system innovation value chain, was discussed.

The president of the Energy Security and Investments Commission and member of the Supervisory Board of TRANSELECTRICA S.A. presented the strategies and priorities of the Romanian TSO, emphasizing the priority of integrating renewable energy and the key infrastructure and financing structure needed.
The panel discussion and Q&A session focused on the balance of funding sources and the lack of collaboration between industry and research, which was attributed to limited resources and a structural problem. The second session of discussions led by Spyridon Pantelis, EERA Project Manager, introduced the topic of R&I opportunities for collaboration and funding Horizon Europe, with a focus on Pillar 2, Cluster 5, which aims to widen participation and strengthen the European Research Area (ERA). The funding available for Clean Tech and the work of the European Innovation Council (EIC) were also presented.

**Ivan Matejak** SUPEERA Coordinator from EERA presented the European Energy Research Alliance, the SET Plan and the SUPEERA project. He highlighted the importance of aligning research and innovation (R&I) as a pillar of the SET Plan and the disparities in engagement among different countries in the SET Plan. Ivan also discussed Romania's energy sector, its energy mix and dependencies, as well as its participation in the SET Plan and the Clean Energy Transition (CET). He showed the structural challenges, the opportunities, and recommendations for Romania to arise its participation in the SET Plan. Key lessons learned from Ivan's presentation are the importance of aligning R&I as a pillar of the SET Plan, identifying disparities in engagement among different countries, and the need to develop recommendations to improve participation in the SET Plan.

**Mattia Cabiati – RSE** presented the PANTERA project's findings and activities, highlighting the regional desk approach set up to address the EU countries less involved in EU level activities. During the presentation, he emphasized the importance of local stakeholder engagement, and that the lack of networking, R&I facilities, and national policy in supporting R&I are limiting a deep integration of research activities at EU level. He gave an overview of the EIRIE platform and explained the potentialities for researchers, R&I organizations, and policy makers. Key lessons learned from Mattia's presentation are the importance of local stakeholder engagement, the need to develop R&I facilities, and the potential of the EIRIE platform to support innovation in the energy sector.

**Rad Stanev** (TU Sofia) emphasized the collaboration opportunities provided by the PANTERA project and invited participants to explore collaborations and research funding opportunities which are on-going through the EIRIE platform. Key lessons learned are the importance of collaboration and the potential of the PANTERA project to provide active support concerning research funding opportunities.

**Mihai Paun** (President of the Energy Security and Investments Commission and Member of the Supervisory Board of TRANSELECTRICA S.A.) presented the strategies and priorities of the Romanian TSO. He emphasized the priority of integrating renewable energy, highlighting the key infrastructure and financing structure. He provided an overview of the Romanian energy production mix and the Romanian Transmission Grid Map, concluding with some examples of European projects on renewable energy integration led by Transelectrica. He noted that the success of the R&I is a bilateral process which is depends both from the local stakeholders and from the EU. Key lessons learned from Mihai's presentation are the importance of integrating renewable energy, financing structure, and the potential of

renewable energy integration projects to support the energy transition.

**Daniela Diaconu** - Scientific Deputy Director, Institute for Nuclear Research (RATEN ICN): Daniela explored RATEN mission and values on nuclear research. After giving an overview of the ambition plans for the next years, she discussed RATEN's participation in EU Platforms and the SET Plan especially in the security and nuclear safety components. She emphasized the importance of being a member of EERA to promote national priorities in European projects and drive forward the clean energy transition in Romania and throughout Europe. Key lessons learned from Daniela's presentation are the importance of national priorities in European projects, and the potential of being a member of EERA to drive forward the clean energy transition.

**Prof. Mihaela Albu** from Polytechnic University of Bucharest gave a presentation regarding the correlation of national, European and International R&D efforts in the evolution of power systems. She also introduced the MicroDERLab and shared some successful results of research and innovation projects in Romania's emerging power system, highlighting also the gap between R&D efforts in Romania and other countries. She spoke about multi-scale data analytics for power profiles and advocated for funding.

### 4.2.2 Lessons learned from case studies

Regional Desk 2 has performed case studies in Bulgaria, Romania and Greece to identify the most critical R&I priorities. The lessons learned from case studies will be shortly summarized below.

**The case study for Bulgaria** was focused on 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.

Being the country with lowest R&I activity in EU funded projects Bulgaria has a high potential for improving. Identifying the hindering factors is a key for the success of the integrated EU R&I funding policy. Relying on interaction with more than 25 contacts with stakeholders the research showed that one of the most significant bottlenecks is the absence of adequate R&I laboratory infrastructure. The EU funded projects ERIGRID 2.0 (https://erigrid2.eu/) offers easy and free of charge access to the most advanced smart grid and DER laboratories in Europe. This option is still not properly utilized by the R&I stakeholders in Bulgaria. Understanding the reasons for this and understanding which are the other main hindering factors is important for overcoming this barrier. Also, it remains highly important to decrease the gap between the R&I stakeholders in the leading countries and in Bulgaria. The case study focused on the PANTERA Desk's 2 support activities in order to identify the main hindering factors, specifically concerning the laboratory infrastructure for smart grids R&I. Additionally, options for overcoming some of the barriers were outlined.

Face to face meetings and surveys with local stakeholders have been performed implementing individual approach to each stakeholder. The collected and processed feedback allowed determination of the gaps and the solutions which might improve the situation. Propositions for supporting the stakeholders R&I activities were given, after which the results were analyzed. As a result, the following reasons, obstacles and lessons learned were found:

- Significant lack of trust in the Bulgarian energy sector in relation to the EU policy related to Bulgaria is present due to previous EU actions towards the Bulgarian energy sector. The EU

support and the lack of control on EU funding on local level brought disappointment in many R&I entrepreneurs and drivers.
- The lack of knowledge, contacts and experience in generation of EU funded projects is a long term hindering factor.
- The inability to compete with large countries which made their infrastructure using strong national funding leads to lack of critical R&I infrastructure which is already urgently needed on a local level.
- Impression for lack of fair and consistent EU policy for stimulating adequate R&I funded activity in all countries is present.
- Significant R&I experts and manpower outflow from Bulgaria to the rich and large EU countries.

The unstable environment allows very few stakeholders to undertake the risk and effort to search for financing for networking activities. The stakeholders are not ready enough to start a full-bodied collaboration with the best R&I players in Europe due to the significant gap between them. Diminishing this gap requires constant work in small steps by the mmajority of the R&I Stakeholders in Bulgaria.

The following actions were identified to be feasible and supportive:
- Building critical R&I infrastructure – this infrastructure is crucial to understand the up-to-date power system and smart grid problems in order to 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.

Some success stories resulting from the PANTERA process in which interested stakeholders were selected and directed to relevant identified actions can be shortly mentioned below. The implementation of the case study step-by-step approach proposed was well accepted from the stakeholders stimulating interest and will to participate in EU funded R&I activities. The following good examples can be noted:
- 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.
A research project between the Bulgarian DSO (Elektrorazpredelenie Yug) and TUS on voltage regulation in distribution networks with high share of converter interfaced distributed energy resources is successfully performed providing critical knowledge for the DSO.
- Consortium between 1 TSO, 1 DSO and 2 universities is 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.

The approach provided positive results and number of good practices showing that strengthening the R&I activities is a long-term bilateral process which requires significant collaborative effort from both local stakeholders and the European Commission.

**The case study for Greece** was dedicated on the use of the key R&I knowledge of Greece in island power systems for the implementation of new European power system architectures with islanded and hybrid micro and nanogrids**.**

Being the most experienced EU country in the Balkan region Greece has a key R&I knowledge in the field of smart grids, energy storage and local energy systems. Compared to the other countries in the region it is most advanced in the R&I activities and at the same time it remains behind the leading western European countries. Still, there are some local specificities, historical background and experiences which can give a competitive advantage of Greece in some R&I topics.
The study provided analysis of prospective smart grid related topics in which Greece can have a competitive advantage compared to the other countries. An analysis of key competitive advantages was performed and a way towards marketing this key knowledge using EIRIE platform is determined. Due to having many islands Greece has historically developed key technical, economic and social models in autonomous power systems. With the present trends in the smart grid development which are pushing forward novel autonomous micro- mini- and nanogrid concepts and architectures the appearance of self- sufficient autonomous island power systems operating in completely disconnected or partly connected mode with the bulk power system is needed. Additionally, due to the complex geo-political situation and the limited fossil fuels free market access and the introduction of distributed renewable energy sources (RES), these new power system architectures are getting more important for the entire continental EU.

The experience in autonomous island power systems of Greece can offer very good basis for the research and development of the novel micro and nanogrids on EU level. With a widest network of proven real-life concepts and experience the local Stakeholders have a chance to become a leader in the R&I in novel power systems with micro and nanogrids and can benefit from common research projects.

**The case study for Romania** provided an analysis on the specific R&I topics where Romania is well positioned and has good potential and opportunities in comparison with the other countries in order to support the Romanian stakeholders to find adequate funding.

The analysis performed found that the expanding key research and education aspects of Low Voltage DC (LVDC) grids and the promising future trends for LVDC networks development are the most prospective topics which can be highlighted. The Low Voltage DC networks are novel and a promising way forward which grows with the increase of DC based RES and Electric Vehicle (EV) systems.

The LVDC networks will grow 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. A research is needed at EU level in the close future facing many technical and non-technical challenges such as the need of improved commutation capacity, higher insulation requirements and socio-centric issues as for example the need for changing the mind-set of the prosumers.

This new research area is in very initial stage in nearly all EU countries.

Romania is proactive in this field and already has some positive results with valuable contributions from Romanian R&I Stakeholders.

This gives very good chances for the Romanian stakeholders for a participation in EU funded project proposals and partner consortia on this topic.

## 4.3 Desk 3 (Cyprus, Malta)

### 4.3.1 Lessons learned from workshops and other interactions with stakeholders

Desk 3 has been very active with activities engaging local stakeholders on the issues related to R&I approach and related values in Cyprus and Malta in support of the energy transition process. Main activities over these years included 3 workshops in Cyprus, one in Crete and one in Malta involving stakeholders of the two countries but also of the broader Mediterranean region.

Through these activities it was clearly concluded that in both countries, stakeholders related to energy, position R&I as key in achieving the long-term targets of energy transition. Irrespective of the noted low activity in the field, this was not translated in interest in playing a key role in achieving the strategic objectives of the energy transition. The interest of the energy minister of Cyprus and the respective Energy Directors of Cyprus and Malta being directly involved in the organised events, with eagerness to listen and position themselves on the hot issues of the energy transition, revealed the very fact that the will for change is there but various inhibitors exist that hinder faster contribution to the required policies for change.

Clearly, this desire for change was underlined by all strata of stakeholders participating in the planned activities including the Office of the Regulator in Cyprus, the Operators (TSOs and DSOs) in both countries, the Research Funding Agencies in both countries, important universities and research centres in both countries and even representatives of the industry in both countries.

In the event in Paphos Cyprus, the project of NAVIGANT / GUIDEHOUSE was invited to educate the participants with their findings covering the field of “RES driving the energy transition: The potential of the Mediterranean Region”. This study was conducted by them for the benefit of the Commission.

Moreover, presenting the tangible results of projects during the events of successful projects like the INTERPLAN, the real benefit is related to the issue of revealing the strengths of R&I work in areas that are so real to the day-to-day operation of the system offering tangible solutions that will make a difference to the quality of work of the system. Hence, the R&I work in solving day to day needs of the industry and the economy receive a boost through such actions and hence stir real interest in policy makers to take more positive action.

What had real positive results during these activities was the evidence of real tangible benefits coming in the direction of the R&I community through the physical implementation of the EIRIE platform. The well-planned visualization and facilitation of the EIRIE platform with the vast benefits that brings with it, raised noticeable interest among the stakeholders and policy makers. The discussion that was conducted using the opinion of the participants that was made evident through online polls, has given the very positive message that the PANTERA project correctly moved in the direction of designing and delivering the multifunctional platform EIRIE with the tens of functionalities that directly benefit the R&I community. The positive outcome of these discussions have touched on issues that are important for the R&I community, and hence a must for the consortium of PANTERA

to deliver. Among others the following were noted:

- A reference repository that directs the user to the details of the EU and country strategies,
- A multi-functional platform accessible by all, with capabilities targeting the R&I community of Europe aiming to be a single point of reference for data, information and knowledge in support of the needs of researchers for conducting their research endeavors.
- The synthesis of solutions offered by the EIRIE platform prove to be of fundamental importance to the attempts to help low activity countries to identify areas of competitive advantage and explore ways of capitalizing on them.
- Provision of results achieved till today with support for effective utilization,
- Tools and functionalities that can help in evaluating progress achieved.
- A methodology that can evaluate R&I needs leading to required next steps.

These findings were taken up by the stakeholders during the round table discussions and helped substantially the discussions based on real evidence. Through these discussions the following areas of concern of the R&I community in the field of energy systems were identified and were confirmed by the views of the participants through the online poll that was conducted during the sessions:

- No consistent/unified methodology or approach on identifying the research needs and gaps. Progress achieved in R&I is not visible.
- Lack of information on R&I needs and how these are related to the strategic objectives of Cyprus.
- R&I endeavours of government and semi-government employees in their specialised fields for addressing issues related to the needs of the service area that they are employed, are not included in the annual budget of departments. This generates a major handicap that we know that we should address.
- Lack of structured participation of universities and local research institutions in the broader economy of Cyprus and means of valuing such contribution in their academic career development. There is the prevailing impression that local involvement does not count in their academic experience, pushing academics to international activity only.
- Local Public Private Partnerships for addressing local issues are not addressed in a structured way learning from best practice approaches of the Commission and economically advance countries in Europe.
- The funding allocated though projects is limited in time (2-3 years) and this has a negative effect in attracting the best talents. It is important to ‘’sustain the talents’’ and we need to address this issue, said that same problems are in her native country Lithuania and maybe true in every European country.
- Countries, and most importantly low activity countries face high bureaucratic practices in dealing R&I activities, that make the process complex, time consuming with financial repercussions that cannot be absorbed by the R&I community of low activity countries.

Other lessons learned during the planned extensive interaction with the stakeholders are the following:

- Discussing the country NECPs with the direct stakeholders with the active contribution of EU initiatives gives a dimension of direct contribution to maturing further the needs of the country and taking up sensitive issues for further elaboration. This discussion brings into the open

the strengths of R&I in addressing the needs of countries in the most optimal way. Hearing the views of the participants through the online polls provide, has helped the discussion and made it much more real and direct with positive benefits in all directions.

- the PANTERA process called RICAP (R&I status and Continuous gAP analysis) through which it is aimed to build appropriate tools that will facilitate the evaluation of projects for feeding in valuable information for identifying R&I needs through the process.
- It is very important to strengthen the interrelation of the government and other authorities with the national universities and research centres. It is important to act on scientific evidence, underlying the importance of close collaboration between industry and the national universities. It is of paramount importance to cultivate the trust to local universities and research centres and try to have close communication with them and through their expert contribution, help to address effectively the challenges of the energy transition.

**Important messages that came through this interaction with key policy stakeholders that has guided the work of the PANTERA consortium in addressing the hindrances that the R&I community is facing in the low activity countries:**

- **Mrs Natasa Pilide, Minister of Energy of Cyprus:** We happily note the activities that your project PANTERA is involved in building the EIRIE platform with its multi-functional capabilities targeting the R&I community of Europe aiming to be a single point of reference for data, information and knowledge in support of the needs of researchers for conducting their research endeavours. We understand this need, and consider the synthesis of solutions offered by the EIRIE platform of fundamental importance to the attempts to help low activity countries like Cyprus to identify areas of competitive advantage and explore ways of capitalizing on them. The functionalities and resources targeted through the development of the EIRIE platform seem to move in this supportive direction and we intend to include its services in the policies that we as Cyprus will pursue.
- **Mrs Abigail Cutajar speaking on behalf of the minister of Energy of Malta:** The outcome of the polls does not surprise her at all. These issues do not apply only to the R&I needs of the country. There are a lot of R&I funding at EU level that as a country we are not stepping into. As a Country we obviously support the energy sector however we might need to give more attention to R&I.
  Mrs Abigail Cutajar referring to R&I in Malta, underlined that the efforts in the country in support of R&I are vast and wide, and thus we need to segregate the issue. The water and energy agency open different calls for R&I. Normally there are two calls per year, there are certain requirements, but they are not bureaucratic as at EU level. She continued saying that Malta aims to invest heavily on R&I especially in new technologies such as offshore renewables etc. Ing. Abigail stressed the importance of the interrelation of the government and energy and water agency with the universities and research centres. She mentioned that it is important to act on scientific evidence, underlying the importance of close collaboration between industry and the Maltese universities. The services that EIRIE offers will help this process and as ministry we promise that we will make good use of these services and aim to strengthen our position in the R&I efforts of the whole EU.
- **Dr Brian Azzopardi (MCAST Malta)** considers that there is a lot of potential untapped in the Maltese island. In the PV sector every surface could be covered by PVs. Offshore there might be more difficulties, and therefore before going offshore we should deplete any onshore resources. Furthermore, he indicated that as academia in Malta, they are collaborating with the industry and they need to invest more to improve their network. There are a lot of

challenges, and the involvement of the universities is crucial. The support given to all R&I community through EIRIE is fundamental in this process.

- ***Nicos Hadjinicolaou***, Industrial Extension Officer at the Ministry of Energy of Cyprus, explained that the Ministry is working towards easing the implementation of renewable energy sources across the country by acting on two fronts: by enforcing regulations to make the installation of PV compulsory for new households and by granting incentives for families and businesses that decide to install PV on existing buildings.
- **Mr George Partasides** working for the Ministry of Energy of Cyprus, and from this role he was active in developing the NECP for Cyprus and he finds that the emphasis given on optimal operation of the distribution system and forecasting are well justified since they play an important role in the evolution towards the zero-emission economy. RES are going to grow fast and for this reason we need the system with improved utilization of storage to play an important role in facilitating this transition. They do understand the fundamental need to be in line with the EU strategy expressed through the SET Plan but local national needs are a priority for them and they do give emphasis in their development and utilization. They are also well aware of the implications of this technology evolution and they are working with experts to develop the systems that will help to implement the right policies for attracting the deployment and utilization of these emerging technologies in support of the shift towards low carbon solutions and meet the strategic objectives of Cyprus.
- ***Dr Venizelos Venizelou*****,** Energy Engineer at Cyprus Energy Regulatory Agency (CERA), stated that CERA promotes schemes that are structured to promote the renewable energy by encouraging the establishment of renewable energy communities, collective self-consumption and all provisions coming out of the electricity directive. **Dr Venizelos *Venizelou*** outlined the core activities and R&I Projects of CERA and presented a paper on "Regulatory Sandboxes in Incentive Regulation" seeking to provide clarity and a framework for the different tools that energy national regulatory authorities can use to facilitate innovation in the context of incentivizing regulation for grid operators. On the topic of technology maturity in Cyprus, Mr Venizelou underlined that the country is still in the process of digitalising the electricity sector and important steps have to be taken to fully adopt the flexibility of the energy market.
- ***Ms Anna Maria Christoforou***, Scientific Officer at the Research and Innovation Foundation (RIF) of Cyprus, explained that RIF (mainly subsidized through government structural funds) has been providing funding, of minimum 1 million euros each, in specific projects that are submitted by researchers to improve efficiency and make the energy systems more innovative. Asked on Cyprus' response to the 5$^{th}$ pillar of the energy union on "research, innovation and competitiveness", ***Ms Christoforou*** listed some of the most important national tools that the country has adopted to comply with the green energy targets. Among the mentioned regulatory instruments there was the Smart Specialization Strategy for Cyprus, which was adopted in 2015 and aims at supporting R&I activities and investments while fostering cooperation between the academic community and the business world in established thematic areas, including energy. **Ms Christoforou** concluded her intervention by recalling that while it is important to have funding for basic science and bottom-up research, it is equally significant to have targeted thematic areas.
- **Dr Antonis Ioulianos** of Research and Innovation Foundation (RIF) of Cyprus clarifies the role of RIF as the national authority in charge of supporting and promoting research, technological development and innovation in Cyprus. The RIF was established in 1996, following an initiative by the Government of the Republic of Cyprus, with the initial name of Research Promotion Foundation (RPF). The RIF is a private legal entity structured as a non-

profit organization, and is registered as an Institution, under the Societies and Institutions Laws. The significant role of scientific research in modern socio-economic development, as well as the vital need to enhance research activities and infrastructures in Cyprus, were determining factors for the founding of the RIF. Since its establishment, the Foundation has developed widespread activities at the National, European and International levels, with a strong focus on the development of national research programs, as well as the representation of Cyprus in European and International programs and organizations. Its current structure was the result of the decision by the Council of Ministers in October 2018, for the overall restructuring of the sector and took over the role of the executive arm of this System.

- **Mr Tasos Gregoriou**, DSO of Cyprus, commented that DSOs are the key players in the new era of energy transition. The era of decarbonization of the energy by 2050 to be carbon neutral, the era of decentralization of the energy as by 2050 all electricity power has to be produced by distributed RES Units, and digitalization of the energy as the system itself and services provided by DSO's have to go digital. The era of:
    - Distributed RES integration
    - Dynamic tariffs
    - Flexibility
    - Active customers
    - Big Data
    - Disruption and emerging technologies (ET)

Mr Tasos Gregoriou appreciated the work done through PANTERA and EIRIE in strengthening links with the R&I community in EU and going further he stresses the importance of flexibility on the road to carbon neutral economy:

- ***Dr Alexandros Nicolaides*** from Cyprus Transmission System Operator underlined the importance to work hand in hand with other stakeholders in order to ensure that all the resources and technologies are coming at the right time so that supportive solutions (for energy storage for instance) catch up with the rapid deployment of new technologies.
- **Dr Nestor Fylaktos** (Cyprus Institute) has indicated that the Cyprus Institute is quite active in R&I in support of the energy transition but very specific in the field of utilization of solar energy through CSP technologies and related technologies. Going further, Dr Nestor Fylaktos has indicated the rich activities of the institute in research complementing the role that it plays in mobilizing work within Cyprus but also representing this to European institutions. Taking into consideration the prevailing R&I status in Cyprus and the support offered through the activities of the Cypriot Authorities he has strongly indicated appreciation of the work done within the PANTERA project in developing EIRIE and the promised functionalities to serve the R&I community of Cyprus and Europe at large.
- **Mr Fanos Karantonis** in relation to the energy transition issues and talking about the Cyprus Employers & Industrialists Federation (OEB) stressed the following:
    - Provide information and update of OEB members on the developments in the field of energy and environment at national, European, and international level.
    - Technical and administrative support to members and joined Professional Associations.
    - Collection, processing and publication of statistical data in the field.
    - Organizing training seminars, events, lectures, thematic days related to energy and the environment.
    - Provision of technical advisory support to the sector related issues.

- Develop national and other European co-funded projects on the fields of energy and the environment.
- Promotion of the cooperation of academia and the industry in the field of energy and environment and the development of research and innovation. Cooperation with liaison offices of public and private academic institutions.
- Promotion of the development of new standards and their implementation.

He stressed that as can be appreciated all these activities are central to OEB and OEB greatly appreciates the initiatives of PANTERA to strengthen this process with other regions through Desk 3. He indicated that he is aligned with the outcome of the efforts made by the project, and he gives a lot of value to the work that is targeted through the work of the project and the planned functionalities on the EIRIE platform. As OEB they will be happy to cooperate with PANTERA in this direction and they are ready to build closer links and contribute where required.

### 4.3.2 Lessons learned from case studies

Desk 3 is engaged with two countries: Malta and Cyprus. The objective of Desk 3 was set to raise interest in the two countries for building collaborative R&I activities that have the potential to be sustainable and beneficial to both countries. This objective is in line with the broader objective of PANTERA for setting up the regional activity and building the collaborative areas in EIRIE and CONFLUENCE.

This broader objective was set as a high-level objective for Desk 3 and that is why we targeted R&I entities in the two countries that can work together to build such a perspective. On the basis of this broader perspective the following activities were planned as the first lot to build the targeted collaborative environment for the entities involved:

- Identify possible entities that have the interest to collaborate.
- Organise common activities.
- Target common research objectives.
- Enhance the planned collaboration work through the functionalities offered by EIRIE / CONFLUENCE to strengthen working relations and offer possibilities for enriching participation options.

Our first investigation for building collaborative approach to achieve the above objectives we have converged to the following entities:

- FOSS Research Centre of University of Cyprus
- ANEL Nicosia Development Agency (https://anel.com.cy/)
- MCAST , Malta College of Arts, Sciecne and Technology (https://mcast.edu.mt/)

After initial agreement of objectives, we planned the first workshop that was organised in Cyprus with all 3 partners contributing and two projects collaborating: PANTERA and NEEMO[2]. The workshop was organised on the 12th of November 2020. The theme of the workshop was decided to

[2] https://neemo-project.eu

be: “The public policies of Cyprus and Malta on electric mobility”.

Participation to this nano-workshops is as seen in the agenda extensive, giving evidence that the collaboration was working and delivering. This nano-workshop gave the opportunity to the PANTERA partners to strengthen collaboration with the Maltese colleagues and build a common vision on energy transition and engage them to the activities of the EIRIE platform for enriching R&I activities in the region.

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

The method that was followed consisted of the following steps:

- Identify the research needs and endeavours coupled with the NECP plan of each country (bilateral meetings/non-structured interview). The effort is common, but the technical starting point is different according to the NECPs of Cyprus/Malta
- Connect appropriate institutions (DSOs and Universities) together and discuss the needs and collaboration opportunities (AIT/UCY/UMIST/EAC/ENEL Malta)
- Common proposal preparation under ERIGRID 2.0. Focus on the preparation and the consortium building and to transfer good practices.
- Implementation and development of our common proposal.
- Building questionnaire to have feedback and build a good practice that can be replicated and escalated to more than two partners.

The technical needs that are co-shaped by the consortium aimed 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 daytime, as a large number of Photovoltaics which are connected to the low voltage network as a negative load, the natural damping provided by the loads is reduced, and therefore, the effective inertia is also reduced. This can compromise the dynamic stability in the event of small load changes, even if the load-generation balance is maintained. 1.To evaluate/ estimate the system inertia online with the help of phasor-based measurements 2. To make decisional analysis on which PVs should participate in frequency response and which ones should participate in frequency regulation. To make PVs and other static sources (where inertia is decoupled through inverters) work in tandem with other distributed generators (DGs) (siting of DG systems to meet the annual energy needs).

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

In November 2022 the three entities MCAST, FOSS and ANEL cooperated in making the planned

conference MEDPOWER22 **on Power Generation, Transmission, Distribution and Energy Conversion** a success. For this reason, MCAST undertook to coordinate the organisation of the conference, PANTERA to organise a workshop using a useful parallel session and present papers from the work that the three partners have developed through their cooperation.

All the above collaborative work is targeted to be an example of how collaboration between R&I entities can flourish and learn from experience gained. For this reason, the partners agreed to host this activity on the provided collaboration area of EIRIE and CONFLUENCE and to this effect work progressed using resources from all partners. Extracts of the work conducted within CONFLUENCE are given below (Figure 6) revealing the strengths that this collaboration can bring forward. The landing page of Desk 3 that the experts of the two countries are building their collaboration work is as follows:

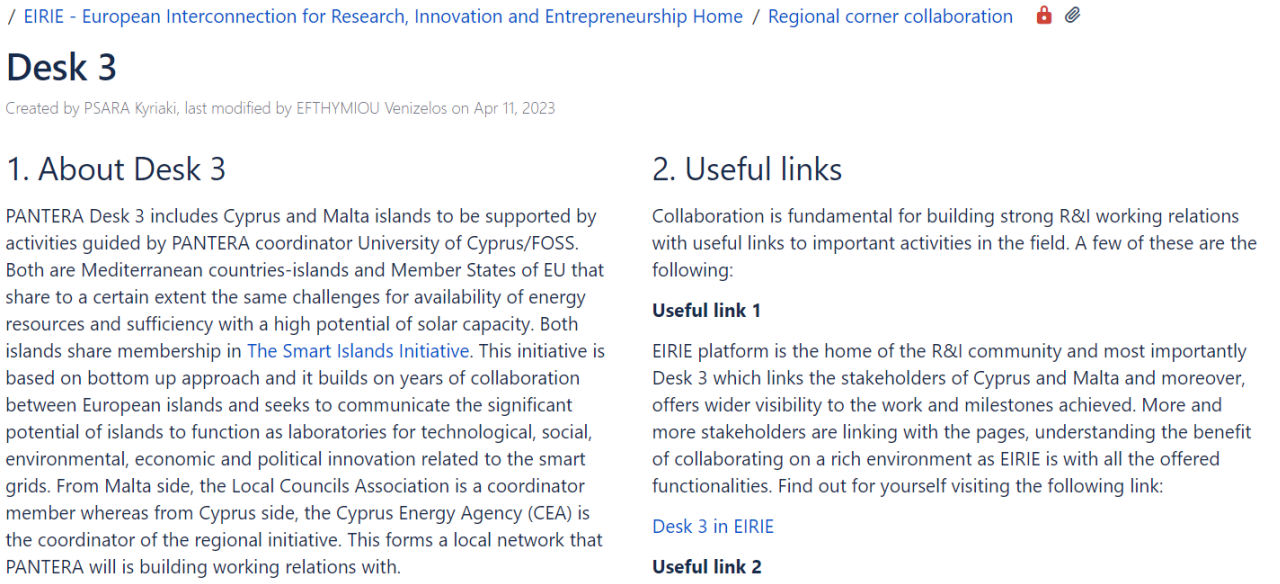


*Figure 6: Desk 3 CONFLUENCE page*

Through the work completed till today and still in progress, use is made of the following library of pages (Figure 7) that host the work of the experts:

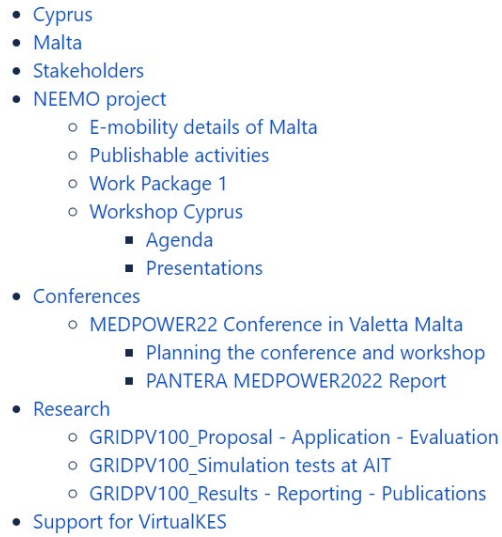


*Figure 7: Desk 3 CONFLUENCE library of pages*

As can be seen, the collaboration area hosts separate pages for the two countries, a page with details of the stakeholders collaborating and a list of pages that detail the work in relation to common projects, research and events planned together including conferences.

A clear indication of the strengths of using the collaboration space of CONFLUENCE is an extract of the work related to the organized MEDPOWER22 conference (Figure 8). This is shown below, and in this extract, the cross referencing with outcome material of the conference are suitably linked giving access to all of valuable material linked to the conference:


*Figure 8: MEDPOWER22 conference page in CONFLUENCE*

## 4.4 Desk 4 (Poland, Czechia, Slovakia)

### 4.4.1 Lessons learned from workshops and other interactions with stakeholders

In Desk4, we only succeed to organise a nano-workshop in the Czech Republic. Several continuous efforts had been made to organize a workshop in Poland and Slovakia but due to a lack of mutual interest and common ground with the stakeholders, several opportunities did not convert into a successful event. Although, we managed to interview stakeholders from the Desk 4 countries to get insights about their respective countries

***Czech Republic Nano-Workshop***

The PANTERA nano workshop entitled Capacity Building on R&I in Smart Grids, Storage and Local Energy Systems. The panel discussion is dedicated to accelerating R&I in the Czech Republic region.


*Figure 9: Panellist with Moderator (Rad Stanev)*

Discussion based on the panel discussion: The panel discussion mostly focuses on the current status of financial instruments in smart grid R&I activities in the Czech Republic and also challenges in securing EU funding. The panel comprised almost equal representation from the university/academia, private companies, and research institutes. The discussion was very insightful with diverse opinions on R&I activities in the nation. We divided the panellist responses into two categories according to their respective domains (university/academia, private companies) to understand the challenges and needs of each domain.

University/academia: According to the university representatives, there is a shortage of skilled personnel in the research activities. The main source of their funding is national funding programs which are easy to target but due to a lack of skilled people funding opportunities are not secured. They also mentioned that the participation of the younger generation in the STEM fields are getting very limited in the last few years. Although many national universities have programs to encourage young people toward higher science education still there is a need for widespread national initiatives to encourage young people toward the STEM field from a very early age. Also, brain drain in the western European country is also a significant reason for less participation of young talent in national research activities. The Czech Republic has a considerably good research infrastructure but researchers are allured by private companies to get high remuneration. They also underlined that several institutions are lacking the research management skills which are significant in acquiring EU-funded projects. There is also a lack of visibility of the EU calls. The most of research is driven by government and industry objectives and due to intellectual property rights issues local industries are not motivated to participate in various calls.

Private companies: As per private companies' representatives, the power and energy sector has been changing at a very high pace which requires more skilled people in the energy sector. Technical education is also depreciated in the last couple of years which also created a huge gap in meeting current industry requirements. They also emphasized that Western countries are more experienced in securing EU funding and there is very high competition, they are lacking significant skills for EU research funding. They also mentioned that any significant change in the status quo of the power system adds an additional burden on the consumer's monthly invoice. The current Ukraine-Russia crisis also limited their expansion in the smart grid activities. They also showed no confidence in the solid-state power system devices i.e., inverters. There is also a lack of acceptance of RES sources in the Czech community which represents minimal awareness of the current energy trends in the nation

There is a lack of skilled people in the technical research field and a lack of awareness of technical education in the country also there is limited political conviction and support for technical R&I activities. There should be a nationwide program to promote technical education among young people. Government should also work on creating subsidies to cover the energy transition cost or adoption of low-carbon technologies so that the people won't bear the 100% RE adoption cost.
The majority of R&I funding is local industry-driven and dependent on national calls and also panellists found that the EU R&I funding process is very complicated. There should be continuous communication between the EU and the research community of the Czech region to converge their R&I needs so both entities can work together and find ways to simplify the EU funding process. The EU should also take extra efforts in promoting the future and the ongoing R&I calls among the Czech research community. Researchers should be educated in research management skills so that they can compete with the other EU countries in the EU funding calls.

There is a primordial regulatory framework still existing in the region which restricts the adoption of new sustainable energy resources. The Czech Republic regulators should learn from the other neighbouring countries to update their regulatory framework for RE adoption.

***Interaction with a Polish stakeholder (senior researcher)***

According to the stakeholder, In the last 5-10 years these are the major challenge in the smart grid implementation is the massive deployment of RES, which have very high variability, which is not followed by the development of the grid in Poland. One way to resolve it is the deployment of Smart Grids to increase flexibility. Voltage stability is also another issue, especially in Northern Poland, where the grid is less developed and the wind production is located (mostly related to transmission). This can be resolved by FACTS, but it is difficult to justify the costs. Lastly, Balancing issues (peak/low demand) together with some technical limitations to power import/export is also a challenging issue.

According to him the first step towards smart grids is **Smart Metering** and then **Observability** and lastly the better **use of flexible resources**.

Asked him about the funding instruments for R&I activities in Poland, and he informed us that, in general, insufficient funding seems to be the main problem esp., for smart grid activities.

New solutions are not appreciated in the current ecosystem and conventional solutions are being used to solve any problem. To deploy Smart Grid solutions, it is necessary to use public funding but ironically DSOs are less interested and reluctant to adapt to the current advancement in the power system. They still prefer to use old-fashioned solutions instead. Proper awareness and pilot systems demonstrating the smart grid solutions would be a significant step to bring everyone to the table.

### 4.4.2 Lessons learned from case studies

***Czech Republic case study***

The case study aims to understand 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.

The first step is to analyse the current policy framework for the RD&I ecosystem and then 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 IEA mentioned in the Czech Republic energy policy review 2021. The four core functions are as follows:

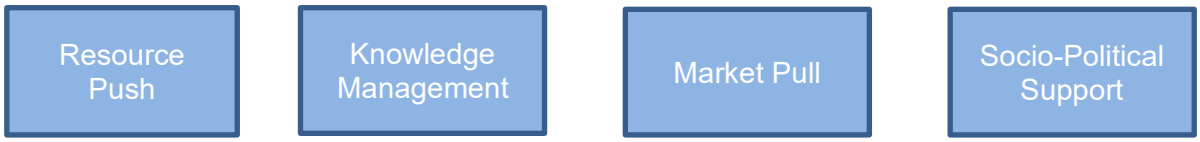


*Figure 10: A four-pillar approach to successful energy innovation systems by IEA*

As per the assessment, there is no dedicated ministry for research, development, and demonstration (RD&D). The Ministry of Industry and Trade is responsible the for energy-related RD&D. A government advisory body, the Research and Development Council, is responsible for the preparation and implementation of national RD&D policy. Due to involved in diverse responsibilities, it is important that 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.

THÉTA's (*THETA: Funding programme for applied research, experimental development and innovation*) sub-programs are good examples of how to strengthen the engagement of private sector actors in energy innovation. the new THÉTA Programme has led to an overall increase of public funding for energy-related RD&D, and serves as the main instrument of support for applied research, It also could help bring new ideas, concepts, and technologies to markets to enable clean energy transitions. Additionally, THÉTA umbrella shows the full range of these technologies and demonstrates the relative state of development between low-carbon RD&D topics and fossil fuels. More diversified RD&D would not only contribute to building up the technological capacity for greater diversity in domestic energy technology options. Additionally, it would also enable to consider advanced sustainable energy technologies in energy research.

Due to the multiple actors involved in the RD&I, 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 community plays an active role, including academia, non-governmental organizations, small and medium-sized enterprises, and innovative start-ups, bringing all appropriate actors into a collaborative "regulatory sandbox".

There is also an opportunity to increase collaboration at the international level on projects that can be critical for RD&D. The Czech Republic could participate in more EU R&D programs beyond nuclear energy programs.

***Poland case study***

Referring to the comments of stakeholders, the Polish case study is focused on smart metering, which is the first step towards implementing smart grids.

The Polish case study gave the idea of the market-driven rollouts of Smart Metering, based on the Technology Innovation System (TIS) analysis for Poland. The country's experiences illustrate that the SM rollout may be successful at the level of single Distribution System Operators, even without

binding regulatory intervention, because their expectations of benefits and the benevolence of regulators in tariff approval may be sufficient driving forces.

To ensure balanced rollout progress across the country, an adequate policy framework is necessary. The major push for SM TIS development in Poland comes from the energy industry, which started the pilot activities following the signal of benevolence from the regulator. A shared understanding of the benefits of SM implementation by the national market regulator and the EU policymakers was the main reason for starting the rollout. Pre-existing national policy instruments, such as tariffs enabling financing of SM systems and detailed public auditing of SM deployment processes, can be recognized as substantial factors accelerating SM TIS development.

On the other hand, several barriers to the SM rollout are present in the policy instruments landscape, including inexistent, legally binding national SM standards. The limited supporting and coordinating role of the government can be considered another barrier. This passive role entailed delaying large-scale SM deployment and decreasing the benefits available to customers. Furthermore, the lack of a precise EU-level or national standardization framework encouraged the DSOs to introduce their own set of regulations, which have not been validated or certified by any public authority, e.g., for cybersecurity or interoperability conformance with relevant standards.
SM in Poland is moderately positive. While the first phase of the rollout was driven mainly by one DSO, the recently introduced obligation scheme can be a sufficient motivating factor for the companies that were skeptical towards the introduction of SM. A few critical issues will decide whether the SM implementation is successful. First, it is yet to be seen whether the obligation scheme, without clear incentives and penalties for the DSOs for reaching the targets set by the government, will be effective. Second, because the introduced obligation scheme is formulated in isolation from targets on energy savings, the potential energy efficiency improvements due to the SM introduction will mostly rely on the DSOs' voluntary activities in the field of soft measures.

Most of Poland's R&D funding programs, notably those implemented by the national funding agencies, 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. 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.

***Slovakia Case study***

The Slovakia case study is based on the initiative SlovSEFF (Slovak Sustainable Energy Financing Facility) started by the European Bank of Reconstruction and Development (EBRD) to support sustainable energy projects. Projects of renewable energy, industrial energy efficiency, and housing energy efficiency are the only eligible categories in this financing scheme. The SlovSEFF was one of the first in a series of financing facilities implemented with the objective to promote energy efficiency and renewable energy projects.

A financing scheme such as SlovSEFF could be an important component for a comprehensive decarbonization strategy of the housing and industrial sectors. This holds especially true in transition countries that lack adequate sustainable energy investment capacities from local banks.

Considering the ambitious sector-specific targets of the EU Member States, comprehensive investments are needed to achieve the desired renovation rate of existing buildings and higher energy efficiency standards in SMEs. This is particularly relevant for energy renovations, as the amortization periods for such measures are often considered too long from an investor's perspective. In fact, the impact of a financing scheme such as SlovSEFF for the industrial and building sector would touch upon the ETS and non-ETS sectors by fostering energy efficiency. However, the carbon mitigation impact depends largely on the emission intensity of the energy mix in the respective country. Besides triggering emission reductions, a comprehensive financing scheme can also potentially have significant impacts regarding the transfer of expertise among banks and companies related to sustainable energy investments. Supplementary grant funding for technical assistance can further incentivize investments and foster this knowledge transfer.

The successful policy design of SlovSEFF should therefore rather be applied to other EU countries in transition that face similar challenges with the energy intensity of the industry or the efficiency standards of their building stock (e.g., Poland, Czech Republic). This holds especially in countries where local banks need additional capacities and technical knowledge regarding sustainable energy financing. For any policy design of such an instrument, it is also important to consider potential drawbacks for the effectiveness, such as windfall and rebound effects as well as cannibalization with similar (financing) instruments. In light of the heterogeneity within the housing and industrial sector, a financing scheme should preferably be targeted towards those investor groups where the number of potential free-riders is expected to be relatively low, e.g., those who currently do not have access to sufficient funds and support schemes. In addition, low-income households and companies with liquidity constraints should receive particular attention in terms of eligibility.

The impact of a financing scheme such as SlovSEFF for the building and industrial sectors touches upon the ETS and non-ETS sectors. There are two aspects particularly relevant to the distinction of sector impacts. First, Foster energy efficiency for district heat (mostly ETS) and decentralized heating systems(non-ETS). Second, a shift among heating systems, e.g., from distributed heating based on fossil fuels to electricity-based heating, radiators, heat pumps, or 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. Likewise, 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.

## 4.5 Desk 5 (Italy, Hungary, Croatia)

### 4.5.1 Lessons learned from workshops and other interactions with stakeholders

The PANTERA project has organised workshops in all the Desk 5 countries (Croatia, Italy and

Hungary) making possible to discuss with local stakeholders the main issues that presently hinder a wider collaboration at EU level. Here are summarised the main outcomes coming from these workshops as well as other findings derived from interactions with stakeholders that the project has gathered in different occasions such as workshops preparatory calls, dedicated interactions to promote the EIRIE platform and also coming from the interview process that made possible to get key insights through more detailed and structured discussions.

Different stakeholders reported that get first-hand information about main relevant research trends and be able to propose edge research topics is challenging. Also becoming part or suitable networks of organisations able to compete at EU level is not easy for, especially small, organisations that have never participated in EU level activities and projects. Indeed, networking opportunities have been indicated as a key point by stakeholders that replied to the stakeholder survey launched by PANTERA at the beginning of the project.

Stakeholder pointed out that, for organisations so far not involved in EU level activities and projects, it's difficult to learn from the experience of ongoing and past projects thus making difficult to propose suitable activities for replying to European open calls for projects of whatever funding scheme.

We would like to report here also some lesson learned from the organisation of workshop itself. In particular related to the stakeholder engagement process in workshops. Even if we have found that all the organised workshops were satisfactory and make possible to the PANTERA project to proceed towards its objectives, the stakeholder engagement has been in some cases not easy. One of the main first feedback of the stakeholders invited to workshops is to clarify what are the main benefits for them to participate in these events, with special reference to short term benefits. This of course can be difficult to estimate and state, being the participation in such events more related to long term perspective. Therefore, what we can say is that to make appealing events is challenging, especially to small organisations. So, despite networking opportunities has been indicated several times as one of the major aspects that hinders the participation, clarify and clearly state the main takeaways from participating to workshop is key to have boost stakeholders' involvement. In some cases, this is due also to a close mind, often companies have already a more or less established network of partners and they think that it's enough avoiding even to evaluate other possible opportunities. This is certainly a habit to deal with while inviting stakeholders.

Another lesson learnt from the interactions with local stakeholders on several occasions it that in some cases financial resources are not enough to actually foster the involvement of organisations in EU level activities and projects. In fact, lack of human resources has been indicated several times as one of the major hindering factors. To overcome this key issue is not easy and a long-term view is needed. Moreover, to get an EU funding could not be enough to solve this. For example, for a small company it is difficult to hire people with permanent contract because of an EU project, in fact the source of funding is limited in time and the company need then to enlarge the business to exploit the new resource properly. Another related aspect is that to get EU funding need an effort in preparing the proposal, both from the technical and from the administrative point of view. This, especially for small organisation can be challenging. The administrative burden, complicated by the different frameworks and rules of available funding programmes, has also been appointed as a hindering aspect on several occasions. This is especially true for small and medium organisation as it is particular heavy the first time that an organisation is entering EU level activities. To alleviate this issue has been indicated by several stakeholders the importance that national agencies could provide to organisations. It has been pointed out that in this case this is not easy to get, and small

and medium companies are somehow left alone and cannot cope with the effort needed.

Considering instead more technical related aspects, one of the issues highlighted is the lack of a proper network of research facilities. Being the TRL required by the end of Horizon project increasing and, in most cases, not limited to laboratory demonstrations, suitable research facility and the involvement of industrial stakeholders available to implement innovative solutions are needed. Stakeholders coming from less developed areas of the countries are in some cases in difficulty to meet this requirement and also to find consortia where to make available and exploit their expertise.

While so far have been summarised, the barriers related to the engagement of local stakeholders at EU level, other relevant hindering factors more related to the smart grids' deployment have been pointed out, in particular during the interview process and reported in other PANTERA deliverable.

### 4.5.2 Lessons learned from case studies

We would like here to further analyse the participation of organisations coming from desk 5 countries to European projects, in particular the Horizon2020 ones through data coming from the Horizon Dashboard[3].

The focus of the investigation is both on the number of participations to founded projects and on the net EU contribution to the countries, comparing the results with the EU member states averages. Only projects founded under the societal challenge "Secure, Clean and Efficient Energy" have been considered in order to map the country involvement in energy-related projects.

The number of participations and the number of projects coordinated by each country, as well as the net EU contribution, has been also normalized considering the countries' population, to have comparable results. Data are presented in the following table.

*Table 4: Data about the participation to Horizon H2020 projects under the societal challenge "Secure, Clean and Efficient Energy"*

| | Population (Million) | # of project coordinated | Participation* | Unique participants** | Signed grants | Net EU contribution |
|---|---|---|---|---|---|---|
| *Italy* | 60,36 | 188 | 1467 | 659 | 623 | 449,9 M€ |
| *Croatia* | 4,07 | 5 | 162 | 59 | 116 | 23,3 M€ |
| *Hungary* | 9,77 | 11 | 124 | 66 | 86 | 21,9 M€ |
| *EU member states* | 514,44 | 1367 | 13035 | 5801 | 1431 | 4.561,9 M€ |

| | Project coordinated every 1 million of inhabitants | Project coordinated over the signed grants | Participation every million of inhabitants | Net EU contribution per capita | Net EU contribution per participation |
|---|---|---|---|---|---|
| *Italy* | 3,12 | 30,18% | 24,33 | 7,46 € | 306.670 € |
| *Croatia* | 1,23 | 4,31% | 39,83 | 5,73 € | 143.955 € |
| *Hungary* | 1,13 | 12,79% | 12,69 | 2,25 € | 177.026 € |

[3] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-dashboard

| | | | | | |
|---|---|---|---|---|---|
| *EU member states* | 2,66 | - | 25,34 | 8,87 € | 349.972 € |

***Participation**: Number of organisations involved in the societal challenge, one organisation participating in N projects is counted N times*

****Unique participants**: Number of organisations participating to the societal challenge*

Italy shows a good amount of project coordinated being above the EU average for project coordinated every millions of inhabitants, while its number of project per million of inhabitants is a bit lower with respects to Europe (24.33 vs 25,34). The Italian EU contribution per capita is slightly below the average (7,46 €), even if not far from one of other big countries such as France (6,80 €, not reported in the table) or Germany (8,40 €/p, not reported in the table).

Croatia has a very low number of coordinated projects (only 5) but demonstrates a high overall participation, with a ratio of participation every millions of inhabitant higher than the EU average. However, the net EU contribution per project is relatively low showing that the Croatian actors often play marginal roles in EU projects.

Hungary needs to improve both its involvement as coordinator and its project participation (being this last figure almost equal to half the average EU, 12,69 vs 25,34). Due to the low number of participations, the net EU contribution per capita is highly below the member states average, but also the net EU contribution per project is quite poor being almost half of the EU average showing, as in the case of Croatia that Hungarian organisation do not play key role in EU funded projects. In any case, for a precise analysis of the figures regarding net contribution per capita it should also be considered that the person month cost is different for different EU member stated. This more detailed analysis is not conducted here.

In addition, the regional differences within each country have been investigated, by looking at the different participation in the different countries' areas. Overall, the distribution of participations is aligned with the demographics of each country, but some peculiarities can be pointed out.

As can be noticed in Figure 1, Italy shows a huge difference between south Italy, including islands, and the rest of the country. Indeed, less than 9% of the whole participations are coming from those areas, thus calling for enhancement of the organizations and companies' engagement in those regions.

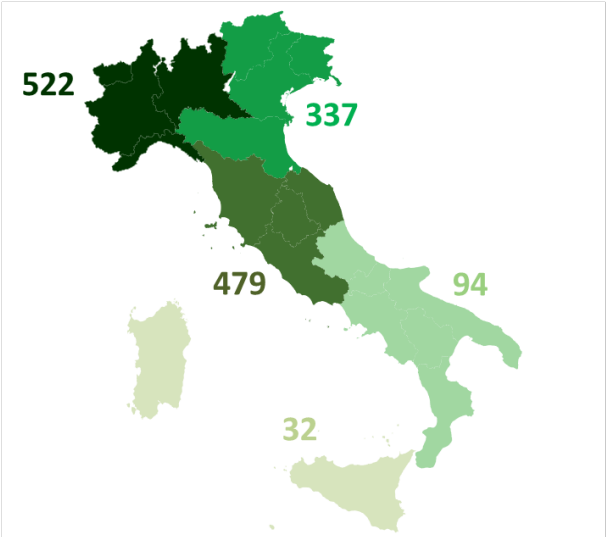


*Figure 11: "Secure, Clean and Efficient Energy" H2020 participation by areas in Italy*

For both Croatia and Hungary, most of the participations are concentrated in the capital and a very poor contribution is coming from the other regions. This is way more empathize in Croatia (Figure 12) where outside Zagreb the level of engagement needs to be strongly increase, since population is quite well distributed over the country. For Hungary, on the other hand, the population distribution, which is really concentrated in Budapest, is aligned with the participation one shown in Figure 13. Nevertheless, organizations and companies outside the capital should be encouraged to submit proposals for EU projects.


*Figure 12: "Secure, Clean and Efficient Energy" H2020 participation by areas in Croatia*

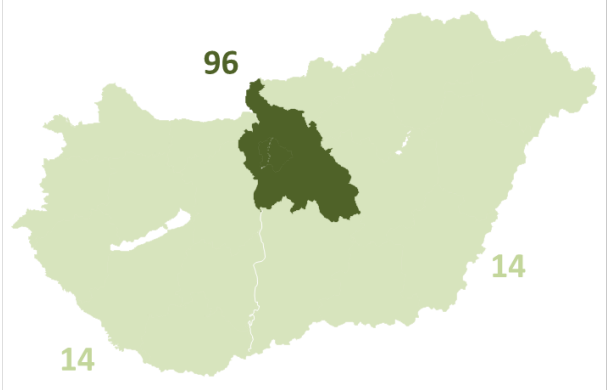


*Figure 13: "Secure, Clean and Efficient Energy" H2020 participation by areas in Hungary*

### 4.6 Desk 6 (Ireland, Portugal)

PANTERA project is aimed at encouraging more spending towards renewable energy, smart grid research and innovation in countries of the EU with lower spending in this area. This is achieved through organizing regional awareness building workshops, seminars and conferences aimed at sharing scientific research as well as creating an IT platform for sharing of information and data.

Digitalisation is a key component of a clean energy system, and the collection, management, and analysis of big data is essential for smart grid operation. However, there are challenges such as interoperability, data standards, privacy protection, and cybersecurity. Standardisation could help eliminate differences inhibiting the flow of information, but currently, there is a lack of interoperability

among technologies, hindering their compatibility.

### 4.6.1 Lessons learned from workshops and other interactions with stakeholders

In December 2019, a PANTERA Regional workshop took place in UCD, Dublin, which was attended by representatives from industry, the national funding agency Enterprise of Ireland, and academia. During the event, several interviews were conducted with representatives from various sectors including Distribution system operators (DSO), Transmission system operators (TSO), new entrants, and academia. In addition, there was an open discussion among all the participants, which helped to identify the significant current challenges in the field of smart grid research and innovation.

The main focus of the workshop was towards Ireland's smart grid, energy storage, and local energy systems landscape. The workshop aimed to exchange best practices and information among R&I experts, policy makers, and foster links with EU level initiatives. More than 50 participants and keynote experts from national and international academic and industry bodies attended the workshop. The topics discussed included the European and Irish smart grid landscapes, supporting R&I through knowledge dissemination, and EU and national R&I funding opportunities. The PANTERA project and its platform were presented and discussed, and participants provided early feedback via the Glisser tool.

During the discussion, it was pointed out by the speakers that the delay in data sharing among several stakeholders could hinder the pace of decarbonization, and this lack of access to data was identified as a major obstacle. They also highlighted the potential for creating new services related to electrification of transport and heating. Some new players in the industry emphasized the need to extract maximum value from existing assets in the system by employing smart and efficient usage techniques, which can be achieved through data analysis.

The results were discussed thoroughly, giving feedback to PANTERA representatives on how to set up the platform.

The important future steps and solutions identified were:

- There is significant activity and interest in Smart Grid R&I across industry and academia in Ireland.
- There is a demand for access to relevant smart grid data to allow building of prototype models.
- The deregulation of the market, and the GDPR rules make cooperation and data sharing among actors in the electricity space difficult.
- The proposed PANTERA platform offers a good opportunity for data and knowledge sharing.
- The PANTERA regional desks offer an opportunity for networking for the Irish smart grid R&I community, participants expressed interest in follow up activities.
- The desired toolsets that could be of use and truly supportive to the R&I community were identified and these will be available in the soon to be shared interactive platform.

The workshop was followed by an online webinar in February 2021, which discussed how to share research data, ensure GDPR compliance, and reduce the risk of divulging potential innovation insights. The SEAI National Energy RD&D Funding Programme in 2021 specifies open data requirements, encouraging project teams to work with open access tools and make project outputs/models/assumptions available to interested stakeholders to facilitate follow-on studies and

reduce duplication of research.

### 4.6.2 Lessons learned from case studies Ireland

The work undertaken during this case study project is composed of two smart grid research projects in Ireland. The first case study focuses on the adoption of heat pumps in Ireland and the data requirements for the research project. The second case study is on a project called BEYOND, which uses blockchain technology for electricity trading. The focus is on low-carbon technologies in distribution networks and the importance of high-quality data to achieve energy transition goals. The challenges and costs associated with collecting and managing data are highlighted and the move towards open data in smart grid research is encouraged.

***Case study 1***

This project aimed to review the literature on air source heat pumps (ASHPs) in temperate climates and conduct a field study to gather ASHP operational data. The study encountered challenges such as the high cost of research-grade monitoring equipment. However, successful collaboration with another organization enabled the team to leverage additional value from existing field trials. The combination of data from the field trial and publicly available weather data allowed the estimation of ASHP performance factors. The results from this study were published as academic papers and a final report was compiled with recommendations on installation and user operation guidelines and published online.

***Case Study 2***

The project aims to design secure, automated and decentralized local electricity markets using blockchain technologies for Austria, Ireland, and Norway, and to provide regulatory and policy recommendations for implementation. In the Irish part, the team will analyse different local energy market designs, identify the best solutions considering Irish Grid Code, and demonstrate two use cases in a real-time simulation environment. The studies suggest that local energy market has multi-benefits such as efficient utilization of DERs and economic savings, but it is important to investigate the impact of local energy market on network operational performance. ESB Networks is establishing a platform to collect necessary data for analysis towards the development of the Digital smart energy community.

The UCD Energy Institute and the IERC share interests in Smart Grid research and the clean energy transition. They see opportunities for collaboration through data sharing, which is a bottleneck for Smart Grid R&I. The availability of high-quality data is critical for the success of future smart grids, and policies need to be developed to support it. PANTERA could contribute to this by providing training for smart grid researchers on data issues, and data sharing agreements need to be designed as part of the Grant Agreement. Data Management Plans can help identify suitable open data, and a repository for data storage and archiving.

The challenges observed can be summarized as below:

- The reliance on authenticated high-quality data for reliable research results.
- The cost and difficulty of configuring research grade meter equipment.
- The Communication layer of the ETIP SNET smart grid architecture being prone to failures.
- The need to carefully manage data for GDPR compliance and project collaboration agreements.
- The time-consuming process of collating and preparing data sets for analysis and modelling.

The proposed solutions to these challenges can be:
- Developing sample data sharing mechanisms to address the bottleneck of Smart grid R&I.
- Collaboration through the sharing or pooling of smart grid data.
- Compliance with SEAI RDD open data requirements from 2021 onwards.
- Designing a data sharing agreement as part of the Grant Agreement.
- Developing meaningful Data Management Plans to identify suitable open data and a repository for data storage and archiving.
- Supporting further training for smart grid researchers on data issues through PANTERA.

### 4.6.3 Lessons learned from case studies Portugal

Portugal is falling short of its goals for R&D intensity. It is expected that the industrial sector will be responsible for integrating distributed resources effectively. To tackle these challenges, this Case Study seeks to align the NECPs with R&I funding from relevant industrial players. The proposed strategy involves establishing partnerships between different organizations and seeking financial support from local power industries, including INESC Porto in Portugal, TUS in Sofia, Bulgaria, and FOSS at UCY in Cyprus.

The objective of the case study is to assist researchers from Portugal, Bulgaria, and Cyprus in achieving the following goals:
- Enhancing their national network through collaboration with the industry that provides valuable support.
- Establishing channels of cooperation with other institutes across Europe for research collaboration and data sharing.
- Accessing research and innovation (R&I) infrastructure and validation cases through industry partnerships.
- Identifying successful strategies and lessons learned for securing funding from industry to conduct impactful research.
- Collaborating with other EU institutes to complement their expertise and establish connections.

The approach that will be employed consists of the following steps:
- Recognize the research needs and goals that align with the National Energy and Climate Plans (NECPs) and industrial stakeholders through bilateral meetings or unstructured interviews.
- Establish a timeline and mode of collaboration.
- Connect relevant institutions such as universities and distribution system operators (DSOs) and explore potential partnership opportunities and funding/support options from entities such as INESC, UCY, EAC, EDP, and TUS.
- Implement and develop the proposed solution.
- If necessary, prepare a joint proposal under ERIGRID2.0.
- Create a questionnaire to collect feedback and identify best practices.

The consortium has jointly determined the technical requirements that can support the respective national energy objectives of each country, which include:
- Identifying technical and business challenges, as well as research questions.
- INESC will focus on the integration of renewable energy sources (RES) and inverters to facilitate proper integration.

- TUS will focus on the market aspects and how inverters can provide appropriate signals and responses, such as market tariffs.
- FOSS will collaborate closely with EAC to access data, insights, and validate research results.
- EDP and the Bulgarian DSO can provide funding for this type of research.

According to the method described above, we have discovered a significant enhancement that has increased the value of the work facilitated by the EIRIE platform. This is demonstrated by the establishment of a new collaboration between FOSS of Cyprus, TUS of Sofia, and INESC TEC of Porto, Portugal, resulting in the development of a fresh platform for cooperation. This collaboration represents the initial outcome of the case study.

After successfully implementing the case study in Malta and Cyprus, the study was expanded to Portugal. We invited R&I partners from INESC TEC university in Porto to join us in adopting our successful working model and collaborate to create stronger research opportunities for all three groups of R&I experts. We worked closely with another partner of PANTERA, the Technical University of Sofia, to bring together three collaborating partners from Cyprus, Bulgaria, and Portugal. Together, we identified areas of common interest and selected researchers from all three groups to collaborate in the agreed areas. One noteworthy success of this approach was the submission of a paper to the IEEE PES SyNERGYMED22 conference held on November 17th and 18th, 2022, in Thessaloniki. The details of this paper are given below:

*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.*

One important lesson learned from this experience is the need to continually update targeted objectives with the stakeholders involved and disseminate final results achieved to all contributors. Additionally, it is essential to keep track of achieved results and clearly identify future steps for all parties involved.

# 5 PANTERA recommendations and potential solutions for target countries

## 5.1 Desk 1

In the specific case of Desk 1, the term "region" in PANTERA refers to the geographical area where all three countries share not only common borders but also close historical, political, cultural, and business connections. These nations became members of the EU after 2004 and fall under the category of widening countries within the Horizon 2020 framework. Based on the vast activities conducted at Desk 1, it can be firmly concluded that stakeholders in all three countries recognize the significance of R&I in attaining the long-term objectives of energy transition.

As for Horizon success, Latvia and Lithuania have paid in more to the budget of the EU's research programmes than they get out, while Estonia is one of the best performing EU13 countries [9]. To improve the situation, Latvia is trying to get the national innovation agency more involved with the

programme and has made first steps towards this by having a contact person working in Brussels, while Lithuania is trying to strengthen its network of National Contact Points.

The key solution to facilitating the participation of the Baltic States in EU R&I appears to be an increased emphasis on collaboration. This collaborative approach is crucial in overcoming existing barriers and ensuring that the voices of relatively smaller countries are heard at the EU level. Establishing a more proactive communication channel between policymakers at the national level and the Commission could greatly contribute to fostering a mutual understanding of the needs and concerns of both parties, as well as support alignment on national policies with EU objectives.

As for national policy alignment, The EC has provided an opportunity for support of designing and implementation of common R&I agenda by launching Enhanced Dialogues in 2022. Seven countries have opted in: Croatia, Czechia, Estonia, Greece, Latvia, Lithuania and Slovenia. Hopefully, this activity will support Baltic States to enhance their performance in framework programmes.

Furthermore, another key opportunity for countries to bring at EU level local R&I innovation instances is through the IWGs of the SET Plan. In this respect, Latvia participates in five IWGs (Positive energy districts, Energy systems, Energy efficiency in buildings, Energy efficiency in industry, Batteries), Lithuania in three (High Voltage Direct Current (HVDC), Batteries, Nuclear safety) and Estonia in two (Batteries and Nuclear safety).

Moreover, interactions during workshops and surveys have revealed the need for enhancing the support provided to researchers by local institutions when it comes to Horizon submissions. To address this, there is a requirement to strengthen the network of NCPs and ensure more active representation of national interests in Brussels. Additionally, it is necessary to introduce supplementary measures that can assist researchers in enhancing the presentation of their proposals.

The role of national public R&D funding in supporting and driving scientific advancements and technological progress within a country is widely acknowledged. All Baltic countries R&D expenditure is below EU average, in case of Latvia even below 1 % of GDP (see Section 3.3 Table 3). The national funding for R&I shall be improved, i.e. increased and what is also of crucial importance tailored to specific needs. Additionally, R&I funding can be increased by allocating more of European Regional Development Fund (ERDF) and Recovery and Resilience Facility (RRF) for the R&D&I purposes.

### 5.1.1 Latvia

In addition to the aforementioned common challenges, the case study and input from various stakeholders indicate that Latvia faces particular difficulties due to its complex administrative procedures in both national and regional funding calls. It is crucial to give greater attention to reducing the administrative burden imposed on researchers, allowing them to focus more on their research activities. Simplifying administrative procedures and streamlining the application and reporting processes can significantly alleviate the bureaucratic hurdles faced by researchers in Latvia.

Many Latvian stakeholders expressed their belief that Horizon is characterized by excessive competitiveness, giving an advantage to more advanced countries. Additionally, they indicated that

the support provided by national funding agencies was deemed adequate but received a rating of "neither good nor bad". Hence, it is crucial to promote closer cooperation between applicants and the national funding agency. In this regard, the agency should play a leading role by providing guidance and advice to applicants, starting from the initial decision-making stage of whether to participate in a specific call. By offering early guidance, agency can help applicants evaluate the viability and potential of their ideas, preventing the allocation of resources to projects with limited prospects. Furthermore, the involvement of agency in the project preparation process can contribute to the alignment and suitability of the proposed projects with the funding objectives. This collaborative approach fosters a more efficient and targeted allocation of resources, facilitating the selection of high-quality projects that are more likely to achieve desired outcomes and impact.

Furthermore, Latvia is facing a significant issue regarding its innovation performance. According to EU innovation scoreboard Latvia was classified as Emerging innovator in 2022. While Latvian researchers display relatively active participation in applying for EU funding, there is a noticeable lack of engagement from companies in this regard. To address this situation, concerted efforts are required to facilitate and promote cooperation between the scientific and business sectors.

### 5.1.2 Lithuania

The workshop held in Vilnius have shed light on another potential reason contributing to lower participation in Horizon. It has been mentioned that participation in Horizon projects is not widely regarded as a significant aspect of academic career progression. Combined with the belief that Horizon is extremely competitive and proposal preparation requires too much resources, this viewpoint diminishes the motivation and enthusiasm among researchers to actively engage in Horizon projects. This limitation has resulted in reduced interest from academic institutions. To tackle this issue, it is essential for academic governance bodies to take appropriate measures to emphasize the importance and value of Horizon project participation for academic careers. One crucial step is to enhance awareness and understanding among academic communities regarding the positive impact that Horizon project participation can have on their professional growth and development. This can be achieved through targeted communication promoting success stories of researcher groups who have made significant advancements through their involvement in Horizon projects, emphasizing how such experiences have positively influenced their career trajectories. This can be supported through EIRIE platform. Furthermore, fostering a supportive environment within academic institutions is essential. This can involve establishing mentorship programs, facilitating networking opportunities, and providing guidance and support to researchers in navigating the complexities of Horizon project applications and management.

### 5.1.3 Estonia

Estonia has been rather successful in Horizon 2020. However, Estonian participation is the European Research Council grants, the Marie Skłodowska-Curie fellowships, or partnership initiatives is still rather low. Estonia's success lies in specialisation in some specific fields, where Estonian research groups are at a world class level, but they need to be further connected to the researchers and innovators in Europe in order to make an impact. The biggest concern for Estonian stakeholders has been the increasing number of "closed clubs". There is a belief, that it is extremely hard to prove yourself to the established networks. This highlights the importance of active engagement in international initiatives, as they provide opportunities for researchers and institutions to expand their networks, showcase their capabilities, and establish credibility on a broader scale.

By actively participating in international initiatives, Estonian stakeholders can overcome the barriers posed by closed networks and gain visibility and recognition for their contributions to R&I. It is crucial to foster an inclusive and open environment that encourages collaboration, knowledge exchange, and equal opportunities for all stakeholders, regardless of their existing affiliations or networks.

## 5.2 Desk 2

Acting in a collaborative mode with the local stakeholders and with the European Commission and the other supportive initiatives Regional Desk RD2 organized number or workshops, nano-workshops, presentation on key events and face to face meetings.

### 5.2.1 Bulgaria

The main recommendations to the local stakeholders for improving their smart grid related research actions and funding are:

- Increasing their R&I competences using local collaboration with PANTERA/ EIRIE Desk 2, research organisations, universities, industry and other stakeholders.
- Improving their R&I level and readiness by following the most recent trends in the leading R&I initiatives of the leading EU stakeholders.
- Active 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.

### 5.2.2 Greece

Based on the specificities and advantages outlined the following recommendations can be given:

- The common operation principles between the conventional island power systems and the novel smart grid power systems with autonomous and semi-autonomous micro and nanogrids positions well the Greek stakeholders in proposing R&I projects in this field. A research on the upcoming calls for proposals is recommended.
- Relying on the experience gained and results available from the island power systems in Greece an intensive work on building project proposal consortia for EU funding in future smart grids with active micro, -mini- and nanogrids can be recommended.

### 5.2.3 Romania

Taking into account the state of the art and the future trends, the following recommendations can be given:

- The proactive participation of Romanian stakeholders in EU and LVDC expert groups will provide many benefits.
- The research towards identifying LVDC gaps and challenges and bottlenecks is necessary.
- Support of the EC corresponding directorates for generation of LVDC EU funded research calls for proposals will better position the stakeholders of Romania.

## 5.3 Desk 3

PANTERA Desk 3 includes Cyprus and Malta islands to be supported by activities guided by PANTERA coordinator University of Cyprus/FOSS. Both are Mediterranean countries-islands and Member States of EU that share to a certain extent the same challenges for availability of energy resources and sufficiency with a high potential of solar capacity. Both islands share membership in The Smart Islands Initiative. This initiative is based on bottom-up approach and it builds on years of collaboration between European islands and seeks to communicate the significant potential of islands to function as laboratories for technological, social, environmental, economic and political

innovation related to the smart grids. From Malta side, the Local Councils Association is a coordinator member whereas from Cyprus side, the Cyprus Energy Agency (CEA) is the coordinator of the regional initiative. This forms a local network that PANTERA will is building working relations with.

Collaboration has proven fundamental in the existence of the EIRIE platform for team building in related activities knowledge creation where needed. EIRIE being a multi-functional collaborative platform, established as a reference operational point to unify European activity, incentivize further investments in smart grids and support access to exploitable results, can spark further work and cooperation capable of bridging the existing gaps. On this basis the stakeholders of Cyprus and Malta came together, strengthened working relations and success stories have been elaborated in section 4.3 above.

### 5.3.1 Cyprus

Cyprus is represented in this work by important actors in the field of energy. These are:

- FOSS Research centre for Sustainable Energy of the University of Cyprus
- ANEL Nicosia Development Agency - an organization established by nine local authorities (municipalities) in the capital city of Nicosia, Cyprus.

Building on the good outcome achieved through the positive results brought forward through the described in section 4.3 case study, the intention is to strengthen the process and bring closer to the regional corner added stakeholders of Cyprus capable of giving answers to the hot issues of:

- Energy communities
- e-Mobility

Both have proved to be mature enough to bring limited success through the collaborative work with Malta and parallel effort in the two countries can expedite the learning phase that can lead to policy changes in the two countries.

Strengthening the active contribution of ANEL can bring important stakeholders in the field of transport and energy communities that can contribute to mobilizing support for collective action. Under the strong guidance of the Research Centre FOSS the representatives of Communities can design the blueprint of the desired active energy communities that include all the technologies and solutions that can play an active role in the energy transition process. This inherently will include e-Mobility infrastructure and system solutions that can play an effective flexibility role in the energy mix. This approach has matured in the pursuit discussions and thus populating the regional corner with more stakeholders of common interest can avoid duplication and move faster to the implementation phase for fast positive results.

Continuing the collaborative work with Malta will further enhance the process and propel the change to make it faster with higher impact with good visibility through EIRIE but also through scientific papers, workshops and conferences that collectively can promote for the benefit of the two countries and the broader Mediterranean Area.

### 5.3.2 Malta

From the side of Malta, stakeholders that are currently contributing are the following:

- MCAST

MCAST Mission Statement
"To provide universally accessible vocational and professional education and training with an international dimension, responsive to the needs of the individual and the economy."

- Established in 2001, the Malta College of Arts, Science and Technology is the country's leading vocational education and training institution. Six Institutes in Malta and the Gozo Campus, MCAST offers over 190 full-time courses and over 300 part-time vocational courses ranging from certificates to Doctoral level (MQF Level 1 to Level 8).

The close collaboration of these stakeholders with the Ministry of Energy of Malta together with the support of the working relations in Cyprus can form the basis of faster implementation of the aspirations expressed in the NECP of Malta. Agreement was reached between the stakeholders of the two countries to work together to avoid duplication and grow through a targeted collective effort. This was the outcome of the activities done till now through the regional corner of Malta and Cyprus and plans are in place to build on these positive lessons learned. The Ministry of Malta was very receptive of such activities and has offered strong support and tangible collaboration for strengthening the process within Malta and the relevant stakeholders. To this effect ENEMALTA has indicated its availability to collaborate within such national forum to align with the aspirations of energy transition and the vital strategic objectives set out in detail in the NECP of Malta.

Continuing the collaborative work with of Malta and Cyprus will further enhance the process and propel the change to make it faster with higher impact with good visibility through EIRIE but also through scientific papers, workshops and conferences that collectively can promote for the benefit of the two countries and the broader Mediterranean Area.

## 5.4 Desk 4

### 5.4.1 Poland

Interaction with the polish stakeholder and the case study on "The Rollout of Smart Meter" facilitate us the substantial information about the major the challenges in the smart grid activities and the energy transition. Less acceptance of new technology, conventional power system infrastructure (also old regulations), limited funding to research projects, limited awareness of current technological advancement are the major reasons behind the inactiveness of the smart grid activities in Poland. Although, the case study shows that the industries and some DSOs' have the potential and intention towards smart meter rollouts, which is a commendable effort in the direction of smart grid, but there is a lack of overall support from the government, regulators, and power system operators.

- Government procurement and RD&D funding and investment in facilitating SM rollouts through policy instruments so it would be mandatory and also 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 building energy management systems to integrate SM installation with other systems used

by consumers in order to empower them and facilitate achieving energy savings. It could also facilitate the acquisition of energy from renewables, improved control, and more tariff and service options.

- It is recommended that the academia and research institutions to maximise their collaboration with other European countries to learn from their past experience in the domain of power system to improvise the status-quo of power system infrastructure and regulatory framework to support smart grid activities.
- It is recommended to organize educational and awareness raising campaigns informing consumers about the benefits of renewable energy and energy transition.

### 5.4.2 Czechia

The PANTERA nano-workshop in Czech Republic gave us opportunity to interact with the local stakeholders mainly from research, academia, and industry which gave diverse perspective and many insights to understand the current situation of smart grid activities in the country. The case study of “The Czech Republic energy policy” also facilitate us key information with reference to energy policy and technology and Innovation. Interaction with stakeholders and the case study enables us to the suggest some recommendations to enhance the national participation in EU supported smart grid activities.

From the policy perspective, the Czech Republic aims to strengthen energy-related research, development, and demonstration (RD&D) funding through the National Research, Development and Innovation Policy and the State Energy Policy, though the country does not have a specific energy RD&D strategy except THETA program started in 2019 which only contributes to transforming the energy sector into a low-carbon economy. It is recommended to create a national RD&D strategy in which there should be focus on diversify the energy mix and also on smart grid research activities. 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. Education and training, research management, and awareness programs should also be the centre-piece of the strategy.

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.

### 5.4.3 Slovakia

We had no opportunity to interact with any stakeholders but as per the case study on “Slovak Energy Efficiency and Renewable Energy Finance Facility”, which is a very remarkable example of a financial instrument supporting renewable energy projects, industrial energy efficiency projects, and housing energy efficiency projects, we recommend some steps which could escalate the smart grid

activities in the Slovakia.

It is recommended to consider of the ambitious sector-specific targets that should be aligned with the other EU Member States. Also, government should make effort to promote and invest in smart grid infrastructure research and projects within the EU framework which definitely need government-backed renewable energy and energy efficiency awareness campaign to gain public awareness to accept renewable energy sources.

There is need of a comprehensive strategy and investments to achieve the desired renovation rate of existing buildings and existing power system, and higher energy efficiency standards which a can support the smart grid implementation. Additional grant funding for technical assistance in EU energy projects can further incentivize investments and foster this knowledge transfer between other EU countries.

## 5.5 Desk 5

Several initiatives and possible ways of cooperation at EU level are in place. The PANTERA projects has always tried to present the different opportunities that stakeholders can exploit. For example, in workshops and during meetings with specific stakeholders, EU and international level activities has always been presented as a potential way to be more involved at EU and international level. Concerning the EU level, the ETIP SNET WGs are a good opportunity to take advantage of, and the PANTERA project has been working with them. Another key opportunity for countries to bring at EU level local R&I innovation instances is through the Implementing Working Groups of the SET Plan. In this respect, while Italy it's participating in all the IWGs, Hungary and Croatia are much less involved being Croatia involved only in the IWG batteries and nuclear safety, while Hungary in the IWGs batteries, CCU-CCS, nuclear safety and the recently launched IWG on high voltage direct current (HVDC) & direct current (DC) technologies.

Analysis has been conducted throughout the PANTERA project allowing to the identification of technology gaps and missing subjects in R&I activities. Here is reported a concise summary, while more details can be found in PANTERA deliverable D4.3. Although all the three countries (Italy, Croatia and Hungary) show great interest in electric and thermal storage, some gaps have been identified, for example "power to x" (by Croatia and Hungary) and in "other storage" technologies. Research interest in "pumped storage" and "other storage" may be influenced by geographical and non-technical issues, but "power to x" is very important for sector coupling, so we recommend Croatia and Hungary to plan R&I projects on this topic. For the generation side, gaps appear for Croatia on "hydropower", for Hungary on "hydrogen & sustainable gases" and for all three countries on "other generation technologies". Among the abovementioned, we recommend Hungary to improve its research engagement on "hydrogen & sustainable gases" which is extremely important for the implementation of low-carbon technologies in all sectors. Some gaps still appear for digitalisation: indeed, Hungary has limited focus on "digital twins" and "artificial intelligence", while Italy shows gaps for "digital twins" only. Since these are key topics for the enhancement of digitalisation, they must be included in future R&I activities

### 5.5.1 Italy

The Agency for the Promotion of European Research (APRE) critically reviewed the impact of Horizon 2020 funding on Italian firms with a focus on the energy sector. Some insights from the

document[4] are reported in the following.

Basing on some specific H2020 call for projects project under the Societal Challenge “Secure, Clean and Efficient Energy”, Italy has been claimed to be ranked third in Europe on the number of projects funded but only fourth on the total amount of resources acquired by Italian entities.
On the overall, we can conclude that the results of Italy under the Horizon 2020 framework were positive and encouraging and the country really gained benefit by the funding programme. Looking towards the future frameworks, improvements could come from gaining higher EU contribution thus trying to cover more important roles in the projects.

APRE, for mapping the perceptions from the companies involved in Horizon 2020, performed a questionnaire and a structured interview with the companies that won at least one call in the 2014-2020 period and the results were encouraging, since “as far as impacts are concerned, the response of enterprises was - to a certain extent - surprisingly positive”.

Aside from the positive aspects that have emerged, the less relevant impacts to enterprises were the patent activities and the emerging of start-ups. Moreover, the companies’ indications allowed to identify useful improvements that can increase their participations in the European Commission’s calls:

- Implementation of useful tools to increase market opportunities for innovative products/services/systems for the energy sector;
- Services aimed at stimulating enterprises, especially small ones, to participate in other calls or access new sources of funding;
- Develop new partnerships and consolidate those already established.

Since companies represent a very important and impactful part of the energy research in Italy, actions aimed at improving the abovementioned aspects should be pursued. An example could come from the promotion of networking possibilities with organization and institution, by setting proper meeting places that can strongly help and encourage enterprises (both big and small scale) to participate in EU funded projects.

### 5.5.2 Croatia

The discussion conducted during the workshop organised in Split and specific discussions with local stakeholders in different frameworks showed some potential reasons as the main causes for some possible lower participation in H2020. One of these is that the administrative support to the institutions for submitting proposal is low. Thus, we recommend authorities and local agencies to improve their engagement in this direction. In addition, the participation in H2020 project has been claimed not to be seen as an important point for academic career. Therefore, these aspects limit the interest from academic institutions, this is an issue that can be addressed by the academic governance. Another barrier sensed by local stakeholders is related the not easy management of funds granted through EU projects.

The European Commission highlights the overall H2020 performances of Croatia as well the key

[4] “L’impatto della partecipazione al programma Horizon 2020 sulle imprese italiane: un’analisi per il settore energia”, APRE 2021 *link*

intentions for the future[5]. Croatia has been pointed out to have been successful in the area of "ICT", "energy", "food" and "maritime" and its intention is to continue to prioritise those area in the new framework programme. Indeed, the Croatian Ministry of Science and Education has implemented national measures to support R&I programmes in several research area including "energy". This is highly encouraging, local organisations should follow the ministerial directions.

As mentioned earlier a stronger participation in IWG set plan is encouraged and can support the alignment of national with EU priorities and vice versa.

### 5.5.3 Hungary

Also, in the case of Hungary, by the workshop organised and through specific interactions have been identified some reasons as the main causes for some possible lower participation in H2020. One reason can be that submission of proposal for Eu projects is disincentivize by the easy access to alternative structural funds which might need to be aligned with those within the horizon program. Some other barriers come out from the lack of international cooperation, so it is recommended that institution become more involved in the European networks by strengthening their international connections. Moreover, the lack of project management experience limits an effective participation of Hungarian organisations in consortia, this can be solved, for example, by proper training programs.

The European Commission highlights the overall H2020 performances and future key intentions also for Hungary[6]. The areas where Hungarian R&I investments in H2020 were concentrated were "health", "ICT", "transportation", and "agricultural and food technologies". Thus, energy has been only a marginal research activity for Hungary in H2020, this nevertheless Hungary's participation in European partnerships will be aligned with the thematic priorities of the S3 strategy for 2021-27 which includes "energy and climate". In this view, we recommend being aware of respecting these perspectives and involving institutions more in the field of energy research than in H2020.
As mentioned earlier a stronger participation in IWG set plan is encouraged and can support the alignment of national with EU priorities and vice versa.

It needs to be noted that recently more than 30 Hungarian institutions (including 21 universities) has been excluded from Erasmus and Horizon funds[7][8]. These affects institutions that are operated as "public trust foundations" or maintained by such foundations that are close to Hungarian Prime Minister Viktor Orbán and his party Fidesz. The reason behind the decisions comes from the inability to remedy violations of the rule of law, which is one of the fundamental values upon which the EU is based on. This is extremely negative, and Hungarian authorities and institutions must do everything in their power to solve the problems that the EU council has found.

## 5.6 Desk 6

The PANTERA project held a workshop in Dublin, Ireland to discuss the smart grid, energy storage and local energy systems landscape: Research & Innovation (R&I) roadmap. The challenges

[5] https://ec.europa.eu/research-and-innovation/sites/default/files/bmr-2022/ec_rtd_bmr-2022-croatia-country-fiche.pdf
[6] https://ec.europa.eu/research-and-innovation/sites/default/files/bmr-2022/ec_rtd_bmr-2022-hungary-country-fiche.pdf
[7] https://www.bayfor.org/en/news/latest-news/news-detail/4373-eu-council-excludes-21-hungarian-universities-from-horizon-europe-and-erasmus-funding-over-hungarian-rule-of-law-breaches.html#:~:text=More%20than%2030%20higher%20education,Hungarian%20rule%20of%20law%20violations
[8] https://sciencebusiness.net/widening/eu-council-action-over-hungarys-rule-law-breaches-sees-21-universities-cut-erasmus-and

identified during the workshop included the need for speedier integration of technology in the market, regulations and data infrastructure, and the need for new regulation to allow new business models. The speakers attending highlighted opportunities for new services in the electrification of transport and heating and the importance of extracting value from existing assets in the system through smart efficient usage. The PANTERA project and its platform were presented and discussed, giving the workshop participants an opportunity to give early feedback through the Glisser tool. Solutions proposed included: supporting research and innovation through knowledge dissemination, EU and national R&I funding opportunities, PANTERA Working Groups - Local and Pan-European R&I challenges and gaps, and PANTERA Desks – Local and Pan-European Networking for promoting regional needs and capitalizing on local strengths and opportunities.
The challenges identified during the workshop and their solutions are summarized below:

***Challenges***

- The need for speedier integration of technology in the market, regulations and data infrastructure.
- The need for new regulation to allow new business models.
- Opportunities for new services in the electrification of transport and heating.
- Extracting value from existing assets in the system through smart efficient usage.

***Solutions***

- Supporting research and innovation through knowledge dissemination.
- EU and National R&I funding opportunities.
- PANTERA Working Groups: local and pan-European R&I challenges and gaps.
- PANTERA Desks: local and pan-European networking promoting regional needs and capitalizing on local strengths and opportunities.

### 5.6.1 Ireland

The UCD Energy Institute and the IERC have a shared interest in conducting Smart Grid research and facilitating the clean energy transition. They recognize the potential for collaboration through data sharing, which is a critical bottleneck for Smart Grid R&I. High-quality data availability is crucial for the success of future smart grids, and policies need to be developed to support it. PANTERA can aid in this effort by providing training for smart grid researchers on data-related issues. Additionally, data sharing agreements should be incorporated as part of the Grant Agreement. The use of Data Management Plans can assist in identifying suitable open data, and a repository for data storage and archiving should also be established.

Some of the solutions proposed are:

- Developing sample data sharing mechanisms to address the bottleneck of Smart grid R&I.
- Collaboration through the sharing or pooling of smart grid data.
- Compliance with SEAI RD&D open data requirements from 2021 onwards.
- Designing a data sharing agreement as part of the Grant Agreement.
- Developing meaningful Data Management Plans to identify suitable open data and a repository for data storage and archiving.
- Supporting further training for smart grid researchers on data issues through PANTERA.

### 5.6.2 Portugal

The main challenges identified in this text are Portugal's falling short of its national targets for R&D intensity and the share of renewable energy sources in the overall energy mix. The proposed solution is to connect the NECP with R&I funding provided by relevant industrial players. The aim is to strengthen the network of national cooperation, find channels of cooperation with other institutes, have access to R&I infrastructure, and identify good practices and lessons learned on raising funding from industry to do impactful research. The methodology includes identifying research needs and endeavours, connecting appropriate institutions, and implementing the proposal. The results include the establishment of new collaborations, successful paper submission to a conference, and positive outcomes for the stakeholders of the electricity grid in the countries involved.

The solutions and recommendations include the need to continually update targeted objectives, keep track of achieved results, and clearly identify future steps for all parties involved.

# 6 Conclusions: EIRIE as a platform to facilitate R&I

It is evident from the analysis in the previous paragraphs that the widening countries in general reveal lower effort / activity in R&I in support of the energy transition, based on a perception that they lag the required capacity to be successful in securing the required funds to meet their endeavours in the field on the one hand but additionally, national R&I contribution is well below the expected levels with themes that are highly local and with low impact. It is clear that the factors that lead to this perception and / or policies are highly related to lag of access to the required knowledge around achieved results, maturity of technologies contributing to progress made, lag of access to stakeholders that are experts in the technology evolution and how local needs and requirements tie in with the wider policies of Europe calling for collective contribution by all following the policy adapted through the Green Deal for leaving no one behind.

The case studies pursued by the consortium of the PANTERA project through the respective regional desks developed and operated through the EIRIE platform give substantial evidence that targeted collaboration work can be meaningful and rewarding giving the basis for building a policy forward that can raise expectations and give confidence to widening countries for demanding more both nationally and at European level. The functionalities offered through EIRIE bring closer to the stakeholders of every country the following possibilities that can play a critical role in meeting the objectives of their endeavours:

- Status of R&I results in all fronts of the technology evolution where are the gaps and as a consequence the real needs springing from visible state of the art developments.
- Real project results open and accessible to substantiate the endeavours of the R&I community.
- Availability of R&I infrastructure in Europe that can complement convincingly the needs and requirements of all project teams to meet their research objectives.
- Collaboration options with stakeholders throughout Europe for building research opportunities to meet their research interests.
- Access to EU activities for contributing to policy formulation and knowledge creation in line with their interests and expertise.
- Best practice repositories that can spark ideas for addressing open challenges at country or regional level.
- Use case repositories that can be the source needed to initiate a winning process to challenging problems that stakeholders are facing at national or regional level.

Moreover, EIRIE is not static in content, functionalities, tools and use. The acknowledgement of DG ENER and JRC that EIRIE is the EU platform for knowledge management and sharing in the field of energy, is key in constant growth in the direction that users desire and pursue. Hence, active stakeholders on EIRIE can influence this change and growth in the direction that will serve them best. Maturing together in this direction can only add to the services that EIRIE can deliver to demanding stakeholders and thus help for bridging current gap in R&I performance of widening countries when compared to EU15 and assist in raising possibilities and capabilities that can truly achieve the high objective of leaving no one behind, set by the policies of the Green Deal.

# 7 ANNEX

## 7.1 PANTERA Country Profiles

|  **LATVIA** | **Desk 1** |
|---|---|
| | **Responsible partner: IPE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [10], [11], [12], [13], [14] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [15] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [19], [20], [21] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1. Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | "Long-Term Energy Strategy of Latvia 2030" gives a vision how the 2030 could look like, but the proposed targets are not officially adopted by the government [22].<br>The Long-Term Energy Strategy is linked to a broader "Sustainable Development Strategy of Latvia until 2030" [23], which covers areas like culture, education, environment and innovation. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum increase by 17% between 2005 and 2020 [24]. |
| | According to the latest national projections and considering existing measures, the target is expected to be achieved: 8% in 2020 compared to 2005 [24]. |
| | In 2020 non-ETS GHG emissions decreased by 1% compared to 2005 [19]. |
| **GHG 2030 target** | According to Effort sharing regulation 2030 Latvia is required to reduce its non-ETS emissions by 6% by 2030 relative to 2005 levels [25]. |
| | Latvia has targeted additional climate mitigation and adaptation measures but there is no certainty that they are sufficient to reach the agreed 2030 target for sectors not covered by the ETS [19]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -17% by 2030 [19]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | Latvia is on track to achieve its 2020 target for the share of energy produced from renewable sources (40%), although the support scheme has proved expensive [24].<br>In 2017, the indicator constituted 39% [11]. |
| | In 2018, share of renewable energy was 40%, thus reaching its 2020 target. However, maintaining the renewables share at this level will remain a challenge [10]. |
| | In 2021, share of renewable energy was 42.1% [11]. |
| **RES 2030 target** | In the NECP, Latvia has set a contribution to the EU renewable energy target of at least 50% in gross final consumption of energy for 2030 [15]. |
| **RES in transport** | In 2017, the penetration of renewable energy in transport was 2.5% [11]. The target according to the first Renewable Directive is 10%. |
| | In 2018, the penetration of renewable energy in transport was 4.7% [11]. |
| | In 2021, the penetration of renewable energy in transport was 6.4% [11]. |
| **RES in** | In 2017, share of RES in electricity was 54.4% [11]. |

| | |
|---|---|
| **electricity** | In 2018, share of RES in electricity was 53.5% [11]. |
| | In 2021, share of RES in electricity was 51.4% [11]. |
| **2. Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: primary energy consumption – 5.4Mtoe, final energy consumption – 4.5Mtoe [26]. |
| | In 2017, primary energy consumption was 4.5Mtoe, final energy consumption was 3.8Mtoe [14]. Given the current trend, Latvia is on track to achieve its energy efficiency target [13]. |
| | In 2018, primary energy consumption increased to 4.7Mtoe, final energy consumption also increased to 4.2Mtoe [14].<br>Given the current trend, Latvia is at some risk of missing its 2020 target [10]. |
| | In 2021, primary energy consumption was 4.5Mtoe, final energy consumption was 4.1Mtoe [14]. |
| **2030 target** | In the NECP, Latvia has set its national energy efficiency contribution for 2030 4.1Mtoe of primary energy consumption, which has been converted into final energy consumption of 3.6Mtoe [15]. |
| **Energy savings** | In 2020, Latvia has reached 106% of total cumulative savings required by 2020 [16]. |
| **3. Energy security and interconnection** | |
| **Interconnection** | According to the NECP data, Latvian electricity grid interconnection level with neighbouring countries in 2017 was 60%. 2030 target for interconnectivity is 60% [15]. |
| **Energy security** | The NECP puts forward an ambitious objective to reduce imports of energy and energy resources from third countries by 50% compared to 2011 by 2030, reaching the energy dependence level of 30-40% [15]. |
| | The ongoing Baltic Synchronisation Project, scheduled for completion by the end of 2025, is key to ensuring security of supply of the whole Baltic region. Latvia continues to implement the key electricity infrastructure projects that form part of the implementation of the Baltic energy market interconnection plan [10]. |
| **Trade deficit** | Latvian energy dependence fell from 64% in 2005 to 44% in 2017 [12]. |
| | In 2018, Latvia's energy import dependency was 44% [12]. |
| | In 2021, Latvia's energy import dependency was 38% [12]. |
| **4. Integrated electricity market** | |
| **Wholesale electricity market** | Latvia is part of the Nord Pool market since 2013 [22]. |
| **Retail electricity market** | Latvia's electricity market was liberalised in 2015. In 2017, 100% of total electricity was traded in the electricity market at contract prices in accordance with bilateral agreements and 62% of that electricity was traded by the dominant trader in the market - "Latvenergo", and the remaining 38% - by other traders. During the year, 4% of all households and 20% of all non-household users changed electricity trader [27]. |
| **Smart metering** | Since 2014, more than 544000 smart meters have been installed; these account for 49% (end of the 2018) of the total fleet of electricity meters and measure 83% of the total amount of electricity consumed by customers. Smart electricity meters are planned for all Sadales tīkls AS (Latvian DSO) customers until 2020 [28]. Total smart meter penetration rate (as of 2018) was 36.3% [56]. |
| | In 2020 the amount of smart electricity meters installed by the company exceeded 1057000, which is almost 98% of the total number of electricity meters of customers of Sadales tīkls AS [20]. |
| **5. Research, innovation and competitiveness** | |
| **R&I strategy** | The main strategic frameworks in which the country operates are the Guidelines for National Industrial Policy 2014-20, the Guidelines for Science, Technology Development and Innovation (2014-20) and in particular the Smart Specialisation Strategy (RIS3, 2014-20) [29]. |
| | Guidelines for Science, technology development, and innovation (2021-2027) [21] published in 2021. Strategy mainly prioritises digitalisation, social challenges, international cooperation. It sets the target for total R&D expenditure as 1.5% of GDP by 2027. |
| **Smart** | 1. Knowledge intensive bio-economy |

| | |
|---|---|
| **specialisation priority areas** | 2. Biomedicine, medical technologies and biotechnology<br>3. Smart materials, technology and engineering<br>4. Advanced ICT<br>5. Smart Energy [18] |
| **R&I objectives related to the Energy Union** | The Latvian NECP does bot clarify the national objectives and funding targets specifically related to the Energy Union to be achieved between 2020 and 2030 [15]. |
| **Involvement in the SET Plan** | Latvia is involved in four IWGs of the SET plan:<br>• Positive energy districts;<br>• Energy systems;<br>• Energy efficiency in buildings;<br>• Energy efficiency in industry;<br>• Batteries. |
| **Innovation performance** | Latvia was a Moderate Innovator in 2019 [30]. |
| | According to new methodology, Latvia was an Emerging Innovator in 2022 (ranking 25 of 27) [6]. |
| **Total R&D expenditure** | Latvia will likely not meet its national R&D intensity target of 1.5% of GDP by 2020 [24]. |
| | Latvia revised downwards the overall R&I target for 2030 from the 3% 'Lisbon target' to 2% in its final NECP [15]. |
| | Guidelines for Science, technology development, and innovation further decreased R&I intensity target to 1.5% in 2027 and 1% in 2024 [21]. |
| | In 2017, R&D expenditure reached 0.51% of GDP [13]. |
| | In 2018, R&D expenditure reached 0.64% of GDP [13]. |
| | In 2021, R&D expenditure reached provisionally 0.69% of GDP (EU average – 2.26%) [13]. |
| **Public R&D expenditure** | The public funding level in 2017 reached 0.37% of GDP [24]. |
| | In 2018, public R&D expenditure was 0.48% of GDP [4]. |
| | In 2021, public expenditure on R&D was provisionally 0.47% of GDP (EU average – 0.75%) [13]. |
| **Business R&D expenditure** | The level of business expenditure in R&D comprises 0.14% of GDP and is among the lowest in the EU [24]. |
| | In 2018, business R&D expenditure was 0.16% of GDP [13]. |
| | Private Latvian R&D investment is stagnating in 2021 it was provisionally 0.23% of GDP [13], about the same as it had been 10 years earlier [19]. (EU average 1.49%) |
| | The low level of business R&D activities is driven by factors such as the shortage of highly skilled workers and very low level of public support for private R&D investment [19]. |
| | Public support for business enterprise expenditure on R&D is very limited: 0.028% (2019) of GDP against EU average - 0.196% of GDP [19]. |
| **Academia-business links** | Having still relatively few research-industry and intra-industry links remain key challenges. Latvian start-ups and SMEs also lag in innovation capacity compared to other EU Member States. To address this, in 2018 Latvia's technology transfer programme was amended to improve innovation voucher support for the innovation activities of SMEs. [10] |
| | In 2020, public-private scientific co-publications was 6.9% against the EU average of 9.05% [19]. |
| **R&D policy coordination** | This weakness is aggravated by inadequate administrative capacity and the scattering of policymaking and implementation among a multitude of ministries and agencies [24]. |
| | In 2019, the government approved a new strategy for the institutional consolidation of the Latvian science policy system. [10] |
| **Funding from Horizon 2020** | Latvia is among least successful countries, it received only 0.17% of the overall Horizon 2020 funding (budget share rank is 26 out of 28, budget share rank per inhabitant is 20 out if 28) [17]. |
| **Research infrastructures roadmap** | National roadmap with identified ESFRI projects is not available [31]. |

|  **LITHUANIA** | **Desk 1** |
|---|---|
| | **Responsible partner: IPE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [32] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [33] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [34], [35], [36] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1. Climate action, decarbonizing the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Revised ambitious National Energy Independence Strategy was approved by the Seimas of the Republic of Lithuania in 2018 [37]. In 2020, the first integrated Lithuanian energy innovation plan including 50 measures supporting National Energy Strategy was approved. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum increase by 15% between 2005 and 2020 [38]. |
| | Lithuania's emissions are expected to increase by 2% in 2020 compared to 2005. It will consequently meet its target [38]. |
| | In 2020 non-ETS GHG emissions decreased by 5% compared to 2005 [34]. |
| **GHG 2030 target** | According to Effort sharing regulation Lithuania is required to reduce its non-ETS emissions by 9% by 2030 relative to 2005 levels [25]. |
| | Lithuania expects emissions to rise by 6% by 2030 relative to 2005 levels [38]. |
| | Lithuania is unlikely to achieve the emission reduction of 9% by 2030. Total GHG levels per capita are below the EU average but remain virtually unchanged since 2010. This is due to the share of fossil fuel consumption remaining constant in manufacturing and agriculture and increasing in the transport sector [32]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -21% by 2030 [34]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | With a 25.6% share of renewables in 2016, Lithuania has already more than achieved its 2020 target (23%) [38]. |
| | Lithuania has already surpassed its 2020 renewable energy target, but the share of renewables is not increasing [32] . |
| | In 2021, Lithuania's share of renewable energy was 28.2% [11]. |
| **RES 2030 target** | According to the NECP, the proposed share of 45% of energy from renewable sources in gross final energy consumption in 2030 is a contribution to the EU renewable energy target for 2030 that is significantly above the share of 34% in 2030 resulting from the formula in Annex II of the Governance Regulation. [33] |
| **RES in transport** | In 2017, the penetration of renewable energy in transport was 3.6% [11]. |
| | In 2018, the penetration of renewable energy in transport was 4.3% [11]. |
| | In 2021, the penetration of renewable energy in transport was 6.5% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 18.3% [11]. |
| | In 2018, share of RES in electricity was 18.4% [11]. |
| | In 2021, share of RES in electricity was 21.3% [11]. |
| **2. Energy Efficiency** | |

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|---|---|
| **Energy consumption** | Indicative energy efficiency target for 2020: primary energy consumption – 6.5Mtoe, final energy consumption – 4.3Mtoe [26]. |
| | Lithuania's final energy consumption was relatively stable between 2010 and 2015, but in 2016 it increased by 5% to 5.1Mtoe. Therefore, in order to reach its 2020 final energy consumption target, Lithuania must further increase its efforts to promote energy efficiency [38]. |
| | In 2018, primary energy consumption was 6.4Mtoe, final energy consumption also increased to 5.6Mtoe [14].<br>In order to reach its 2020 final energy consumption target, Lithuania must radically increase its efforts to implement additional policies and measures [22]. |
| | In 2021, primary energy consumption was 6.6Mtoe, final energy consumption was 5.7Mtoe [14]. |
| **2030 target** | In the NECP, Lithuania's national contribution for energy efficiency is set as primary energy consumption of 5.5Mtoe and final energy consumption of 4.5Mtoe [33]. |
| **Energy savings** | In 2020, Lithuania has reached 111% of total cumulative savings required by 2020 [16]. |
| **3. Energy security and interconnection** | |
| **Interconnection** | Lithuania's target for interconnectivity is in line with EU target (15%) in 2030 (23%). The planned level of electricity interconnection by 2030 is 111%. [33] |
| **Energy security** | NECP sets objectives by 2030 of 45% renewables powered electricity and increasing the share of domestic renewable energy for electricity generation to 70% to replace imports. By 2050, domestic renewable electricity should account for 100% of electricity generation [23]. |
| | Lithuania, together with Estonia and Latvia, is making progress on the synchronisation of their electricity grids and the rest of Europe. Synchronisation will take place through Poland, notably via the existing link between Poland and Lithuania together with a new high-voltage direct current line between Lithuania and Poland, Grid optimisation measures will also be carried out. All of these actions will involve significant investments in the coming years. [32] |
| **Trade deficit** | With the final shutdown of Ignalina nuclear power plant in 2009, the Lithuanian energy dependence increased from 55% in 2005 to 72% in 2017 [12]. |
| | In 2018, Lithuania's energy import dependency was 74% [12]. |
| | In 2021, Lithuania's energy import dependency was 73% [12]. |
| **4. Integrated electricity market** | |
| **Wholesale electricity market** | Lithuania is part of the Nord Pool market since 2012 [22]. |
| **Retail electricity market** | Lithuanian domestic electricity market is not liberalized. |
| | Liberalisation of the electricity market is set to start in 2021 and will run until 2024 [32]. |
| | Lithuania postponed the full liberalisation of its retail power market to 2026. |
| **Smart metering** | The mass roll-out of smart metering in Lithuania by 2023 is included in the National Energy Independence Strategy [37]. Total smart meter penetration rate (as of 2018) was 2.4% [56]. |
| | The roll out of smart metering was approved by the regulator. The objective is to install 1 million smart meters, from 2020 to 2023, covering 70% of those consumers, for whom smart meters are most cost-effective [32]. |
| | Smart meter roll-out is planned in two stages: 1st stage until 2026 - applicable to consumers who consume more than 1,000 kWh per year, 2nd stage until 2037 - applicable to consumers who consume less.<br>In 2021 ESO (Lithuanian DSO) and French company Sagemcom Energy and Telecom SAS have concluded a procurement agreement for smart metering infrastructure, which will ensure the acquisition and implementation of about 1.2 million new generation smart electricity meters as well as system data management and communication solutions. By the end of 2023, residents consuming over 1,000 kWh of electricity per year and all business customers will be upgraded from old meters to the new smart ones. [35] |
| **5. Research, innovation and competitiveness** | |

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| **R&I strategy** | Several strategies and programmes in the field of R&I, although the National Progress Strategy 'Lithuania 2030' is an overarching reference as it sets the strategic direction for the development of the country. It includes some general terms around R&I. Six other documents influence the direction of R&I: the National Progress Strategy 'Lithuania 2030;' the National Progress Programme for Lithuania for the period 2014-2020 (NPP); the Programme for Development of Studies and R&D for 2013-2020; the updated Concept of the Establishment and Development of Integrated Science, Studies and Business Centres (Valleys); the Lithuanian Innovation Development Programme for 2014-2020 and the Programme on the Implementation of the R&D&I Priority Areas and Their Priorities. [29] |
| | The new National Progress Program for 2021–2030 was approved by Lithuanian government in 2020 [36]. It is a particularly important piece of work, the results of which will be used as a basis for the formation and implementation of state policy (directions, objectives, indicators) for the next 10 years.<br>In 2021 the Government Approved the Integrated Plan "New Generation Lithuania" [39] providing for reforms and investments for the development of Lithuania as a country generating high added value. |
| **Smart specialisation priority areas** | 1. Agricultural innovations and food technologies<br>2. Energy and sustainable environment<br>3. New production processes, materials and technologies<br>4. Health technologies and biotechnologies<br>5. Transport, logistics and ICT<br>6. Inclusive and creative society [18] |
| **R&I objectives related to the Energy Union** | National objectives and funding targets related to research, innovation and competitiveness to support Energy Union priorities build on the national energy independence and smart specialisation strategies [23]. |
| **Involvement in the SET Plan** | Lithuania is involved in three IWGs of the SET Plan:<br>• High Voltage Direct Current (HVDC);<br>• Batteries;<br>• Nuclear safety. |
| **Innovation performance** | Lithuania was a Moderate Innovator in 2019 [30]. |
| | According to new methodology, Lithuania remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | Lithuania is far away from reaching its R&D intensity 2020 target of 1.9% [34]. |
| | The country aims to reach a spending level of 2% in R&I by 2030 [33]. |
| | In 2017, R&D expenditure amounted 0.9% of GDP [13]. |
| | In 2018, R&D expenditure decreased to 0.94% of GDP [13]. |
| | In 2021, R&D expenditure reached 1.11% of GDP (EU average – 2.26%) [13]. |
| **Public R&D expenditure** | Public investment, which is funded mainly from EU funds, made up the bulk of R&D investment at 0.57% of GDP [38], [13]. |
| | Public R&D intensity went to 0.55% of GDP in 2018 [13]. |
| | Investment in R&D is well below the EU average, and has not yet recovered from the sharp drop in 2016. This is mostly because of the fall in public R&D intensity due to diminishing rates of investment from European structural and investment funds. Inefficient public funding limits public research and innovation capacities and lowers the quality of output. This is amplified by a cumbersome institutional network and a shortage of talent. [33] |
| | In 2021, public expenditure on R&D provisionally constituted 0.56% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | Business expenditure on R&D in 2017 was 0.33% of GDP [13]. |
| | In 2018, business expenditure on R&D was 0.39% of GDP [13]. |
| | Over the last decade, business R&D investment increased significantly, from 0.29% of GDP in 2015 to 0.54% in 2021 [13] (EU average – 1.49%). Yet this investment has not translated into an increase in technological production or an increase in employment in fast growing innovative firms [34]. |
| | Public support for business enterprise expenditure on R&D 0.126% (2019) of GDP is smaller than EU average - 0.196% of GDP [34]. |

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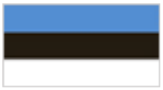
| **Academia-business links** | 2019 R&I inputs into the innovation system (innovation friendly environment, non-R&D innovation expenditures) were adequate but output remained weak (unattractive research systems, modest employment impact). Innovating companies are of moderate size, are weakly integrated in international value chains, and struggle to attract investments of sufficient critical mass. Science-business cooperation is limited to high-tech "pockets of excellence". [33] |
| | In 2020, public-private scientific co-publications was 5.4% against the EU average of 9.05% [34]. |
| **R&D policy coordination** | R&I policy coordination was slightly improved by reassigning responsibility for it to the Ministry of Economy and the Ministry of Education and Science, and transferring the experimental development in companies file to the Ministry of Economics. However, a coherent new R&I policy still needs to be developed. [38] |
| | The government is making efforts to improve the design and funding of the innovation ecosystem. Innovation reform aims to (i) reduce the fragmentation of programmes, funding mechanisms and support services for research and innovation, (ii) improve innovation skills across businesses and public institutions, and (iii) increase innovative and pre-commercial procurement to 20% of total procurement expenditure by 2027. However, the consolidation of research and innovation agencies has stalled. The planned Innovation Support Fund will be funded domestically to limit the dependency on funding from ESIF funds. [32] |
| | The fragmentation of the investment results in an inability to achieve critical mass and raise the quality of the science base. The recovery and resilience plan will introduce measures to address fragmentation of the research system while raising public R&D funding, as well as strengthening the creation of joint business-science R&D missions. [34] |
| **Funding from Horizon 2020** | Lithuania is among least successful countries, it received only 0.14% of the overall Horizon2020 funding (budget share rank is 27 out of 28, budget share rank per inhabitant is 23 out if 28) [17]. |
| **Research infrastructures roadmap** | National roadmap with identified ESFRI projects is available, with latest update in 2015 [31]. |

|  **ESTONIA** | **Desk 1** |
|---|---|
| | **Responsible partner: IPE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments"* | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [40] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [41] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [42], [43], [44], [45] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonizing the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | In 2017, the "Energy Sector Development Plan" was adopted and published [46]. The "General Principles of Estonian Climate Policy until 2050" were approved in the Estonian Parliament in April 2017 [47]. |
| | Estonia is planning to update its 2017 General Principles of Climate Policy guidance to incorporate findings from the recently commissioned study 'Analysis to increase the Estonian climate ambition by 2050'. In this way, Estonia is seeking to align its long-term policy vision with concrete ways to reach the 2030 effort sharing target. [40] |
| | A national long-term development strategy "Estonia 2035" was adopted in 2021 [42]. It covers following dimensions: skills and labour market, sustainability of the nation, health and social protection, economy and climate, space and mobility, governance. |
| | Estonia has developed specific strategic plans: Environmentally friendly energy solutions on small islands; Estonian Hydrogen Roadmap, Sustainable mobility in major urban areas; Environmentally friendly transport (rail); Promoting energy efficiency and reducing GHG emissions; Energy Efficiency of Residential Buildings; Sustainable Transport; Sustainable mobility in major urban areas [43] |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 11% increase in 2020 compared with 2005 [48]. |
| | Emissions are projected to be 11% higher in 2020 than in 2005, according to national projections and considering existing measures. This means that the target is expected to be met [48]. |
| | Provisional GHG emissions data for 2018 show that Estonia currently emits 17% more GHG emissions in the non-ETS sectors than it did in 2005. Projections with existing measures, however, indicate that Estonia will likely meet its 2020 target. [40] |
| | In 2020 non-ETS GHG emissions increased by 10% compared to 2005 [44]. |
| **GHG 2030 target** | According to Effort sharing regulation 2030 target Estonia is required to reduce its non-ETS emissions by 13% by 2030 relative to 2005 levels [25]. |
| | Under the existing policies, Estonia is projected to fall short of its 2030 target [48]. |
| | Current projections based both on existing and additional measures illustrate that Estonia will miss its effort sharing target for 2030 by a significant margin [40]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -24% by 2030 [44]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | With a renewable energy share of 29.2% in 2017, Estonia is already above its 25% target for 2020 [48]. |
| | With a renewable energy share of 30% in 2018, Estonia is already above its 25% target for 2020 [40]. |

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| | In 2021, Estonia's share of renewable energy was 38% [11]. |
| **RES 2030 target** | Estonia estimates a share of 42% of energy from renewable sources in gross final consumption of energy for 2030. This level of ambition, is significantly above the share of 37% in 2030 that results from the formula in Annex II of the Governance Regulation. [41] |
| **RES in transport** | With a 0.4% share of RES in transport in 2017, Estonia is lagging behind the binding 10% target in transport to be achieved by 2020. [11] |
| | In 2018, the penetration of renewable energy in transport was 3.3% [11]. |
| | In 2021, the penetration of renewable energy in transport was 11.2% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 17.6% [11]. |
| | In 2018, share of RES in electricity was 19.7% [11]. |
| | In 2021, share of RES in electricity was 29.3% [11]. |
| **2. Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: primary energy consumption – 6.5Mtoe, final energy consumption – 2.8Mtoe [26]. |
| | In 2017, Estonia's primary energy consumption decreased to 5.6Mtoe, compared to 2016. On the other hand, final energy consumption increased to 2.9Mtoe. [48] |
| | In 2018, primary energy consumption was 5.6Mtoe, final energy consumption also increased to 2.96Mtoe [14]. |
| | In 2021, primary energy consumption was 4.45Mtoe, final energy consumption was 2.8Mtoe [14]. |
| **2030 target** | NECP sets the target for finale energy consumption of 2.9Mtoe and primary energy consumption of 5.4Mtoe in 2030 [41]. |
| **Energy savings** | In 2020, Estonia has reached 130% of total cumulative savings required by 2020 [16]. |
| **3. Energy security and interconnection** | |
| **Interconnection** | In 2017, Estonia had an electricity interconnectivity level of 63%. [41] |
| **Energy security** | Estonia's main objective in the energy security dimension appears under the headline of ensuring continuous energy supply. This can be ensured by more extensive use of domestic energy resources – oil shale and renewable energy, while at the same time ensuring that the share of any one energy source does not exceed 30% by 2020. [49] |
| | The gradual phase-out of oil shale-based electricity generation means that electricity imports and the development of domestic renewable energy will play a key role in ensuring security of supply [40]. |
| **Trade deficit** | The Estonian energy dependence fell from 28% in 2005 to 4.6% in 2017 [12]. |
| | In 2018, Estonia's energy import dependency was 1.2% [12]. |
| | In 2021, Estonia's energy import dependency was 1.4% [12]. |
| **4. Integrated electricity market** | |
| **Wholesale electricity market** | Estonia is part of the Nord Pool market since 2011 [22]. |
| **Retail electricity market** | Estonian market was liberalised in 2013. In 2017 there were 16 independent electricity suppliers in Estonia, 10 of them are active players in the market. [50] |
| **Smart metering** | Estonia completed a roll-out of smart meters and developed a data hub to ensure the efficient handling of data in retail energy markets, relatively low proportion of households is switching suppliers, which in turn allows incumbents to maintain a high market share [48]. |
| | Estonia is among the EU leaders in terms of availability of dynamic price contracts. These contracts cover about 1/3 of the population and directly reflect the price in the wholesale spot market [48]. |
| **5. Research, innovation and competitiveness** | |
| **R&I strategy** | Single overarching strategy: Knowledge Based Estonia 2014-2020 (2014) [29]. |
| | The directions for the development of R&D&I are determined in the Estonian Research and Development, Innovation and Entrepreneurship Strategy 2021-2035 [45]. Strategy mainly prioritises: technology transfer and commercialization, specific areas/sectors (including R&I targets for cleantech), societal challenges, environmental challenges, stakeholder participation and consultation. Strategy foresees indicators and periodic monitoring. |

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| **Smart specialisation priority areas** | 1. e-Health<br>2. Materials Technologies<br>3. Biotechnology<br>4. Enhancement of Resources<br>5. ICT: e-Government and Data Science<br>6. ICT: Industry 4.0, Robotics and Embedded Systems<br>7. ICT: Cyber Security [18] |
| **R&I objectives related to the Energy Union** | National objectives and funding targets related to research, innovation and competitiveness are not set specifically for the energy sector [41].<br>The NECP notably plans to address hydrogen potential the transport, building, electricity generation and gas networks sectors [41]. |
| **Involvement in the SET Plan** | Estonia is involved in two IWGs of the SET Plan:<br>• Batteries;<br>• Nuclear safety. |
| **Innovation performance** | Estonia was a Strong Innovator or in 2019 [30]. |
| | According to new methodology, Estonia was a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | R&D target set in the 2013 National Reform Programme: 3% of GDP, of which 2% for the private sector [48]. |
| | In 2017, total R&D expenditure was 1.28% of GDP [13]. |
| | In 2018, expenditure on R&D reached 1.41% of GDP [13]. |
| | The only substantial change is the 50% increase in basic funding for universities in 2017. The actual funding increases in other areas have been quite modest. R&D. [40] |
| | In 2021, R&D expenditure provisionally constituted 1.75% of GDP (EU average – 2.26%) [13]. |
| **Public R&D expenditure** | Public expenditure in R&D reached 0.66% of GDP in 2017 [13].<br>While currently around 48% of funding for R&D is provided by the EU, Estonia plans to increase the state budget allocation for R&D to 1% of GDP [48]. |
| | In 2018, public R&D expenditure increased to 0.79% of GDP [13]. |
| | In 2021, public R&D expenditure was 0.75% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business R&D expenditure was 0.6% of GDP [13]. |
| | In 2018, business R&D expenditure was 0.6% of GDP [13]. |
| | In 2021, business R&D expenditure was 0.98% of (EU average – 1.5%) [13]. |
| | Estonia does not provide tax incentives for business R&D expenditure, and public support for business enterprise expenditure on R&D remains well below the EU average. Moreover, the number of new graduates in science and engineering has decreased, creating a skills shortage to support business innovation. [44] |
| | Public support for business enterprise expenditure on R&D is very limited, 0.057% of GDP (2019) against EU average - 0.196% of GDP [44]. |
| **Academia-business links** | Cooperation between research institutions and enterprises is still limited. As an indicator of the lagging cooperation, the share of public-private co-authored publications was 53.1 per million population in 2018 (EU average 86.4). Estonian industry lags behind the EU average in the number of researchers employed in private companies. The number of employed researchers with a PhD has been constantly decreasing in the business sector as a whole, as well as in key sectors such as manufacturing, information and communication industries. [40] |
| | In 2020, public-private scientific co-publications was 8.9% close to EU average of 9.05% [44]. |
| **R&D policy coordination** | A promising step towards better coordination between innovation and research policies is the initiative to merge the national entrepreneurship strategy and the research and development strategy: the process of writing a single strategy — TAIES — provides clear opportunities to improve coordination. [40] |
| **Funding from Horizon 2020** | Estonia is among successful countries in terms of the Horizon 2020 funding contribution normalised per inhabitant (budget share rank per inhabitant is 10 out of 28). It received 0.4% of the overall Horizon2020 funding (budget share rank is 21 out of 28) [17]. |
| **Research infrastructures roadmap** | National roadmap with identified ESFRI projects is available and updated in 2019 [31]. |

|  **BULGARIA** | **Desk 2** |
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| | **Responsible partner: TUS** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments"* | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [51] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [52] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [53], [54], [55] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Energy Strategy of Bulgaria covering the period till 2020 was published in 2011 [56]. |
| | Bulgaria has not yet finalised its energy strategy beyond 2020 and a coal phase-out is currently not being discussed. In fact, the continued use of lignite coal resources is anticipated in the medium and long term [51]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum increase of 20% in 2020 compared to 2005 levels [57]. |
| | In 2020 Bulgaria's non-ETS emissions are expected to be 1.7% less than in 2005, which is an overachievement of the 2020 [57]. |
| | In 2020 non-ETS GHG emissions increased by 26% compared to 2005 [53]. |
| | The energy sector is the main source of GHG emissions [53]. |
| **GHG 2030 target** | Effort sharing regulation requires Bulgaria to keep its no-ETS GHG emissions at no higher than the 2005 level [25]. |
| | Based on its own projections, Bulgaria may miss its 2030 target of keeping its GHG emissions at no higher than the 2005 level [40]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -10% by 2030 [53]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | The 2017 share of renewable energy in gross final energy consumption was 18.7% and is well above the 2020 target of 16% of gross final energy consumption [57]. In 2017, the indicator constituted 18.7% [11]. |
| | In 2018, Bulgaria's share of renewable energy was 20.6% [2]. |
| | In 2021, Bulgaria's share of renewable energy was 17% [11]. |
| **RES 2030 target** | The Bulgarian NECP sets a share of 27% renewable energy in gross final consumption of energy for 2030 as contribution to the EU renewable energy target for 2030, which is in line with the share of 27% in 2030 that results from the formula in Annex II of the Governance Regulation [52]. |
| **RES in transport** | The penetration of renewable energy in transport sector in 2017 was 7.2% [11] . The respective 2020 target is 10 %. |
| | In 2018, the penetration of renewable energy in transport was 8% [2]. |
| | In 2021, the penetration of renewable energy in transport was 7.6% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 19% [11]. |
| | In 2018, share of RES in electricity was 22.4% [11]. |
| | In 2021, share of RES in electricity was 18.8% [11]. |
| **2 Energy Efficiency** | |

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| **Energy consumption** | Indicative energy efficiency target for 2020: 16.9Mtoe expressed in primary energy consumption and 8.6Mtoe expressed in final energy consumption [26]. |
| | Indicative national target not yet achieved. In 2017 primary energy consumption stood at 18.3Mtoe. In 2017 final energy consumption stood at 9.9Mtoe. [57] |
| | In 2018, primary energy consumption was 18.4Mtoe, final energy consumption was 9.9Mtoe [5]. |
| | In 2021, primary energy consumption was 18.6Mtoe, final energy consumption was 10.3Mtoe [5]. |
| **2030 target** | The Bulgarian NECP includes a national energy efficiency contribution for 2030 of 28% (primary energy consumption) and 32% (final energy consumption), which translates into a national contribution of 17.5Mtoe of primary and 10.3Mtoe of final energy consumption [51]. |
| **Energy savings** | In 2020, Bulgaria has reached 92% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | According to Bulgaria's NECP, it has set an electricity system interconnection target of at least 15 % by 2030. [52] |
| **Energy security** | National energy security objectives regarded in the Bulgarian NECP are: diversification of the supply of energy resources; increasing the flexibility of the national energy system; addressing constrained or disrupted supply of energy sources for the purpose of enhancing the resilience of regional and national energy systems; and improving interconnectivity and information security (cybersecurity). [52] |
| | The Energy Act was amended to remove fees levied on electricity exports. This lifted obstacles to trade with market participants from neighbouring systems. Bulgaria is also working on market coupling projects with North Macedonia, Croatia and Serbia. Progress on market coupling with Romania and Greece has stalled. [51] |
| | To support the security of supply objectives of the Energy Union, Bulgaria is planning to rely on the use of indigenous energy resources. The operational licence of the Unit 6 reactor of the Kozloduy Nuclear Power Plant was extended until 2029, following a recent similar extension of the licence for Unit 5 in 2017. [51] |
| **Trade deficit** | The Bulgaria energy dependence fell from 47% in 2005 to 39% in 2017 [12]. |
| | In 2018, Bulgaria's energy import dependency was 36% [12]. |
| | In 2021, Bulgaria's energy import dependency remained 36% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | IBEX, the Independent Bulgarian Energy Exchange, was established in January 2014, as a fully-owned subsidiary of the Bulgarian Energy Holding EAD and holds a 10-year license from the Bulgarian Energy and Water Regulatory Commission to organise a Power Exchange for electricity in Bulgaria. |
| | IBEX joined the European Single Intraday Coupling in November 2019 and is now a part of a platform for continuous trading of intraday electricity covering 21 European countries [51]. |
| **Retail electricity market** | Retail markets for electricity and natural gas remain price-regulated. Consumers do not have sufficient access to open, transparent and competitive offers and their level of satisfaction with the quality of service received is among the lowest in the EU. [57]. |
| | Bulgaria is planning to introduce market-based elements in the formation of retail prices for electricity by July 2020. In the meantime, retail markets remain regulated and linked on a cost-plus basis to a non-market segment of wholesale supply [51]. |
| | Regulatory framework was adopted, based on which since 1 October 2020 all non-household customers have been purchasing electricity at freely negotiated prices, which is an important condition for market liberalisation [54]. |
| **Smart metering** | No specific laws have been adopted to frame the deployment of smart metering. As most of household consumers are supplied by regulated supply prices smart meters are of little relevance. |
| | There has been a significant increase in installed smart meters of household customers, which increased from 653 in 2018 to 14 316 in 2021. However, they represent only 10% of all installed meters of household customers. [54] |
| **5 Research, innovation and competitiveness** | |

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| **R&I strategy** | Single overarching strategy: National strategy for development of scientific research in the Republic of Bulgaria 2017-2030 [29]. |
| | In 2020, The National Development Programme Bulgaria 2030 [55] was approved by the Council of Ministers, the vision, goals and priorities for the socio-economic development of Bulgaria in the period 2021- 2030. The strategy prioritises international cooperation, technology transfer and commercialisation, societal challenges, environmental challenges, R&D governance. |
| **Smart specialisation priority areas** | 1. New technologies in creative and re-creative industries<br>2. Mechatronics and clean technologies sectors<br>3. Healthy life and biotechnology industries<br>4. Informatics and ICT [18] |
| **R&I objectives related to the Energy Union** | NECP highlights 13 R&I objectives, mostly relating to energy. Most objectives are rather general, apart from a few that are more specific [41]. |
| **Involvement in the SET Plan** | Bulgaria is involved in only one IWG of the SET Plan, i.e., Nuclear safety. |
| **Innovation performance** | Bulgaria was a Modest Innovator in 2019 [30]. |
| | According to new methodology, Bulgaria was an Emerging Innovator in 2022 (ranking 26 of 27) [6]. |
| **Total R&D expenditure** | Bulgaria national R&D intensity target of 1.5% of GDP by 2025 [57]. |
| | The National Development Programme Bulgaria 2030 sets 2030 target as 2.5% of GDP. |
| | In 2017, R&D expenditure reached 0.74% of GDP [13]. |
| | In 2018, R&D expenditure reached 0.75% of GDP [13]. |
| | In 2021, R&D expenditure reached 0.77% of GDP (EU average – 2.26%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.21% of GDP [4]. |
| | In 2018, the public funding level constituted 0.21% of GDP [4]. |
| | In 2021, the public funding level constituted 0.26% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.52% of GDP [13]. |
| | In 2018, business expenditure in R&D was 0.54% of GDP [13]. |
| | In 2021, business expenditure in R&D was 0.51% of GDP (EU average – 1.49%) [13]. |
| | Public support for business enterprise expenditure on R&D is very limited, 0.018% of GDP (2019) against EU average - 0.196% of GDP [53]. |
| **Academia-business links** | Links between academia and businesses are still insufficiently developed to support knowledge and technology transfer. This is also reflected in the low share of public-private scientific co-publications. Several relevant initiatives to promote innovation, knowledge transfer and science-business links are slowly progressing, supported by the ESIF. The future regional innovation centres, as well as the Centres for Competence and Centres of Excellence, will serve as a link between science and business and local/national authorities. [51] |
| | In 2020, public-private scientific co-publications was 5.3% below the EU average of 9.05% [53]. |
| **R&D policy coordination** | The lack of an adequate funding portfolio in R&D remains a barrier for fostering public-private cooperation and internationalisation as well as reintegration of researchers and innovators. |
| | Investments in R&D in low-carbon technologies are rather low but increasing. Investments are driven primarily by the private sector. Several relevant initiatives to promote innovation, knowledge transfer and science-business links are slowly progressing, supported by the ESIF. [51] |

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| | The authorities announced a doubling of the budget for research programmes to support the strategy for development of scientific research 2017-2030. In addition, the government has approved 11 national scientific programmes for 2018-2022, with a budget of more than €30 million. On the other hand, the Smart Growth Council that was set up in 2015 to provide independent, robust and coordinated management of national and EU funding is under-utilised. [51] |
| | Research infrastructure is outdated and low wages act as deterrents to attracting and retaining young talent. [51] |
| | Investment in research remains fragmented and concentrated in the capital region and multinational companies. [51] |
| | Bulgaria has introduced an update of the Research Performance Assessment procedure, but the structural reform of the research landscape that was essential to tackle its fragmentation and increase performance has not been carried out. The proposed creation of a state Agency for Innovations and Applied Research to ensure stronger governance and ownership of the R&I policies could lead to positive developments. [51] |
| | The Recovery Plan also includes measures to reform the research and innovation ecosystem, including the creation of a new consultative body, the Innovation Board, and a new legislative framework for R&I development and research universities. New instruments for the funding of research will complement the reform. [53] |
| **Funding from Horizon 2020** | Bulgaria is among least successful countries, it received only 0.24% of the overall Horizon 2020 funding (budget share rank is 23 out of 28, budget share rank per inhabitant is 26 out if 28) [17]. |
| **Research infrastructures roadmap** | Roadmap published in 2010, updated in 2017 [31]. |

|  **ROMANIA** | **Desk 2** |
|---|---|
| | **Responsible partner: TUS** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [58] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [59] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [60], [61] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1. Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Romania's Energy Strategy 2019-2030 was developed with perspectives for 2050, and in 2016 [62]. |
| **GHG 2030 target** | Non-ETS GHG emission reduction target is maximum increase of 19% in 2020 compared with 2005 [63]. |
| | According to the latest national projections based on existing measures, non-ETS emissions will increase by 1.4% between 2005 and 2020. The target is consequently expected to be met. [63] |
| | In 2020 non-ETS GHG emissions stayed at the same level compared to 2005 (i.e. 0% increase) [60]. |
| **GHG 2030 target** | Effort sharing regulation requires Romania to reduce its non-ETS emissions by 2% by 2030 relative to 2005 levels [25]. |
| | The 2030 target would be missed by a margin based on existing measures, as emissions are projected to increase above the base year in the long run [63]. |
| | Although Romania has among the lowest GHG per person in the EU, the country has some of the highest rates of carbon intensity.<br>Moreover, several industrial sectors contribute significantly to emissions. Transport, agriculture and manufacturing show a somewhat rising trend [51]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -12.7% by 2030 [60]. |
| | Romania is not likely to reach its current 2030 target for non-ETS emissions of -2% even with additional measures. Moreover, to reach the proposed target under the "Fit for 55" package will require considerable additional efforts [60]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | Romania is on track and slightly above in attaining its renewable energy target (24%) for 2020. In light of the stable or slightly decreasing share, continued efforts are needed to install more capacity in a context of economic growth. [58]<br>In 2017, the indicator constituted 24.5% [11]. |
| | With 24.8% renewable energy share in gross final consumption, Romania is on track in attaining its renewable energy target for 2020 [11]. |
| | In 2021, Romania's share of renewable energy was 23.6% (24.5% in 2020) [11]. |
| **RES 2030 target** | The Romania's NECP sets a 30.7% renewable energy contribution in gross final consumption of energy for 2030, which is significantly below the renewable share of at least 34% in 2030 that results from the formula in Annex II of the Governance Regulation [59]. |
| | Romania has committed to phase out most of its coal-fired generation capacity (85%) by 2025 and to fully phasing out coal by 2032 [60]. |

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| **RES in transport** | The penetration of renewable energy in transport sector in 2017 was 6.6% [11] .The respective 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 6.3% [11]. |
| | In 2021, the penetration of renewable energy in transport was 7.7% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 42% [11]. |
| | In 2018, share of RES in electricity was 41.8% [11]. |
| | In 2021, share of RES in electricity was 42.5% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 43Mtoe expressed in primary energy consumption and 30.3Mtoe expressed in final energy consumption [26]. |
| | Romania appears to be on track for reaching its 2020 target. However, both primary and final energy consumption increased in 2017, and therefore continued efforts are needed to limit energy consumption in a context of economic growth [63]. |
| | In 2018, primary energy consumption was 32.6Mtoe, final energy consumption was 23.6Mtoe [5]. |
| | In 2021, primary energy consumption was 33.1Mtoe, final energy consumption was 25.4Mtoe [5]. |
| **2030 target** | NECP sets 2030 target as national energy efficiency contribution of 32.3Mtoe by 2030, expressed in primary energy consumption only, which corresponds to 25.7Mtoe of final energy consumption [59]. |
| **Energy savings** | [16] provides no data for energy savings in Romania by 2020. |
| **3 Energy security and interconnection** | |
| **Interconnection** | In 2017, Romania's electricity interconnectivity level was 7 % [63].<br>The current interconnection capacity of Romania is below 10% objective for year 2020. The NECP foresees developing the power transmission grid, thus reaching an interconnectivity level of at least 15.4 % in 2030. [59] |
| | With improved infrastructure Romania could tap into its potential for renewable power generation. The implementation of the Planned Projects of Common Interest (PCI) in electricity will contribute to interconnection goal (10%). The Back-Sea Corridor PCI cluster aims to relieve grid congestion in Southeast Romania and enable the integration of renewable power generation in both Romania and Bulgaria, creating a bridge to the energy markets of the Western Balkan countries. [58] |
| **Energy security** | Romania aiming to decrease its energy dependency to 68% by 2030. Diversification of sources is an important pathway to energy security; the plan also includes consideration of the transition from coal to fewer emitting sources (including nuclear). [59] |
| **Trade deficit** | The Romania energy dependence fall from 27% in 2005 to 23% in 2017 [12]. |
| | In 2018, Romania's energy import dependency was 24% [12]. |
| | In 2021, Romania's energy import dependency increased to 32% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | Wholesale electricity market is liberalized. OPCOM is the Romanian Electricity and Gas Market Operator. OPCOM is also a Nominated Electricity Market Operator designated according to the Regulation (EU) 2015/1222 for performing the day-ahead and intraday markets coupling for Romania. |
| **Retail electricity market** | On retail market different types of regulated and competitive tariffs exist. |
| | The electricity market in Romania has become fully liberalized starting with January 2021 [61]. |
| **Smart metering** | The Romania planned massive roll-out of smart meters by 2024 [64] |
| | At the end of 2021, 18% of users connected to low voltage distribution networks integrated in smart metering infrastructure were registered in the country [61]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | Single overarching strategy: National Strategy for Research, Development and Innovation 2014-2020 [29]. |

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| **Smart specialisation priority areas** | 1. Education, Cultural and Creative Industries<br>2. Analysis, Management and Security of Big Data<br>3. Services<br>4. Safe, accessible, nutritionally optimized<br>5. Increasing end-use energy efficiency.<br>6. New-generation vehicles and ecological<br>7. Service and process innovations<br>8. Development of innovative space [18] |
| **R&I objectives related to the Energy Union** | Romania does not yet have national objectives and funding targets in research, innovation and competitiveness for after 2020 [59]. |
| **Involvement in the SET Plan** | Romania is involved in four IWGs of the SET Plan:<br>• High Voltage Direct Current (HVDC);<br>• Positive energy districts;<br>• Batteries;<br>• Nuclear safety. |
| **Innovation performance** | Romania was a Modest Innovator in 2019 [30]. |
| | According to new methodology, Romania was an Emerging Innovator (ranking 27 of 27) [6]. |
| **National target** | The Romanian national 2020 R&D intensity target is 2% of GDP [63]. |
| **Total R&D expenditure** | In 2017, R&D expenditure reached 0.5% of GDP [13]. |
| | Romania will not achieve the R&D intensity target by 2020. The country's R&D expenditure in 2018 stayed at 0.5% of GDP [13]. |
| | In 2021, total R&D expenditure decreased to 0.47% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.20% of GDP [13]. |
| | In 2018, the public funding level constituted 0.20% of GDP [13]. |
| | In 2021, the public funding level constituted 0.18% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | The level of business expenditure in R&D comprised 0.29% [13]. |
| | In 2018, business expenditure in R&D was 0.3% of GDP [13]. |
| | In 2021, business expenditure in R&D was 0.29% of GDP (EU average – 1.49%) [13]. |
| | Public support for business enterprise expenditure on R&D is very limited, 0.018% of GDP (2019) against EU average - 0.196% of GDP [60]. |
| **Academia-business links** | Academia-business links continue to be poor. Regulatory barriers (e.g. red tape, conflicting or unclear rules) hamper academia-business links, which tend to occur on an ad-hoc basis [58]. |
| | In 2020, public-private scientific co-publications was 5.7% below the EU average of 9.05% [60]. |
| **R&D policy coordination** | Scientific performance and academia-business links continue to be poor. Policies supporting the transition towards a more knowledge-based economy remain limited. The economic competitiveness, research and innovation and smart specialisation strategies cannot achieve their stated objectives without a sufficient level of public R&D funding. Besides the tax exemption for ICT professionals, there are no targeted measures for innovative start-ups. The 'Start-up Nation' programme was not deemed well-tailored to the needs of innovative start-ups. [58] |
| | In early 2017, government emergency ordinance 3/2017 introduced a 10-year tax exemption for R&D firms, but procedural norms are still in preparation [58]. |
| | The combination of EU funds grants and financial instruments for supporting innovative enterprises is largely unexplored [58]. |
| | Momentum for innovation is growing, but is concentrated in a few regions. There is a lack of strategic vision for the start-up ecosystem [60]. |
| **Funding from Horizon 2020** | Romania is a least successful country in terms of Horizon2020 contribution normalised per inhabitant - budget share rank per inhabitant is 28 out if 28, it received 0.44% of the overall Horizon2020 funding (budget share rank is 20 out of 28) [17]. |

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| **Research infrastructures roadmap** | Roadmap published in 2017. Updated version under preparation [31]. |

|  **GREECE** | **Desk 2** |
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| | **Responsible partner: TUS** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [65] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [66] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [67] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | A holistic strategy was prepared by the Greek Government "Greece Growth Strategy for the Future" and covers energy related aspects [68]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is 4% reduction by 2020 compared to 2005 [69]. |
| | Greece is expected to over-achieve its 2020 effort sharing decision greenhouse gas emissions target by a significant margin, with a reduction of 22% by 2020 relative to the 2005 level [60]. |
| | In 2020 non-ETS GHG emissions decreased by 33% compared to 2005 [67]. |
| **GHG 2030 target** | Effort sharing regulation requires Greece to reduce its non-ETS emissions by 16% by 2030 relative to 2005 levels [25]. |
| | They are projected to decrease by 25%, with existing measures and 29% with additional measures. [60] |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -23% by 2030 [67]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | The renewable energy share in Greece was 15.2% in 2016. While being above the 2015/2016 indicative trajectory, further efforts are necessary to reach the 2020 target (18%) [69]. In 2017, the indicator constituted 17.3% [11]. |
| | In 2018, share of renewable energy in Greece was 18% in 2018 [11]. |
| | In 2021, share of renewable energy in Greece was 21.9% [11] |
| **RES 2030 target** | The Greek NECP sets out a contribution of at least 35% (in gross final consumption of energy) for renewable energy share in 2030, which is more than the result of the formula in Annex II of the Governance Regulation (31%) [66]. |
| **RES in transport** | The penetration of renewable energy in transport sector in Greece according to Eurostat data in 2017 was 1.8% [11] .The respective 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 3.8% [11]. |
| | In 2021, the penetration of renewable energy in transport was 4.3% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 24.5% [11]. |
| | In 2018, share of RES in electricity was 26% [11]. |
| | In 2021, share of RES in electricity was 35.9% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 24.7Mtoe expressed in primary energy consumption and 18.4Mtoe expressed in final energy consumption [26]. |

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| | At 23.55Mtoe in 2016, Greece is on track to meet its primary energy consumption targets for 2020, but it should make more efforts to keep the primary energy consumption at this level or to minimise its increase when the GDP grows again during the next five-year period [69]. |
| | In 2018, primary energy consumption was 15.9Mtoe, final energy consumption was 22.6Mtoe [5]. |
| | In 2021, primary energy consumption was 15.2Mtoe, final energy consumption was 20.3Mtoe [5]. |
| **2030 target** | According to the NECP, the objective is to improve energy efficiency in final energy consumption by at least 38% in relation to the foreseen evolution of final energy consumption by 2030, as estimated in 2007 in the context of the EU energy policies, thus resulting in final energy consumption levels of not more than 16.5Mtoe in 2030. This rate of reduction is even higher if adjusted to primary energy consumption, in which case it stands at more than 43%. [66] |
| **Energy savings** | In 2020, Greece has reached 73% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | While mainland Greece has a high level of interconnection for electricity, additional investments are needed. In particular, to complete the interconnections with the Cyclades islands, already financed from EU funds and to create interconnections with Crete [69]. |
| | The interconnectivity level is 10%, and Greece expects to reach the 13% interconnectivity target for 2020 [66]. |
| | Greece aims to reach an electricity interconnectivity target of 21% by 2030 and to expand its cross-border infrastructure with neighbouring countries for both electricity and gas to this end. Under the plan, this target should already be met by 2025 [66]. |
| | While mainland Greece has a good level of interconnection for electricity, additional investment is needed in particular to complete the interconnections with the Cyclades islands, and to create interconnections with Crete and neighbouring countries [66]. |
| **Energy security** | Greece has huge potential to become a regional energy hub, both for gas and electricity, however, this requires the development of major infrastructure projects with its neighbouring countries [69]. |
| | The Greek NECP defines a high level of security of supply as a priority in the transformation of the energy system, it covers interconnectivity, diversification of resources, investments in electricity storage and considerations on cybersecurity. The plan sets a target to put an end to the energy isolation of islands by early 2029, interconnecting them with the mainland where possible. [66] |
| **Trade deficit** | The Greece energy dependence raised from 68% in 2005 to 71% in 2017 [12]. |
| | In 2018, Greece's energy import dependency was 71% [12]. |
| | In 2021, Greece's energy import dependency was 74% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | The Greek wholesale electricity market is based on a pure day ahead mandatory pool mechanism. In the non-interconnected islands, autonomous power systems currently operate without any wholesale electricity market. [70] |
| | At regional level, Greece is taking steps to implementing the internal market rules for electricity as soon as possible. This should allow the country to couple its wholesale markets with Italy and Bulgaria and, and with its neighbouring Energy Community Countries in the future. Close cooperation with the South Eastern region and the Energy Community is crucial here. The Hellenic Energy Exchange, established in 2018, is accelerating this process. [65] |
| **Retail electricity market** | Prices were liberalised in July 2013 and only social tariffs for those in need are still in place, though market distortions keep the link between wholesale and retail electricity weak. Competition levels in the electricity market remain low. [60] |
| | Although competition has increased in recent years, the Public Power Corporation still holds a 74% share of the retail market as of August 2019 [65]. |
| | In the retail market, the market share of the Public Power Cooperation is currently close to 65%, which is significantly above the 50% target set by national legislation [67]. |

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| **Smart metering** | Current plans involve only pilot installations of smart meters [69]. Total penetration of smart meters in 2018 was 2.6% [64]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | Single overarching strategy: National Strategy for Research, Technological Development and Innovation (ESETAK) 2015-2021 [29]. |
| **Smart specialisation priority areas** | 1. Culture, Tourism and Creative economy<br>2. Materials and Construction<br>3. Transport and logistics<br>4. Environment and sustainability<br>5. Energy and its cross-cutting implications (transport, industrial production<br>6. Informatics and telecommunication services<br>7. Health and pharmaceuticals<br>8. Agri-food nutrition [18] |
| **R&I objectives related to the Energy Union** | R&I activities relate to the improvement of the energy efficiency of buildings, while R&I actions focus on renewable technologies. The NECP indicates energy networks, digitalisation and development of smart grids as priority areas for R&I. Actions on energy storage are also planned. [66] |
| **Involvement in the SET Plan** | Greece is involved in three IWGs of the SET Plan:<br>• Concentrated solar power/Solar thermal electricity;<br>• Offshore wind energy;<br>• Batteries. |
| **Innovation performance** | Greece was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Greece remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | Greece national R&D intensity target of 1.21% of GDP [69]. |
| | Greece increased its national R&D target to 1.3% of GDP [65]. |
| | In 2017, R&D expenditure reached 1.15% of GDP [13]. |
| | In 2018, R&D expenditure reached 1.21% of GDP [13]. |
| | In 2021, R&D expenditure reached 1.45% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.59% of GDP [13]. |
| | In 2018, the public funding level constituted 0.61% of GDP [13]. |
| | In 2021, the public funding level constituted 0.76% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.56% of GDP [13]. |
| | In 2018, business expenditure in R&D was 0.58% of GDP [13]. |
| | In 2021, business expenditure in R&D was 0.69% of GDP (EU average – 1.49%) [13]. |
| | Public support for business enterprise expenditure on R&D is limited, 0.049% of GDP (2015) against EU average - 0.196% of GDP [67]. |
| **Academia-business links** | Links between academia and the productive sector remain weak. Level of public-private scientific co-publications remains comparatively low. As a policy response, the country launched the 'Research-Create-Innovate' funding scheme in 2017 to encourage business research, development and innovation and knowledge transfer. [65] |
| | In 2020, public-private scientific co-publications was 8.1% close to the EU average of 9.05% [67]. |
| **R&D policy coordination** | The Public R&I system has benefited from stable levels of funding in the past decade. The government is adopting a series of measures to tackle persistent weaknesses and some of the most pressing challenges in the research and innovation system. [69] |
| | There are persisting weaknesses, with the loss of skilled human capital remaining a major challenge. Despite a relative high engagement of businesses in innovative activities, the production of academic research is not appropriately oriented to support the productive sector, as reflected by the low number of patents. Further, large disparities in innovation capacities remain, due to lack of robust governance, including low administrative capacity and weak coordination mechanisms. [65] |
| **Funding from Horizon 2020** | Greece is among successful countries in terms of participation in Horizon2020 (participation rank 8 out of 28) and in terms of budget share per inhabitant (rank 12 out of 28), it received 2.51% of the overall Horizon 2020 funding (budget share rank is 11 out of 28) [17]. |

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| **Research infrastructures roadmap** | Roadmap updated in 2014 [31]. |

|  **CYPRUS** | **Desk 3** |
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| | **Responsible partner: FOSS, S5** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments"* | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [71] | IPE | 06.04.2020 |
| 3. | Content update from the NECP [72] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [73], [74], [75] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | The new Long-Term Strategy "Vision 2035" has been completed and presented in 2022 [73]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is 5% decrease in 2020 compared with 2005 [76]. |
| | GHG emissions in Cyprus continue to increase, and according to preliminary 2017 data and the latest national projections, Cyprus is expected to miss its target with a significant margin [76]. |
| | GHG emissions in Cyprus continue to increase, and according to preliminary 2018 data and the latest national projections, Cyprus is expected to miss its target with a significant margin of around 9 percentage points [71]. |
| | In 2020 non-ETS GHG emissions decreased by 3% compared to 2005 [74]. |
| **GHG 2030 target** | Cyprus' binding national target for GHG according to Effort sharing regulation is to limit GHG at least by 24% in relation to its GHG emissions in 2005 in non-ETS sectors, compared to 2005 levels [25]. |
| | Cyprus is expected to fall short of its 2030 target. On the positive side, Cyprus has estimated that with additional measures, in areas, such as: (i) transport (e.g. promoting low-emission vehicles and reduction of vehicle use), (ii) waste management (e.g. promoting biogas and exploiting organic waste), (iii) buildings (e.g. replacing old systems and promoting co-generation) and (iv) industry by promoting energy efficiency can help reduce the gap to 17 percentage points and it is of crucial importance to ensure sufficient investments for these measures. [76] |
| | 2030 GHG target will be missed by 25 percentage points compromising significantly the transition to climate neutrality and sustainable growth [71]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -32% by 2030 [74]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | Cyprus renewable energy share increase from 9.3% in 2016 to around 9.9% in 2017; achieving the target for 2020 (13%) appears problematic. Considering Cyprus' high potential in this area the objective is still possible, but it would require a significant shift of the national energy policies. [76] |
| | Share of RES reached 13.9% in 2018 driven by the increased contribution of renewables for heating and cooling [71]. |
| | In 2021, Cyprus's share of renewable energy was 18.4%. [11] |

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| **RES 2030 target** | According to the Cyprus NECP, it sets out a 22.9% share of energy from renewable sources in gross final consumption of energy in 2030, which is in line with results from the formula contained in Annex II of the Governance Regulation [72]. |
| **RES in transport** | The penetration of renewable energy in transport sector in 2017 was 2.6% [11]. The respective 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 2.7% [11]. |
| | In 2021, the penetration of renewable energy in transport was 7.2% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 8.9% [11]. |
| | In 2018, share of RES in electricity was 9.4% [11]. |
| | In 2021, share of RES in electricity was 14.8% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 2.2Mtoe expressed in primary energy consumption and 1.8Mtoe expressed in final energy consumption [18]. |
| | Primary energy consumption reduced during the economic recession from 2.5Mtoe in 2012 to 2.2Mtoe in 2015, but in line with the sustained economic growth rose again to 2.5Mtoe in 2017. This poses a serious challenge in reaching the target without strong additional measures. [76] |
| | In 2018, primary energy consumption was 2.6Mtoe, final energy consumption was 1.9Mtoe [5]. |
| | In 2021, primary energy consumption was 2.3Mtoe, final energy consumption was 1.7Mtoe [5]. |
| **2030 target** | The Cypriot contribution to the EU-level target for 2030 is of low ambition and amounts to 2.0Mtoe of final energy consumption and 2.4Mtoe of primary energy consumption in 2030 [72]. |
| **Energy savings** | In 2020, Cyprus has reached 134% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | The planned EuroAsia interconnector would end Cyprus' energy isolation. When constructed, the EuroAsia interconnector will connect Cyprus with Israel, Crete and Attica. A feasibility study is currently under way. [76] |
| | According to NECP, Cyprus aims at an interconnectivity level of 15% for 2030 [72]. |
| **Energy security** | Cyprus is a small isolated energy system, with high dependency on oil products for its energy needs. |
| | NECP describes that energy security will be improved by the future EuroAsia Interconnector and by an increased share of domestically sourced renewable energy. Cyprus is also planning to diversify its distribution routes, including through the development of pipelines, LNG facilities. [72] |
| **Trade deficit** | The Cypriot energy dependence fell from 100% in 2005 to 96% in 2017 [12]. |
| | In 2018, Cyprus energy import dependency was 92% [12]. |
| | In 2021, Cyprus energy import dependency was 90% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | Cyprus is not integrated and not interconnected with any neighbouring power systems. No wholesale market is currently operating in Cyprus. |
| **Retail electricity market** | The Electricity Market was liberalised by 35% with effect from 1st of May 2004 and was further liberalised by approximately 65% in total with effect from January 2009, to include all "non-domestic" consumers which are able to select their Supplier according to what is in their best interest. From 1st of January 2014 the market is fully liberalised and all consumers of electrical energy are able to choose their Supplier. However, currently there is no other active Supplier in Cyprus apart from the (Electricity Authority of Cyprus EAC). [77] |
| | The sole supplier the EAC is a State-owned enterprise that operates as a de facto monopoly. There are only few renewable generators, which signed power purchase agreements with the Electricity Authority of Cyprus for the whole production. Therefore, although the consumers are legally entitled to choose their supplier, in practice the lack of alternative suppliers means that they are unable to do so. Steps are being taken to open up the electricity market in Cyprus, but progress has been slow. [66] |

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| | In the first quarter of 2021, in addition to the "EAC Supply", another two suppliers entered the electricity supply sector. These two private suppliers buy green energy which is produced by RES producers and primarily supply commercial and industrial electricity customers under bilateral contracts. [75] |
| **Smart metering** | NECP outlines plans to modernise the network infrastructure, including though the rollout of 400 000 smart meters by 2027 [72]. |
| **R&D performance** | |
| **R&I strategies** | Cyprus has multiple R&I related strategies [29]. |
| | A new R&I Strategy Framework for the period 2019-23 has been announced by the National Board for Research and Innovation in May 2019, with ambitious yet uncertain outcomes. Key enablers of this strategy framework include a new integrated governance system, in particular the establishment of a Deputy Ministry for Research, Innovation and Digital Policy, and a focus on knowledge transfer and commercial exploitation to stimulate R&I activity in the private sector. One of the planned measures is the creation of clusters of excellence, gathering universities and businesses in line with the national Smart Specialisation Strategy, which should be updated to reflect the recent changes at national level and new priorities at EU level. [71] |
| **Smart specialisation priority areas** | 1. ICT<br>2. Environment<br>3. Tourism<br>4. Agriculture and nutrition<br>5. Health, ICTs and biomedical applications<br>6. Transport, logistics and shipping<br>7. Structured environment and construction<br>8. Energy production and use, renewables and hydrocarbons [18] |
| **R&I objectives related to the Energy Union** | The country's strategic framework for research and innovation strategic framework revolves around nine pillars and enablers of strategic importance. Renewables, natural gas and energy efficiency are identified as priorities. [72] |
| **Involvement in the SET Plan** | Cyprus is very active and is involved in ten IWGs of the SET Plan:<br>• Solar photovoltaics;<br>• Concentrated solar power/Solar thermal electricity;<br>• Deep geothermal energy;<br>• Ocean energy;<br>• High Voltage Direct Current (HVDC)<br>• Positive energy districts<br>• Energy systems;<br>• Energy efficiency in industry;<br>• Batteries;<br>• Renewable fuels and bioenergy. |
| **Innovation performance** | Cyprus was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Cyprus became a Strong Innovator in 2022 [6]. |
| **Total R&D expenditure** | The R&D intensity in Cyprus stood at 0.56% of GDP in 2017, higher than its EU 2020 target (0.5%) — a target that was not deemed to be ambitious enough [76]. |
| | The NECP plans for R&I to reach as much as 1.5% of GDP by 2023 [72]. |
| | In 2017, R&D expenditure reached 0.54% of GDP [13]. |
| | In 2018, R&D expenditure stayed at 0.61% of GDP [13]. |
| | In 2021, R&D expenditure reached 0.87% of GDP (EU average – 2.23%) [13] |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.27% of GDP [13]. |
| | In 2018, the public funding level constituted 0.34% of GDP [13]. |
| | In 2021, the public funding level constituted 0.3% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.2% of GDP [13]. |
| | In 2018, business expenditure in R&D was 0.25% of GDP [13]. |
| | In 2021, business expenditure in R&D was 0.41% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D is limited, 0.043% of GDP (2019) against EU average - 0.196% of GDP [74]. |

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| **Academia-business links** | The quality of the public research system is a point of strength, but its interaction with the business sector is very limited. University-business cooperation is very weak, due to both low demand from the business side and a lack of entrepreneurial culture in the academic sector. As a result, the commercialisation of research results remains at a low level. The law allowing universities to create spin-offs was adopted as measures to stimulate academia-business cooperation. [71] |
| | In 2020, public-private scientific co-publications was 8.1% close to the EU average of 9.05% [74]. |
| **R&D policy coordination** | Incentives have been put in place to improve knowledge transfer, progress in implementing the smart specialisation strategy is key in diversifying the economy. In addition, a policy support facility measure to stimulate the utilisation of research laboratories of government–funded organisations by the business community is planned to start in 2019. |
| | Deputy Ministry of Research was established in 2020. |
| **Funding from Horizon 2020** | Cyprus is among most successful countries in terms of in terms of budget share per inhabitant (rank 8 out of 28), it received 0.47% of the overall Horizon 2020 funding (budget share rank is 19 out of 28) [17]. |
| **Research infrastructure roadmap** | Roadmap under preparation [31]. |

|  **MALTA** | **Desk 3** |
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| | **Responsible partner: FOSS** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [78] | IPE | 06.04.2020 |
| 3. | Content update from NECP [79] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [80], [81] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | The National energy policy for Malta was launched in December 2012 after the publication of a first draft in 2009 and the finalisation of a strategic environmental impact assessment in September 2012 [82] |
| | Malta lacks an integrated approach to climate policy with a cross-sectoral focus. As its Low-Carbon Development Strategy has not been completed (to be finalised in the beginning of 2020), Malta does not yet have an action plan to reach its 2020 targets. [83] |
| | Malta is currently preparing a strategy for climate neutrality by 2050, and on 14 June 2019 it endorsed the Valletta Declaration supporting this goal [78]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is 5% decrease in 2020 compared with 2005 [83]. |
| | According to the latest national projections submitted to the Commission, the 2020 target under the Effort Sharing Decision is expected to be missed by a margin of 11 pps [83]. |
| | In 2020, emissions are projected to be above the 2005 level, Malta would thereby miss the 2020 target [78]. |
| | In 2020 non-ETS GHG emissions increased by 17% compared to 2005 [80]. |
| **GHG 2030 target** | Effort sharing regulation requires Malta to reduce its non-ETS emissions by 19% by 2030 relative to 2005 levels [17]. |
| | In 2030, this gap with the effort sharing target is expected to rise to 46 pps [83]. |
| | In 2030, this gap with the effort-sharing target is expected to rise to 62 pps [78]. |
| | Malta has the highest relative gap of any Member State to its 2030 GHG reduction target under the EU Effort Sharing Regulation [80]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target, for Malta remains the same: -19% by 2030 [80]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | Target of share of renewables in gross final consumption of energy is 10% by 2020. The share of renewables in Malta was 7.2% in 2017. In view of rising energy consumption and the steeper trajectory towards 2020, further investments in the renewable energy sector are required to meet the 2020 target. [83] |
| | Malta has made progress towards the 2020 renewable energy target, reaching 8% in 2018 [78]. |
| | In 2021, Malta's share of renewable energy was 12.2% [11]. |
| **RES 2030 target** | On renewable energy, the NECP include 2030 RES target: 11.5%, which is significantly below the share of 21% that results from the formula in Annex II of the Governance Regulation [79]. |

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| **RES in transport** | The penetration of renewable energy in transport sector in 2017 was 6.9% [11] The respective 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 8% [2]. |
| | In 2021, the penetration of renewable energy in transport was 10.6% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 6.8% [11]. |
| | In 2018, share of RES in electricity was 7.7% [11]. |
| | In 2021, share of RES in electricity was 9.7% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 0.8Mtoe expressed in primary energy consumption and 0.6Mtoe expressed in final energy consumption [18]. |
| | Malta should increase its efforts to decrease its primary and final energy consumption in order to ensure that its indicative national 2020 energy efficiency targets are met. Malta's final energy consumption is continuously increasing over the last years with the transport and the services being the most consuming sectors. [83] |
| | In 2018, primary energy consumption was 0.82Mtoe, final energy consumption was 0.66Mtoe [5]. |
| | In 2021, primary energy consumption was 0.77Mtoe, final energy consumption was 0.59Mtoe [5]. |
| **2030 target** | Indicative energy efficiency target for 2020 amounts to 1.1Mtoe of final energy consumption and 0.8Mtoe of primary energy consumption in 2030 [79]. |
| **Energy savings** | In 2020, Malta has reached 116% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | The electricity networks in Malta and Sicily (Italy) are linked by a 200MW HVAC interconnector, connecting Malta to the European electricity grid, which came into full operation in 2015. Electricity imported over the interconnector is projected to meet between 24-35% of Malta's electricity demand during the period 2021-2030. [83] |
| **Energy security** | Malta's high-level objectives in the area of energy security as set out in the NECP can be summarized into the following: continues diversification of energy sources and suppliers; reduction of import dependency through the deployment of indigenous sources of renewable energy whilst taking into account the specificities of Malta's energy system; increasing the flexibility of the national energy system, including through the roll-out of cost-effective, innovative solutions such as storage; periodic contingency planning in the case of supply disruption for the electricity, gas and oil sectors; increased deployment of RES. [79] |
| **Trade deficit** | The high dependency on oil and petroleum products decreased from 79% in 2016 to 56% in 2017, whereby the share of natural gas now amounts to 30% of the energy mix. The share of renewable energy is also increasing on an annual basis. The share of electricity imported over the interconnector in the energy mix in 2017 was 9%. [83] |
| | In 2018, Malta's energy import dependency was 97.5% [12]. |
| | In 2021, Malta's energy import dependency was 97% [12]. |
| **4 Integrated electricity market** | |
| **Electricity market** | Due to its size and insularity, Malta has no wholesale and retail markets for electricity and gas. The state-owned energy company Enemalta remains the only enterprise with a licence to supply electricity to final customers. [83] |
| **Smart metering** | Malta is proceeding with electricity smart meter roll out, with more than 90% of final customers having an electricity smart meter [83]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategies** | Single overarching strategy: Multi-annual National R&I Strategy 2020 [29]. |
| | The National R&I Strategy post-2020 is under preparation, smart specialisation strategy is being updated and the National AI Strategy launched in autumn 2019. The results of these policies are to be evaluated in the coming years [78]. |
| **Smart specialisation priority areas** | Malta is one of several countries which has defined 2027-2030 priorities.<br>1. Sustainable Use of Resources for Climate Change Mitigation & Adaptation<br>2. Future Digital Technologies<br>3. Marine and Maritime Technologies<br>4. Health and Well-Being |

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| | 5. Aviation and Aerospace<br>6. Smart Manufacturing [18] |
| **R&I objectives related to the Energy Union** | The national strategy for R&I in energy and water for 2021-2030 that is under development [79]. |
| | National Strategy for Research and Innovation in Energy and Water [81] was launched in 2020. |
| **Involvement in the SET Plan** | Malta is involved in only one IWG of the SET Plan, i.e. Batteries. |
| **Innovation performance** | Malta was a Moderate innovator in 2019 [30]. |
| | According to new methodology Malta remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | R&D intensity remained flat in recent years (0.55% of GDP in 2017 against 2.07% for the EU) and the country is likely to miss its target of 2% R&D intensity by 2020 [83]. |
| | In 2017, R&D expenditure stood at 0.55% of GDP [13]. |
| | In 2018, R&D expenditure stood only at 0.58% of GDP [13]. |
| | In 2021, R&D expenditure reached 0.63% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, Malta's public investment in R&D was 38% of total investment and constituted 0.21% of GDP [83]. |
| | The recent slight increase in public R&D intensity is partly explained by the significant inflow of structural funds. The low level of public R&D investment in the public science base limits the full usage of the country's scientific and technological potential. [83] |
| | In 2018, the public funding level constituted 0.22% of GDP [13]. |
| | In 2021, the public funding level constituted 0.24% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | Business enterprise R&D expenditure intensity has declined since 2012 (0.34% of GDP in 2017) [83]. |
| | In 2018, business expenditure in R&D was 0.36% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.4% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D is limited, 0.038% of GDP (2019) against EU average - 0.196% of GDP [80]. |
| **Academia-business links** | Research activity suffers from limited national funding for R&D, technological development, and industrial cooperation. Academia-business links are underdeveloped due to the low R&D absorption capacity of Maltese firms [78]. |
| | In 2020, public-private scientific co-publications was 5.6% below the EU average of 9.05% [80]. |
| **R&D policy coordination** | The R&I Strategy 2014-2020 has little visibility and its implementation is scattered between various governmental bodies with limited coordination [83]. |
| | Six different ministries/governmental bodies are responsible for R&I policy, while public research is mainly performed by the University of Malta. Coordination mechanisms remain weak between the different authorities involved in the implementation of the smart specialisation strategy and the R&I strategy. The Horizon 2020 Policy Support Facility's peer review of the Maltese R&I system pointed to the need for a major overhaul of R&I policy governance, with possibly one institution/minister providing political leadership. [78] |
| | Most innovative companies are foreign-owned, which partly explains the low uptake of most R&I schemes. [78] |
| | The R&I system lacks public and private support both in terms of investment and dedication to the field. [78] |
| **Funding from Horizon 2020** | Malta is among not very successful in terms of Horizon2020 budget share per inhabitant (rank 19 out of 28), it received 0.05% of the overall Horizon 2020 funding (budget share rank is 28 out of 28) [17]. |
| **Research infrastructures roadmap** | No roadmap available [31]. |

|  **POLAND** | **Desk 4** |
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| | **Responsible partner: DERlab** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [84] | IPE | 06.04.2020 |
| 3. | Content update from NECP [85] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [86], [87] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | The last adopted in 2009 energy strategy is the Poland Energy Strategy 2030, at the moment the work is going on the long-term strategy "Energy Policy of Poland until 2040". The Ministry of Energy submitted for public consultation a draft version of „Energy Policy of Poland until 2040". |
| | In 2021, the Polish government adopted 2040 energy policy. It is the first strategic document regarding Polish energy approved in 12 years. It presents solutions to meet EU climate and energy goals such as the construction of offshore wind capacity or the commissioning of the first nuclear power plant in the country planned for 2033. [87] |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 14% increase in 2020 compared with 2005 [88]. |
| | According to the latest national projections, Poland is expected to achieve its 2020 emission target for sectors outside the EU Emissions Trading Scheme [88]. |
| | In 2020, the emissions' increase is projected to level at +14% from 2005 levels; however, this implies an intensified effort to reduce emissions in the next two years to meet 2020 target [84]. |
| | In 2020 non-ETS GHG emissions increased by 12% compared to 2005 [87]. |
| **GHG 2030 target** | Effort sharing regulation requires Poland to reduce its non-ETS emissions by 7% by 2030 relative to 2005 levels [17]. |
| | 2030 target could be missed by a wide margin if no additional measures are taken [84]. |
| | GHG emissions have increased slightly in recent years, especially in the transport sector. This puts Poland in the group of EU Member States with the highest emissions per capita. Energy supply and use are jointly responsible for the highest share of national greenhouse gas emissions. Around 90% of electricity is still generated in conventional power plants, mainly using domestic hard coal and lignite. [84] |
| | Poland has been decarbonising at the second slowest rate among all lower income Member States [87]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -18% by 2030 [87]. |
| **1.2 Uptake of renewable energy resources** | |
| **RES 2020 target** | Poland faces a risk of missing its 2020 target of 15% of energy from renewables. In 2017, the share of renewables in gross final energy consumption declined to 10.9%. Investment in new renewable energy capacity has slowed down. [88] |
| | Poland is at risk of missing its 2020 target. With 11.16% (provisional Eurostat 2018 data), it is below the indicative trajectory (12.3%) leading to the 15% target. [84] |
| | In 2021, Poland's share of renewable energy was 15.6%. [11] |

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| **RES 2030 target** | The renewable energy contribution to the EU's 2030 target set out in the NECP (21-23%) is below the share of 25% in 2030 that results from the formula of Annex II of the Governance Regulation [85]. |
| **RES in transport** | In 2017, the penetration of renewable energy in transport was 4.2% [11], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 5.6% [11]. |
| | In 2021, the penetration of renewable energy in transport was 5.7% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 13.1% [11]. |
| | In 2018, share of RES in electricity was 13% [11]. |
| | In 2021, share of RES in electricity was 17.2% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 96.4Mtoe expressed in primary energy consumption and 71.6Mtoe expressed in final energy consumption [18]. |
| | Contrary to the EU trend, since 2005, Poland has increased both its primary energy and final energy consumption due to strong economic growth and historically high energy intensity of the Polish economy. In 2017, Poland's primary energy consumption reached 99.8Mtoe, exceeded its 2020 indicative target. Final energy consumption, at 71.0Mtoe was just below the 2020 indicative target. [88] |
| | In 2018, primary energy consumption was 104.1Mtoe, final energy consumption was 74.9Mtoe [5]. |
| | In 2021, primary energy consumption was 104Mtoe, final energy consumption was 75.2Mtoe [5]. |
| **2030 target** | For energy efficiency Poland's contribution to the EU target defined in the NECP is of modest ambition and amounts to 91.3Mtoe of primary energy and 67.1Mtoe of final energy consumption [85]. |
| **Energy savings** | In 2020, Poland has reached 71% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | Poland has committed towards achieving the synchronisation of its electricity grid with the Baltic states by 2025 [88]. |
| | The planned interconnection level for 2030 is 8.7% [85]. |
| **Energy security** | Compared to EU average, the Polish energy mix has a significantly higher share of solid fuels (notably coal and lignite), which are mainly used in power generation and heating. At the same time, Poland's energy dependency, i.e. the proportion of energy that the economy is importing, is currently lower than EU average. [88] |
| | Developing nuclear energy is one of the objectives recalled in the NECP. Activation of a first block of the first nuclear power plant is foreseen to take place in 2033. Share of coal in electricity generation will be systematically reduced - in 2030 it will reach the level of 56-60%. [85] |
| **Trade deficit** | Poland's energy dependence raised from 18% in 2005 to 38% in 2017 [12]. |
| | In 2018, Poland's energy import dependency was 44% [12]. |
| | In 2021, Poland's energy import dependency was 40% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | Poland has a competitive wholesale market. Three largest producers (which were part of the groups: PGE Polska Grupa Energetyczna S.A., TAURON Polska Energia S.A., ENEA S.A.) had in total almost 2/3 of the installed capacity and were responsible for almost 70% of domestic electricity production [89].<br>TGE (Polish Power Exchange) it is the Nominated Electricity Market Operator (NEMO) for the Polish pricing area and the only licensed commodity exchange in Poland [90]. |
| **Retail electricity market** | In 2017, there were five default suppliers and over 119 alternative trading companies active in the electricity supply to end-users, including households [89]. |
| | The role of state-owned enterprises in the energy sector has increased in recent years. This underlines the importance of a strong and independent regulator [84]. |
| **Smart metering** | The Primary law that enables smart metering for electricity is under legislative process. The draft provisions were presented for public consultation in October 2018. Total smart meter penetration rate (as of 2018) was 8.3% [56]. |
| | On 3 July 2021, a major amendment to the Energy Law Act came into force. Among |

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| | the numerous changes, systemic solutions for smart metering were introduced – consisting in an obligation for DSOs to install by 31 December 2028 remote reading meters connected to a remote reading system at energy consumption points constituting at least 80% of the total number of energy consumption points of final customers, including those representing at least 80% of the total number of energy consumption points of final customers in households, with metering and billing systems without current or voltage transformers, connected to a network with a rated voltage of no more than 1 kV. [91] |
| **5 Research, innovation and competitiveness** | |
| **R&I strategies** | The strategic framework includes the Strategy for Innovativeness and Efficiency of the Economy as the overarching document (2013). This is supplemented by the Enterprise Development Programme (PRP) as implementing programme of SIEG (2014); National Smart Specialisations (KIS) (2014); National Research Programme (KPB) (2014); Polish Roadmap of Research Infrastructures (PMDIB) (2014); Operational Programme Smart Growth 2014-2020 (POIR) (2014); Regional Operational Programmes (RPOs). Strategy for Innovation and Efficiency of the Economy – Dynamic Poland 2020 (2013-20.) [29] |
| **Smart specialisation priority areas** | 1. Natural resources and waste management<br>2. Innovative technologies and industrial processes<br>3. Sustainable energy<br>4. Bio-economy comprising agri-food, forestry and environment<br>5. Healthy Society [18] |
| **R&I objectives related to the Energy Union** | Specific 2050 national objectives for promoting clean energy technologies are not present in the NECP [85]. |
| **Involvement in the SET Plan** | Poland is involved in five IWGs of the SET Plan:<br>• Positive energy districts<br>• Energy efficiency in industry;<br>• Batteries;<br>• Renewable fuels and bioenergy;<br>• Nuclear safety. |
| **Innovation performance** | Poland was a Modest Innovator in 2019 [30]. |
| | According to new methodology Poland was an Emerging (previously called Modest)) Innovator (ranking 24 of 27) in 2022 [6]. |
| **Total R&D expenditure** | National R&D intensity target is 1.7% for 2020 [88]. |
| | Poland aims to increase expenditure in research and development to 2.5% of GDP by 2030 [85]. |
| | In 2017, R&D expenditure was 1.03% of GDP [13]. |
| | On a regional level, in 2015 five regions spent well above 1% of regional GDP on R&D, but in four regions this ratio was below 0.35% [88]. |
| | In 2018, R&D expenditure was 1.21% of GDP [13]. |
| | In 2021, R&D expenditure was 1.44% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | Public investment constituted 35% of the total investments in 2017 (0.36% of GDP) [88]. |
| | In 2018, the public funding level constituted 0.4% of GDP [13] |
| | In 2021, the public funding level constituted 0.53% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | Business investment constituted 64% of the total investments in 2017 (0.67% of GDP) [88]. |
| | In 2018, business expenditure in R&D was 0.8% of GDP [4]. |
| | Although business expenditure on R&D has more than quadrupled in the past ten years, it remains below the EU average [84]. |
| | In 2021, business expenditure in R&D was 0.91% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.17% of GDP (2019) is close to EU average - 0.196% of GDP [87]. |
| **Academia-business links** | The potential of cooperation between science and business remains underexploited [84]. |

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| | In 2020, public-private scientific co-publications was 5% below the EU average of 9.05% [87]. |
| **R&D policy coordination** | Despite measures taken, including number of amendments to the act on higher education, only limited progress was observed in better links between research, innovation and industry. |
| | Poland is introducing measures to improve its scientific performance. The 2018 Act on Higher Education and Science is under implementation, with implementing legal acts being prepared and adopted. The new evaluation criteria for scientific organisations emphasise the importance of international cooperation and the internationalisation of science. The first edition of the 'Excellence Initiative – Research University' programme was completed in October 2019, with the selection of 10 universities to be reinforced in their research activities. A new configuration of the university councils, including external stakeholders, may positively affect universities' social and economic impact. [84]. |
| | Recent changes in the scientific evaluation system do not properly support the development and internationalisation of Polish research institutions. Increasing fragmentation of current research support instruments, often with the remit of various line ministries and with a risk of duplication of support between national and regional agencies, impairs possible synergy gains. [87] |
| **Funding from Horizon 2020** | Poland is among least successful countries in terms of Horizon2020 budget share per inhabitant (rank 27 out of 28), it received 1.09% of the overall Horizon 2020 funding (budget share rank is 15 out of 28) [17]. Greece being four times smaller in terms of population received twice bigger funding. |
| **Research infrastructures roadmap** | Roadmap published in 2014 [31]. |

|  | **SLOVAKIA** | **Desk 4** |
|---|---|---|
| | | **Responsible partner: DERlab** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [92] | IPE | 06.04.2020 |
| 3. | Content update from NECP [93] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [94], [95] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Greener Slovakia: Strategy of the Environmental Policy of the Slovak Republic until 2030 was published in 2019 [96]. |
| | Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050 was approved in 2020 [97]. |
| | The National Hydrogen Strategy is a framework non-legislative document that defines the strategic role of the state in the use of hydrogen technologies in the Slovak Republic in the context of current developments in the European Union [94]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 13% increase in 2020 compared with 2005 [98]. |
| | Slovakia is set to overachieve its 2020 target [96]. |
| | In 2020, emissions are projected to be 20% below the 2005 level [92]. |
| | In 2020, GHG emissions were 15% below the 2005 levels [95]. |
| **GHG 2030 target** | Effort sharing regulation requires Slovakia to reduce its non-ETS emissions by 12% by 2030 relative to 2005 levels [17]. |
| | According to the NECP, 2030 GHG target is -20% [93]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -23% by 2030 [95]. |
| | GHG emissions in non-Emissions Trading System sectors are currently projected to increase, which makes meeting the national target of a 23% reduction by 2030 particularly difficult [95]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | 2020 renewable energy target: 14%. Slovakia had a 12% share of renewable energy in gross final consumption in 2016. This was above the indicative goal for 2017/2018 of 11.4 % needed to stay on track towards its 2020 target, however 2016 shares for Slovakia are lower than those of 2015, pointing to the risk of a decreasing trend. [98] |
| | Slovakia had an 11.9% share of renewable energy in gross final consumption in 2018. After two years of falling shares this indicates a slight stabilisation, but the upward trend would need to be significantly accelerated during the remaining period, in particular given the projected increased demand. [92] |
| | In 2021, Slovakia's share of renewable energy was 17.4% [11]. |
| **RES 2030 target** | The proposed contribution to the EU level target of renewable energy is a share of 19,2% of energy from renewable sources in gross final consumption of energy in 2030. This contribution is significantly below the share of 24% in 2030 that results from the formula contained in Annex II of the Governance Regulation. [93] |

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| **RES in transport** | In 2017, the penetration of renewable energy in transport was 6.7% [2], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 7% [2]. |
| | In 2021, the penetration of renewable energy in transport was 10.6% [2]. |
| **RES in electricity** | In 2017, share of RES in electricity was 21.3% [11]. |
| | In 2018, share of RES in electricity was 21.5% [11]. |
| | In 2021, share of RES in electricity was 22.4% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 16.4Mtoe expressed in primary energy consumption and 10.4Mtoe expressed in final energy consumption [18]. |
| | The primary energy consumption was of 16.1Mtoe in 2017. Final energy consumption stood at 11.1Mtoe, exhibiting a trend that makes reaching the 2020 target unlikely. [98] |
| | Primary energy consumption was of 15.8Mtoe in 2018, still below the EU 2020 target. Final energy consumption stood at 11.1Mtoe, exhibiting a trend that makes reaching the 2020 target very unlikely. Enhanced efforts need to be put into and additional measures considered for keeping primary energy consumption in check and considerably reducing final energy consumption. [92] |
| | In 2021, primary energy consumption was 16.3Mtoe, final energy consumption was 11.4Mtoe [5]. |
| **2030 target** | The Slovak contribution to the EU target is of low ambition and amounts to 15.7Mtoe for primary energy and 10.3Mtoe for final energy consumption [93]. |
| **Energy savings** | In 2020, Slovakia has reached 112% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | Slovakia has significant electricity interconnection capacity (43%) compared to its electricity generation capacity. The planned increase of new nuclear capacity is accompanied by new connections, e.g. with Hungary, aimed at reducing congestion. The interconnection level is projected to be at 52% in 2030. [93] |
| **Energy security** | Maintaining a high level of security of supply is a priority for Slovakia due to the high dependency on energy imports [93]. |
| **Trade deficit** | In 2017, Slovakia's energy import dependency remained 65% similar to 2005 level of 66% [12]. |
| | In 2018, Slovakia's energy import dependency was 64% [12]. |
| | In 2021, Slovakia's energy import dependency was 53% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | Electricity is traded predominantly based on bilateral trades concluded under the market conditions, usually via various broker platforms, Prague Power Exchange (PXE) and European Energy Exchange (EEX) [99]. |
| **Retail electricity market** | Retail energy markets are heavily regulated, with all households and small and medium-sized enterprises being supplied with electricity and gas at regulated prices. The current regulatory system, expected to apply until 2021, hampers market development and innovation. Although energy prices are in general lower than the EU average, electricity prices for companies are the highest in the region, putting Slovak companies at a competitive disadvantage. [98] |
| **Smart metering** | Total smart meter penetration rate (as of 2018) was 5.1% [64]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | The national Smart Specialisation Strategy (RIS3 document) serves as the national R&I strategy for 2014-2020 [29]. |
| **Smart specialisation priority areas** | 1. Public health and medical technology<br>2. Healthy food and the environment<br>3. Digital Slovakia and creative industries<br>4. Industry for 21st century<br>5. Cars for the 21st century [18] |
| **R&I objectives related to the Energy Union** | The plan identifies the key areas and funding needs for research and development for 2019-2023 with an outlook to 2028, including exploration of domestic resources, development of storage technologies, power-to-x, new transmission systems and nuclear research [93]. |

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| **Involvement in the SET Plan** | Slovakia is involved in three IWGs of the SET Plan:<br>• Energy efficiency in industry;<br>• Batteries;<br>• Nuclear safety. |
| **Innovation performance** | Slovakia was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Slovakia was an Emerging Innovator (ranking 23 of 27 in 2022 [6]. |
| **Total R&D expenditure** | National R&D target: 1.2% of GDP [98]. |
| | In 2017, R&D expenditure was 0.88% of GDP [13]. |
| | Total R&D expenditure stood at 0.84% of GDP in 2018 [13]. |
| | In 2021, R&D expenditure was 0.93% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | Public R&D investment rose from 0.27% in 2007 to 0.4% in 2017 [98]. |
| | In 2018, the public funding level constituted 0.38% of GDP [13]. |
| | In 2021, the public funding level constituted 0.41% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.48% of GDP [4]. |
| | In 2018, business expenditure in R&D was 0.45% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.52% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.05% of GDP (2019) is limited against EU average - 0.196% of GDP [79]. |
| **Academia-business links** | The low quality of the science base hinders science-business cooperation [92]. |
| | In 2020, public-private scientific co-publications was 5.5% below the EU average of 9.05% [79]. |
| **R&D policy coordination** | A lack of R&D strategy and targeted measures, the limited engagement of research institutions and limited research capacity contribute to low private R&D expenditure [98]. |
| | A fragmented governance system renders public R&D investment inefficient. Policy development and implementation suffer from a lack of coordination between ministries and implementing agencies, and the lack of a comprehensive, long-term research and innovation strategy. Major reforms have been regularly postponed. No substantial policies were adopted to decrease the fragmentation of the public research system and the reform of the Slovak Academy of Sciences was stopped in its final stage. [92] |
| | Various measures are underway to improve the SME research ecosystem, mostly financed by the European Structural and Investment Funds. [92] |
| **Funding from Horizon 2020** | Slovakia is among least successful in terms of Horizon2020 budget share per inhabitant (rank 25 out of 28), it received 0.2% of the overall Horizon2020 funding (budget share rank is 25 out of 28) [17]. |
| **Research infrastructures roadmap** | No roadmap available [31]. |

|  **CZECHIA** | **Desk 4** |
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| | **Responsible partner: DERlab** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments"* | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [100] | IPE | 06.04.2020 |
| 3. | Content update from NECP [101] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [102], [103], [104] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | On 18th of May 2015 the government of the Czech Republic approved the updated version of the State Energy Policy [105]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 13% increase in 2020 compared with 2005 [106] |
| | Emissions are expected to be at 2005 level in 2020, according to national projections considering existing measures. This means that the Czech Republic is expected to overachieve its target [106]. |
| | In 2018, GHG emissions increase compared with 2005, was 4% [100]. |
| | In 2020, GHG emissions increased by 4% relative to the 2005 levels [102]. |
| **GHG 2030 target** | Effort sharing regulation requires Czechia to reduce its non-ETS emissions by 14% by 2030 relative to 2005 levels [17]. |
| | The country is likely to meet the 2030 target in the non-ETS, according to the projections of the NECP [101]. |
| | According to the NECP, GHG emissions target: 30% reduction in 2030 compared with 2005 [101]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -26% by 2030 [102]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | With a renewable energy share of 14.8% in 2017, the Czech Republic is on track to meet its target for 2020 (13%) [106]. |
| | In 2021, the share of renewable energy was 17.7% [11]. |
| **RES 2030 target** | The Czech Republic plans to achieve the RES share in gross final consumption at 22% by 2030. This level of ambition is below the share of 23% in 2030 that results from the formula contained in Annex II of the Governance Regulation. [101] |
| **RES in transport** | In 2017, the penetration of renewable energy in transport was 6.6% [11]. |
| | In 2018, the penetration of renewable energy in transport was 6.52% [11]. |
| | In 2018, the penetration of renewable energy in transport was 7.5% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 13.7% [11]. |
| | In 2018, share of RES in electricity was 13.7% [11]. |
| | In 2021, share of RES in electricity was 14.5% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 44.3Mtoe expressed in primary energy consumption and 25.3Mtoe expressed in final energy consumption [18]. |

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| | The Czech Republic increased its primary energy consumption to 40.1Mtoe in 2017. Final energy consumption increased to 25.5Mtoe, above the set target [96]. |
| | In 2018, primary energy consumption was 40.5Mtoe, final energy consumption was 25.3Mtoe [5]. |
| | In 2021, primary energy consumption was 39.6Mtoe, final energy consumption was 26.2Mtoe [5]. |
| **2030 target** | The Czech contribution to the EU target translates into primary energy consumption of 41.4Mtoe and final energy consumption of 23.7 Mtoe [101]. |
| **Energy savings** | In 2020, Czechia has reached 71% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | The country is well interconnected in the internal electricity market. It currently has an interconnection capacity of 19.3%. However, congestion management in Central Europe needs a solution at regional level that facilitates cross-border electricity flows, while ensuring system security. [106] |
| | There are plans to increase the electricity interconnection level to at least 30% by 2030 [101]. |
| **Energy security** | As regards energy security, the objective is to limit import dependency below 65% by 2030 and 70% by 2040 [101]. |
| **Trade deficit** | Energy dependence raised from 28% in 2005 to 37% in 2017 [12]. |
| | In 2018, energy import dependency was 37% [12]. |
| | In 2021, energy import dependency was 40% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | The Czech electricity market is an integral part of the wider European electricity market. In the Czech Republic, electricity is traded at Prague-based Power Exchange Central Europe (PXE) (established in 2007), and in spot markets (day-ahead and intraday) organised by OTE (Czech electricity and gas market operator). The market coupling of the Czech, Slovak and Hungarian day-ahead markets started in September 2012 and has been successful so far. [96] |
| **Retail electricity market** | Czech power market is fully liberalised. Market concentration remains very high, but the dominant position of three main power suppliers, ČEZ, E.ON and PRE is gradually decreasing. [96] |
| | At the end of 2021, the retail electricity market had 102 active suppliers. Approximately a million customers changed their electricity supplier, up by 126% on 2020 when some 445,000 customers switched their supplier. [103] |
| **Smart metering** | Cost Benefit Analysis for smart metering was negative [64]. |
| **5 Research, innovation and competitiveness** | |
| **R&I Strategies** | Single overarching strategy: The National Research, Development and Innovation Policy of the Czech Republic 2016-2020 [29]. |
| | National Research, Development and Innovation Policy of the Czech Republic 2021+ is the overarching national-level strategic document for advancing all components of research, development and innovation in the Czech Republic. It prioritises international cooperation, technology transfer and commercialisation, skills for R&I, innovative entrepreneurship, R&I governance. [104] |
| **Smart specialisation priority areas** | 1. Creative Czech Republic<br>2. Digital Market Technologies and Electrical Engineering<br>3. Health care, advanced medicine<br>4. Transport means for the 21st century<br>5. Mechanical engineering<br>6. Natural resources, agriculture and food [18] |
| **R&I objectives related to the Energy Union** | Czechia has no specific quantifiable targets for public research, development and innovation related specifically to the Energy Union objectives, these are covered in the overall R&I priorities [101]. |
| | Activities related to R&D in the area of energy are very low, representing only around 0.1% of GDP (down from 0.3% in 2011). Moreover, out of the €21 million invested in research in 2016, around half went to activities related to nuclear and fossil fuels. [100] |

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| **Involvement in the SET Plan** | Czechia is involved in six IWGs of the SET Plan:<br>• High Voltage Direct Current (HVDC)<br>• Positive energy districts<br>• Energy efficiency in industry;<br>• Batteries;<br>• Carbon Capture and Storage - Carbon Capture and Utilisation (CCS-CCU)<br>• Nuclear safety. |
| **Innovation performance** | The Czechia was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Czechia remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | R&D target set in the national research policy: 1% of GDP for public R&D expenditures [96]. |
| | The overall R&D intensity in 2017 stood at 1.77% of GDP [13]. |
| | In 2018, R&D expenditure was 1.9% of GDP [13]. |
| | In 2021, R&D expenditure was 2% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | Public R&D investment lacks a coherent strategy. Its level of intensity stood at 0.66% of GDP in 2017 and if the current trend is maintained, the 2020 target of 1% of GDP might not be reached. [96] |
| | In 2018, the public funding level constituted 0.72% of GDP [13]. |
| | In 2021, the public funding level constituted 0.74% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | Business expenditure on R&D increased from 0.77% of GDP in 2010 to 1.13% of GDP in 2017. However, close to two thirds of these expenditures are incurred by foreign firms. While some of these firms have set up medium and high-tech research and innovation facilities, their activities are mainly directed towards experimental development rather than industrial research. [96] |
| | In 2018, business expenditure in R&D was 1.18% of GDP [4]. |
| | In 2021, business expenditure in R&D was 1.25% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.16% of GDP (2019) is less then EU average - 0.196% of GDP [102]. |
| **Academia-business links** | Links between academia and business are insufficient to support knowledge and technology transfer. Regulatory barriers persist for spin-off creation and cooperation is often informal. In the public sector, researchers' careers largely depend on their publications track record, discouraging them to work with the industry. [100] |
| | In 2020, public-private scientific co-publications was 6.7% below the EU average of 9.05% [102]. |
| **R&D policy coordination** | The country has not yet created a fully functioning innovation ecosystem based on domestic research and development [96] |
| | Competence for R&I policy is shared between different authorities without an adequate coordination mechanism or synergies. A leading central institution with a cross-cutting coordination and practical overview role is lacking. Consequently, the decision-making bodies mostly work in silos. [100] |
| | Regional authorities managed to strengthen their role in promoting and cultivating the business and innovation environment, despite the fragmented governance. At the same time, the current economic situation helps firms become less dependent on grants. [100] |
| **Funding from Horizon 2020** | Czechia is among least successful countries in terms of Horizon2020 budget share per inhabitant (rank 21 out of 28), it received 0.75% of the overall Horizon 2020 funding (budget share rank is 16 out of 28) [17]. |
| **Research infrastructures roadmap** | Roadmap published in 2010, updated in 2011, 2015 and 2019 [31]. |

|  **HUNGARY** | **Desk 5** |
|---|---|
| | **Responsible partner: RSE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [107] | IPE | 06.04.2020 |
| 3. | Content update from NECP [108] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [109], [110] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1. Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Hungarian "National Energy strategy" was developed by the Ministry of National Development in 2012 [111]. |
| | Hungary's National Hydrogen Strategy [112] was published in 2020. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 10% increase in 2020 compared with 2005 [107]. |
| | By 2017, emissions fell by 9% compared with 2005. According to the latest projection, the 2020 target is expected to be met by a wide margin. [113] |
| | By 2018, emissions fell by 10% compared with 2005 [107]. |
| | In 2020, GHG emissions decreased by 7% relative to the 2005 levels [109]. |
| **GHG 2030 target** | Effort sharing regulation requires Hungary to reduce its non-ETS emissions by 7% by 2030 relative to 2005 levels [17]. |
| | According to the NECP, GHG emissions should be reduced by at least 40% by 2030 over the year 1990 (-25,8% compared to 2005 level) [108]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -19% by 2030 [109]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | 2020 renewable energy target: 13%. Although in 2017 the preliminary renewable share (13.3%) was higher than the 2020 target, it decreased from the last year (14.3%), owing to lower share of renewables in heating and cooling, and transport. [113] |
| | Although in 2018 the preliminary renewable share (12.5%) was close to the 2020 target, it decreased from 2017, owing to lower share of renewables in heating and cooling [107]. |
| | In 2021, Hungary's share of renewable energy was 14.1% [11]. |
| **RES 2030 target** | According to the NECP, Hungary set the target of reaching a 21% share of renewable energy sources within primary energy consumption by 2030 [108]. |
| **RES in transport** | The penetration of renewable energy in transport sector in 2017 was 6.8% [11], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 7.7% [11]. |
| | In 2021, the penetration of renewable energy in transport was 6.2% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 7.5% [11]. |
| | In 2018, share of RES in electricity was 8.3% [11]. |
| | In 2021, share of RES in electricity was 13.7% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 26.6Mtoe expressed in primary energy consumption and 18.2Mtoe expressed in final energy consumption [18]. |

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| | Both primary and final energy consumption rose amid strong economic growth for the third consecutive year in 2017, respectively reaching 24.5Mtoe and 18.5Mtoe. Final energy consumption target will be difficult to meet without additional measures [113]. |
| | The increasing trend in both primary and final energy consumption amid strong economic growth came to a halt in 2018 and both indicators remained unchanged compared to 2017 (reaching respectively 24.5 and 18.5 Mtoe) [107]. |
| | Hungary is at risk of failing to meet its 2020 energy saving target. This is largely due to high household energy consumption per capita, which remains 12% higher than the EU average despite considerably lower income levels [107]. |
| | In 2021, primary energy consumption was 24.9Mtoe, final energy consumption was 19.2Mtoe [5]. |
| **2030 target** | For energy efficiency Hungarian contribution to the EU target defined in the NECP is of a very low ambition and constitutes 30.7Mtoe of primary and 18.8Mtoe of final energy consumption in 2030 [108]. |
| **Energy savings** | [16] provides no data for energy savings in Hungary by 2020. |
| **3 Energy security and interconnection** | |
| **Interconnection** | According to the plan, the level of interconnectivity with neighbouring counties is currently at 50% of gross total installed capacity. This is significantly above the EU-level target set for 2030. Hungary plans to increase interconnectivity further, to 60% by 2030. [108] |
| **Energy security** | Hungary is a net importer of fossil fuels and electricity. Energy security objectives for electricity in the NECP are framed around the role of national assets (nuclear, renewable energy) and market integration. [108] |
| **Trade deficit** | Hungary's energy dependence remained at similar level at 2017 compared to 2005 and constituted 62% [12]. |
| | In 2018, Hungary's energy import dependency was 58% [12]. |
| | In 2021, Hungary's energy import dependency was 54% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | The operation of the wholesale electricity sector was liberalised under the Electricity Act (2007), dismantling the former public utility sector. Licensed traders are entitled to purchase electricity from generators, other traders or abroad. They are entitled to sell electricity to end-users, to other traders or abroad. Whereas earlier electricity traders were generally subsidiaries established by the DSOs to be present on the open segment of the market, since liberalisation of the market and the setup of the Hungarian Power Exchange (HUPX), the number of traders has increased. Trading is mostly undertaken through bilateral contracts, with an increasing reliance on spot trading platforms, such as HUPX. HUPX has contributed significantly to the stabilisation and decrease of electricity prices. |
| **Retail electricity market** | From 2008 (from 2009 in case of natural gas) Hungary legally opened the household market segment to the free-market traders. There were75 licensed electricity suppliers in Hungary in 2018. but the vast majority of them is not active in the households and micro- and small companies market segment. Electricity and natural gas prices are regulated for households. The Ministry of Innovation and Technology fixes the end-consumer prices with a price decree. Suppliers that do not deliver electricity or gas to households can define freely their prices. [110] |
| **Smart metering** | Total smart meter penetration rate (as of 2018) was 1% [64]. |
| | Hungary is one of the lagging countries of the smart meters' deployment in the whole EU. The missing retail competition and the politically driven household energy tariffs are challenging the business viability of investments into smart meters. [110] |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | National Research and Development and Innovation Strategy (2013-2020). There is also the Széll Kálmán Plan 2.0 of 2012, which defines the mid-term and long-term aims of the government and is aligned to the EU-2020 documents. [29] |
| | The new National Research, Development and Innovation Strategy was accepted by the Government of Hungary in 2021. The strategy prioritises R&I governance, stakeholder participation, business innovation, access to finance, skills for R&I, public research, technology transfer and commercialisation, societal challenges and specific areas, as cleantech and new industrial policy. |

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| **Smart specialisation priority areas** | 1. Clean and renewable energies<br>2. Healthy local food<br>3. Inclusive and sustainable society<br>4. Healthy society and wellbeing<br>5. Agricultural innovation<br>6. Sustainable environment<br>7. ICT and information services<br>8. Advanced technologies in the vehicle and other machine industries [18] |
| **R&I objectives related to the Energy Union** | Hungary intends to develop anenergy innovation strategy to seaport energy transition. The NECP lacks detailed figures and timelines. In terms of quantified targets, Hungary aims to have implemented at least 20 pilot innovation projects by 2030, with a minimum of 10 patents registered in the course of their implementation. [108] |
| **Involvement in the SET Plan** | Hungary is involved in ten IWGs of the SET Plan:<br>• High Voltage Direct Current (HVDC)<br>• Batteries;<br>• Carbon Capture and Storage - Carbon Capture and Utilisation (CCS-CCU);<br>• Nuclear safety. |
| **Innovation performance** | Hungary was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Hungary was an Emerging Innovator (ranking 21 of 27 in 2022 [6]. |
| **Total R&D expenditure** | R&D target: 1.8% of GDP. Expenditure on R&D increased by 0.15 percentage points to 1.35 % of GDP in 2017. Hungary needs to make further, significant efforts to meet the national target. [113] |
| | In 2017, R&D intensity in Hungary was 1.32% of GDP [13]. |
| | In 2018, R&D expenditure was 1.51% of GDP [13]. |
| | In 2021, R&D expenditure was 1.65% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.35% of GDP [13]. |
| | In 2018, the public funding level constituted 0.35% of GDP [13]. |
| | In 2021, the public funding level constituted 0.4% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2027, business expenditure in R&D was 0.96% of GDP [4]. |
| | In 2018, business expenditure in R&D was 1.14% of GDP [4]. |
| | In 2021, business expenditure in R&D was 1.24% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.245% of GDP (2019) is higher than EU average - 0.196% of GDP [109]. |
| **Academia-business links** | Cooperation with the business sector is mostly limited to large companies due to the lack of demand and capacity of smaller firms. Researchers seldom bring their results to the market. The roll-out of the 8 Higher Education and Industry Cooperation Centres (FIEKs), aimed at improving academia-business cooperation, continued in 2019. [107] |
| | In 2020, public-private scientific co-publications was 10.1% is higher than the EU average of 9.05% [109]. |
| **R&D policy coordination** | The smart specialisation strategy would benefit from being updated, reinforced and more focused. In 2017, eight university-business cooperation centres were set up with EU co-financing to foster collaboration. The centres should develop sustainable institutional operations and to run innovation projects. [113] |
| | Recent changes have increased government influence over scientific Institutions. A National Science Policy Council (NTT) was set up to advise the government on strategic issues and supervise the operation of the National Research, Development and Innovation Fund. In addition, the research institute network of the Hungarian Academy of Sciences was separated from the Academy and reorganised under the newly founded Eötvös Loránd Research Network (ELKH). Through the appointment of members to the new bodies, the government has increased its influence over the R&D field, creating uncertainty to guarantee scientific freedom. An increasing proportion of public sector researchers are considering leaving for the private sector or abroad; these intentions are particularly high among talented, young and competitive researchers. [107] |
| | Hungary has a scope for improvement by increasing the supply of high-skilled labour, raising R&D expenditure in the public sector and encouraging cooperation among potential innovators. [107] |

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| **Funding from Horizon 2020** | Hungary is among least successful countries in terms of Horizon2020 budget share per inhabitant (rank 22 out of 28), it received 0.54% of the overall Horizon 2020 funding (budget share rank is 18 out of 28) [17]. |
| **Research infrastructures roadmap** | Roadmap published in 2018 [31]. |

|  **CROATIA** | **Desk 5** |
|---|---|
| | **Responsible partner: RSE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [114] | IPE | 06.04.2020 |
| 3. | Content update from NECP [115] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [116], [117], [118] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | Energy strategy of Croatia was adopted in 2009 [119]. In May 2019, the Croatian Government proposed a new national Energy Strategy to run until 2030, including an overview to run to 2050. |
| | In 2021, Croatia adopted a long-term decarbonisation strategy [117]. |
| | In 2022, Croatia adopted a Hydrogen Strategy [118]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 11% increase in 2020 compared with 2005 [120]. |
| | Total GHG emissions in Croatia were reduced by 23.3% from 1990 to 2017. Based on the latest national projections submitted to the Commission, and considering existing measures, Croatia is expected to meet its GHG emission target by a wide margin. [120] |
| | Croatia reduced its total greenhouse gas emissions by 22.5% from 1990 to 2018. Transport remains the sector contributing the most to greenhouse gas emissions (30%), followed by industry (23%) and agriculture (13%). [114] |
| | In 2020, GHG emissions decreased by 9% relative to the 2005 levels [116]. |
| **GHG 2030 target** | Effort sharing regulation requires Hungary to reduce its non-ETS emissions by 7% by 2030 relative to 2005 levels [17]. |
| | According to the NECP, Croatia projects to achieve Effort sharing regulation 2030 target [115]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -17% by 2030 [116]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | With a renewable energy share of 28% in 2018, Croatia is well above its target (20%) for 2020 [120]. |
| | The share of renewable energy sources stagnates as Croatia adopts a more ambitious target [114]. |
| | In 2021, Croatia's share of renewable energy was 31.3%. [11] |
| **RES 2030 target** | The national contribution for renewable energy proposed in the NECP is set at an ambitious share of 36.4% of energy from renewable sources in gross final consumption of energy in 2030 [115]. This is considered as ambitious target. |
| **RES in transport** | The penetration of renewable energy in transport sector in Croatia according to Eurostat data in 2017 was 1.2 % [11], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 2.6% [11]. |
| | In 2021, the penetration of renewable energy in transport was 7% [11]. |
| **RES in electricity** | In 2021, share of RES in electricity was 46.4% [11] |
| | In 2021, share of RES in electricity was 48.1% [11]. |

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| | In 2021, share of RES in electricity was 53.5% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 10.7Mtoe expressed in primary energy consumption and 7Mtoe expressed in final energy consumption [18]. |
| | Croatia's primary and final energy consumption remains below the country's 2020 energy efficiency targets: 8Mtoe (primary energy consumption, 2016) and 6.6Mtoe (final energy consumption, 2016) [120]. |
| | Croatia's primary and final energy consumption remains below its 2020 energy efficiency targets: 8.2Mtoe (primary energy consumption, 2018); 6.9 Mtoe (final energy consumption, 2018) [114]. |
| | In 2021, primary energy consumption was 8.3Mtoe, final energy consumption was 7Mtoe [5]. |
| **2030 target** | The energy efficiency contribution defined in the NECP to the EU-level target for 2030 is of low ambition and amounts to 6.9Mtoe of final energy consumption and 8.2Mtoe of primary energy consumption in 2030 [115]. |
| **Energy savings** | [16] provides no data for energy savings in Romania by 2020. |
| **3 Energy security and interconnection** | |
| **Interconnection** | The interconnection level of Croatia (30%) exceeds the 15% EU level aimed for 2030 and further interconnectors with neighbouring states are considered as part of Croatia's role as an important link between electricity systems of Central and South East Europe in the development of the internal energy market [115]. |
| **Energy security** | The Projects of Common Interest currently being developed, in particular the Krk LNG terminal and the SINCRO large-scale smart grid project, are essential to Croatia's security of supply of electricity and gas [120]. |
| | The "Clean Energy for EU Islands Initiative" was launched in May 2017 with the aim of helping islands and their inhabitants to generate their own sustainable low-cost energy, to embrace renewable energy, create jobs and economic growth and reduce greenhouse gas emissions. Four island communities in Croatia (Cres/Lošinj, Hvar, Korčula and Brač) were selected to participate in a pilot project. For these unique territories investing in renewable sources would reduce the island's energy dependency from the mainland, especially in summer months when consumption is highest. [114] |
| | According to the Croatian NECP, energy security objectives are: ensure a lasting, secure and quality supply of all energy-generating products; diversification of supply routes of energy and energy-generating products; increasing gas and energy storage capacity in the energy system; increasing the flexibility (and thus resilience) of energy systems; protection of critical infrastructure and mitigating risks related to cyber security and climate change. [115] |
| **Trade deficit** | Croatia's energy dependence remained at similar level and constituted 53% in 2005 and 2017 [12]. |
| | In 2018, Croatia's energy import dependency was 53% [12]. |
| | In 2021, Croatia's energy import dependency was 55% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | Wholesale trading has been opened up to competition and is based on free-market, negotiated prices. The electricity traders typically conclude the following agreements on the wholesale market: electricity transmission or distribution agreement; electricity purchase agreement; and balancing energy agreement. |
| **Retail electricity market** | Starting from 2016, energy price regulation for households for electricity has been phased out [120]. |
| **Smart metering** | Despite positive cost benefit analysis Croatia has not yet affirmed the plan and programme of measure to introduce smart meters for end consumers. Total smart meter penetration rate (as of 2018) was 2.3%. [64]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | Several national strategies shape the development of the national innovation system. The Strategy for Education, Science and Technology6 (SECT) sits at the centre of this heterogeneous policy framework. Additional references include the Strategy for fostering innovation 2014-2020 and the Industrial Strategy (2014). [29] |
| **Smart** | 1. Energy and Sustainable Environment |

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| **specialisation priority areas** | 2. Transport and Mobility<br>3. Security<br>4. Health and Quality of Life<br>5. Food and Bio-economy [18] |
| **R&I objectives related to the Energy Union** | Croatia has no specific national 2050 targets for deploying low-carbon technologies [115]. |
| **Involvement in the SET Plan** | Croatia is involved in two IWGs of the SET Plan:<br>• Batteries;<br>• Nuclear safety. |
| **Innovation performance** | Croatia was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Croatia was an Emerging Innovator (ranking 22 of 27 in 2022 [6]. |
| **Total R&D expenditure** | Croatian national target is of 1.4% of GDP [120]. |
| | In 2017, R&D expenditure was 0.85% of GDP [13]. |
| | In 2018, R&D expenditure was 0.95% of GDP [13]. |
| | In 2021, R&D expenditure was 1.24% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.44% of GDP [13]. |
| | In 2018, the public funding level constituted 0.49% of GDP [13]. |
| | In 2021, the public funding level constituted 0.66% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.46% 0.41% of GDP [4]. |
| | In 2018, business expenditure in R&D was 0.46% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.58% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.038% of GDP (2019) is very limited compared to EU average - 0.196% of GDP [116]. |
| **Academia-business links** | The legal autonomy enjoyed by university faculties lead to low cooperation across universities (both within and outside the country, as well as with the business sector) and hinder interdisciplinary research. A draft law on science and higher education in Croatia aims to reform the system by introducing measures to recognise and reward research excellence and it would bring in a new system of university governance, expand performance-based funding to include science-business cooperation as an assessment criterion and spell out guidelines for research ethics. [114] |
| | In 2020, public-private scientific co-publications was 8.1% close to the EU average of 9.05% [116]. |
| **R&D policy coordination** | Lack coordination and effective management in R&I policies leads to poor targeting and inadequate prioritisation of support instruments. In addition, some of the undertaken reforms of public research institutes and universities remain unfinished. [120] |
| | Investment in R&D increased substantially, but its efficiency remains low and highly dependent on EU funds. Investment is focused towards 'close–to-market' initiatives run by bigger companies, leaving research activities underfunded [114]. |
| | Croatian companies are concentrated in low- to medium-tech sectors, and government support to R&D-based innovative firms is lacking. State-owned Enterprises lack incentives for competition through innovation and research. Croatian firms, especially smaller and younger companies, indicate a positive link between R&D-based innovation and productivity growth. Nonetheless, government support programmes are heavily skewed towards helping mature and larger companies, with less support given to diversification and new ventures. In addition, many support programmes are overcomplicated and poorly adapted to business needs. [114] |
| **Funding from Horizon 2020** | Croatia is among least successful countries in terms of Horizon2020 budget share per inhabitant (rank 24 out of 28), it received 0.2% of the overall Horizon 2020 funding (budget share rank is 24 out of 28) [17]. |
| **Research infrastructures roadmap** | National roadmap with identified ESFRI projects was published in 2014 [31]. |

|  **ITALY** | **Desk 5** |
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| | **Responsible partner: RSE** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
| 2. | Content update from [11], [12], [13], [14], [121] | IPE | 06.04.2020 |
| 3. | Content update from NECP [122] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [123], [124] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | The National Energy Strategy (SEN) [125] defines the national energy targets to drive the energy transition. The SEN is closely coordinated with the European Strategic Energy Technology Plan (SET Plan) and is complemented by the Integrated National Energy and Climate Plan [126]. The plan sets the energy scenario towards 2030, fostering a wide-ranging transformation in which the combination of decarbonisation, circular economy, efficiency and rational and fair use of natural resources represent objectives and instruments for the future of the economy. |
| | Published by the Ministry of Economic Development, the National Hydrogen Strategy Preliminary Guidelines set the vision and targets for hydrogen penetration toward a decarbonized and sustainable economy [124] |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is 13% decrease in 2020 compared with 2005 [126]. |
| | According to the projections submitted in 2017, Italy is on track to meet its 2020 GHG emission target. In 2017, according to preliminary data, emissions were reduced by 20% from 2005 [126]. |
| | According to the projections submitted in 2019, by 2020 Italy will have reduced its emissions by 20%, therefore overachieving its target [121]. |
| | In 2020, GHG emissions decreased by 24% relative to the 2005 levels [123]. |
| **GHG 2030 target** | Effort sharing regulation requires Hungary to reduce its non-ETS emissions by 33% by 2030 relative to 2005 levels [17]. |
| | According to the NECP, planned 2030 GHG emission reduction could reach 34.6% [122]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -44% by 2030 [123]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | RES target for 2020 in gross final consumption 17% with a renewable energy share of 18.3 %. In 2017, Italy is well above the trajectory to reach its 2020 renewable energy target. [126] |
| | With a renewable energy share of 17,78% in 2018, Italy remains above its 2020 renewable energy target [122]. |
| | In 2021, Italy's share of renewable energy was 19%. [11] |
| **RES 2030 target** | The NECP proposed contribution expressed as 30% share of energy from renewable sources in gross final consumption of energy in 2030, is slightly above the share that results from the formula in Annex II of the Governance Regulation. [122] |

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| **RES in transport** | The penetration of renewable energy in transport sector in Italy according to Eurostat data in 2017 was 6.5 % [11], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 7.7% [11]. |
| | In 2021, the penetration of renewable energy in transport was 10% [11]. |
| | Italy has recently set a target of 6 million electric cars by 2030 [122]. |
| **RES in electricity** | In 2018, share of RES in electricity was 33.9% [11]. |
| | In 2017, share of RES in electricity was 34.1% [11]. |
| | In 2021, share of RES in electricity was 36% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 158Mtoe expressed in primary energy consumption and 124Mtoe expressed in final energy consumption [18]. |
| | After the growth of both primary and final energy consumption in the period 2013-2014, energy consumption in the country decreased between 2015 and 2016. However primary energy consumption registered again a small increase, moving from 148.0Mtoe in 2016 to 148.9Mtoe in 2017. Final energy consumption decreased slightly from 115.9Mtoe in 2016 to 115.2Mtoe in 2017. In light of the possible economic recovery in Italy and of the recent upward trend in primary energy consumption, further efforts are however needed both to remain within the levels set for the 2020 energy efficiency target and in view of the new 2030 objectives. [126]. |
| | Primary energy consumption registered a small decrease, moving to 147.5Mtoe in 2018. However, final energy consumption increased slightly to 116.5Mtoe in 2018. [121] |
| | In 2021, primary energy consumption was 145.3Mtoe, final energy consumption was 113.3Mtoe [5]. |
| **2030 target** | The Italian contribution to the collective 2030 EU target is considered sufficient and amounts to 125.1Mtoe for primary energy and 103.8Mtoe for final energy consumption [122]. |
| **Energy savings** | In 2020, Italy has reached 91% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | Interconnection capacity is currently primarily located at the country's northern border (4 lines with France, 12 with Switzerland, 2 with Austria, 2 with Slovenia). In total, there are 7 circuits at 380kV, 9 circuits at 220 kV and 3 circuits at 150/132kV on the northern border. There is also a direct current connection with Greece and one that connects Sardinia and the peninsula with Corsica. Sardinia is also connected to Corsica by an alternating current cable. A 220kV double circuit cable connects Sicily with Malta. [126] |
| | According to the NECP, Italy's interconnectivity level in 2030 will reach 10% [122]. |
| **Energy security** | In terms of security of supply, the aim is, on the one hand, to become less dependent on imports by increasing renewable sources and energy efficiency and, on the other hand, to diversify sources of supply. The NECP aims at reducing the level of dependency (from 77.7% in 2016 to 75.4% in 2030 and to 74.6% in 2040) and sets out levels for additional storage (almost 1000 MW by 2023, split between hydroelectric and electrochemical production, and 6 000 MW in addition to 4 000 MW distributed storage by 2030). [122] |
| **Trade deficit** | The Italy energy dependence decreased from 83% in 2005 to 77% in 2017 [12]. |
| | In 2018, Italy's energy import dependency was 46% [12]. |
| | In 2021, Italy's energy import dependency was 74% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | GME (Italian Energy Markets Operator) operates power, gas and environmental markets. On the power market platform managed by GME (also known as Italian Power Exchange, IPEX), producers and purchasers sell and buy wholesale electricity. GME has been nominated as NEMO for the day-ahead and intraday markets in Italy. |
| **Retail electricity market** | Law no.125 of 3rd August 2007, completed the liberalization of the retail market and at the same time instituted the standard offer service, regulated by the Authority, and intended for domestic customers and small businesses who do not choose a vendor in the open market. The standard offer service has two purposes: to ensure, on the one hand, the continuity of the electricity service (universal service function) and, on the other, a specific contractual quality at reasonable prices (price control function). [127] |

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| | The phasing out of regulated tariffs in the energy sector has again been postponed until 2022 (they were supposed to enter into force mid-2020, following another postponement from mid-2019) [121]. |
| **Smart metering** | Total smart meter penetration rate (as of 2018) was 98.5%. [64]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | Single overarching strategy: National Research Programme 2014-2020 (approved in 2016) [29]. |
| | The National Research Program 2021-2027 is the document that guides research policies in Italy. Strategy mainly prioritises R&I governance, public research capabilities, specific areas as new industrial policy, clean tech, clusters and regional support, social challenges, environmental challenges, international cooperation, digitalisation. |
| | In 2020 Italian Ministry of Education, Universities and Research published Strategy for hydrogen research. |
| **Smart specialisation priority areas** | Smart specialisation priority areas are defined at regions level, no information in country level available on [18]. |
| **R&I objectives related to the Energy Union** | The final NECP confirms the objective to double the public funds for research into clean energy, from around EUR 222 million in 2013 to the approximately EUR 444 million from 2021. The overall R&I target is a 1.53% of GDP by 2020. R&I priorities mostly relate to renewables, storage (including hydrogen, power to gas), the integration of renewables within the energy system, the devices for the security of the electrical system, e-mobility, bio-refineries, materials processes and systems for the energy efficiency in the industry and in buildings. [122] |
| **Involvement in the SET Plan** | Italy is involved in all IWGs of the SET Plan and is chairing the IWG on Ocean energy and co-chairing IWGs on Deep geothermal energy, Energy Systems, Renewable fuels and bioenergy. |
| **Innovation performance** | Italy was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Italy remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | R&D target: 1,53% of GDP Italy is not on track to meet its EU2020 target, as, R&D intensity would need to grow at more than double the growth rate of the current trend. [126]. |
| | In 2017, R&D expenditure was 1.37% of GDP [13]. |
| | In 2018, R&D expenditure was 1.42% of GDP [13]. |
| | In 2021, R&D expenditure was 1.49% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.49% of GDP. |
| | In 2018, the public funding level constituted 0.5% of GDP. |
| | Public R&D expenditure reached 0.5% of GDP in 2018, the second lowest level among EU15 countries [121]. |
| | In 2021, the public funding level constituted 0.55% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.85% of GDP [4]. |
| | In 2018, business expenditure in R&D was 0.9% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.91% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.246% of GDP (2018) is higher than the EU average - 0.196% of GDP [123]. |
| **Academia-business links** | Regional differences exist. R&I in the southern regions are mainly supported by programmes co-financed through EU Structural Funds, but they are not able to reverse the gap in R&I. This is mainly because the enterprise base in the South is weak and its demand for innovation is scarce. No significant measures have been taken to address this challenge. Since 2017 most of the R&D growth is due to the activity of new firms investing in R&D, while firms that were already R&D performers recorded stable expenditure. [121] |
| | In 2020, public-private scientific co-publications was 8.26% close to the EU average of 9.05% [123]. |

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| **R&D policy coordination** | The public R&D is coordinated by the ministry of economic development (MiSe) together with the ministry of education, universities and research (MIUR). Public schemes supporting innovative investment remain temporary and still lack an in-depth assessment of their efficiency. R&D tax incentives generally have a positive but modest effect on investment in intangibles. [126] |
| | The previous plan Impresa 4.0 (National Industry 4.0 Plan) has been renamed Transizione 4.0, to signal the new focus on green investment in addition to innovation. Tax incentives to promote investment in physical and intangible capital have been extended for the next years and transformed into a tax credit, which could increase the number of beneficiary firms by up to 40%. The new tax credit also intends to support the circular economy and environmental sustainability, and spending in skills enabling the digital transition. Investment in key technologies, such as Artificial Intelligence and cybersecurity, has been announced in the National Innovation Plan 2025, next to key initiatives in the field of High-Performance Computing. [121] |
| **Funding from Horizon 2020** | Italy has moderate success in terms of Horizon2020 budget share per inhabitant (rank 18 out of 28) despite high participation rate (rank 4 out of 28). Italy received 8.34% of the overall Horizon 2020 funding (budget share rank is 5 out of 28) [17]. |
| **Research infrastructures roadmap** | Roadmap published in 2011, updated in 2017 [31]. |

|  **IRELAND** | **Desk 6** |
|---|---|
| | **Responsible partner: UCD, IERC** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" within D6.1 *"Review of EU strategic priorities and relevant policy developments*" | IPE | 31.05.2019 |
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| 3. | Content update from NECP [129] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [130], [131], [132] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1 Climate action, decarbonising the economy** | |
| **1.1 Decarbonization and energy strategies** | |
| **National energy related strategies** | The Government's energy White Paper (2015) [133] sets out a framework for energy policy to 2030 and outlines a transition to a low carbon energy system for Ireland by 2050. In 2018 government of Ireland launched a Project Ireland 2040 and published the National Development Plan 2018-2027 [134]. |
| | In 2021, launched the new National Development Plan 2021-2030 [130] with particular focus on priority solutions to strengthen housing, climate ambitions, transport, healthcare, jobs growth and economic renewal. Moreover, specific topics, as digitalisation, renewable heat, energy efficiency, etc. are covered in separate strategic documents. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is 20% decrease in 2020 compared with 2005 [135]. |
| | National projections indicate that cumulated emissions (on the basis of existing measures) over the 2013-2020 compliance period will exceed allocations and that emissions in 2020 will be around their 2005 level, i.e. 20 percentage points short of the reduction target [135]. |
| | National projections indicate that cumulated emissions (on the basis of existing measures) over the 2013-2020 compliance period will exceed allocations and that emissions in 2020 will be only about 5% lower than the 2005 level, i.e. around 15 percentage points short of the reduction target [128]. |
| | In 2020, GHG emissions decreased by 6% relative to the 2005 levels [131]. |
| **GHG 2030 target** | Effort sharing regulation requires Hungary to reduce its non-ETS emissions by 30% by 2030 relative to 2005 levels [17]. |
| | Not reaching 2020 target meant that Ireland will need to buy allocations from other Member States in surplus in order to comply with the Effort Sharing Decision and it will put Ireland in a difficult starting position for the 2021-2030 compliance period under the Effort Sharing Regulation [135]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -42% by 2030 [131]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | Ireland will miss its 16% target and reach a minimum of 12.3% and maximum of 14.3% by 2020 [135]. |
| | National projections indicate that Ireland's overall achievement approximately 13% in 2018 [128]. |
| | In 2021, Ireland's share of renewable energy was 12.5%. [11] |

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| **RES 2030 target** | NECP sets the ambition levels of achieving a 34% share of renewable energy in energy consumption by 2030 [129]. |
| **RES in transport** | In 2017 RES in transport stood at 7.4%, compared to the 2020 target of 10% [135]. |
| | In 2018, the penetration of renewable energy in transport was 7.2% [11]. |
| | The penetration of renewable energy in transport decreased from 10.2% in 2020 to 4.3% in 2021 [11] |
| **RES in electricity** | In 2021, share of RES in electricity was 30.3% [11]. |
| | In 2018, share of RES in electricity was 33.3% [11]. |
| | In 2021, share of RES in electricity was 36.4% [11]. |
| **2 Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 13.9Mtoe expressed in primary energy consumption and 11.7Mtoe expressed in final energy consumption [18]. |
| | In 2017, primary energy consumption was 14.4Mtoe, final energy consumption was 11.9Mtoe [5]. |
| | In 2018, primary energy consumption was 14.6Mtoe, final energy consumption was 12.4Mtoe [5]. |
| | In 2021, primary energy consumption was 13.9Mtoe, final energy consumption was 11.4Mtoe [5]. |
| **2030 target** | The Ireland's contribution to the collective 2030 EU target is considered of low ambition and amounts to 13.7Mtoe for primary energy consumption and 11.2Mtoe for final energy consumption [129]. |
| **Energy savings** | In 2020, Ireland has reached 121% of total cumulative savings required by 2020 [16]. |
| **3 Energy security and interconnection** | |
| **Interconnection** | Ireland's geographical location brings challenges in terms of interconnection with neighbouring countries. Ireland is exclusively connected to the United Kingdom through two electricity interconnectors. Diversification of energy interconnections is key to reducing Ireland's energy import dependency and supporting the integration of renewable power. Two projects have been identified as EU Projects of Common Interest: the Celtic interconnector toFrance and the Greenlink interconnector to UK. [135] |
| **Energy security** | Maintaining a high level of security of supply is a priority in the ongoing transformation of Ireland's energy system, with an objective to achieve an electricity system that is 70% renewable by 2030 and increase the share of domestic renewable energy. The United Kingdom's expected withdrawal from the EU comes across as a key risk for Ireland but due to ongoing uncertainty, the exact impact on market functioning is not yet known. [129] |
| | Ireland set out a new, increased renewable electricity target of 80% by 2030, which roughly doubles the share within the next decade [131]. |
| **Trade deficit** | Ireland was the 10th most energy dependent EU Member State in 2016, importing 69% of the energy it consumed, a sharp decline from 2005 when it imported 90% (4th most dependent). This consumption level further declined to 67% in 2017. [12] |
| | In 2018, Ireland's energy import dependency was 68% [12]. |
| | In 2021, Ireland's energy import dependency was 77% [12]. |
| **4 Integrated electricity market** | |
| **Wholesale electricity market** | In Ireland, the all-island wholesale Single Electricity Market (SEM) has been in place since 2007. It is regulated by the SEM Committee. The Integrated Single Electricity Market between Ireland and Northern Ireland went live in October 2018. The Integrated Single Electricity Market is key to a real all-island market in line with EU market rules. [135]. |
| **Retail electricity market** | Electricity supply was fully deregulated in Ireland in 2011, customers can choose between suppliers who are free to compete with their own prices. |
| **Smart metering** | In 2018 no smart meters were installed [64].<br>The electricity smart metering roll-out, scheduled to begin in 2019 [135]. |
| **5 Research, innovation and competitiveness** | |
| **R&I strategy** | Single overarching strategy: Strategy for research and development, science and technology, 2016-2020 (Innovation 2020) [29]. |

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| | The cross-government strategic framework Future Jobs Ireland was launched in 2019 to define a new economic pathway for Ireland. This framework aims to support innovation and technological change, improve the small and medium enterprises (SME) productivity, enhance skills, increase labour force participation and smooth the transition to a low carbon economy. [128] |
| | A new strategy "Impact 2030: Ireland's Research and Innovation Strategy", adopted in 2022, puts R&I at the heart of addressing Ireland's social, economic and environmental challenges [132]. |
| **Smart specialisation priority areas** | 1. Future Networks & Communications<br>2. Innovation in Services & Business Processes<br>3. Processing Technologies & Novel Materials<br>4. Manufacturing Competitiveness<br>5. Smart Grids & Smart Cities<br>6. Marine Renewable Energy<br>7. Sustainable Food Production & Processing<br>8. Food for Health<br>9. Therapeutics – Synthesis, Formulation, Processing & Drug Delivery<br>10. Diagnostics<br>11. Medical Devices<br>12. Connected Health & Independent Living<br>13. Digital Platforms, Content & Applications<br>14. Data Analytics, Management, Security & Privacy [18] |
| **R&I objectives related to the Energy Union** | Ireland's national development plan launched four new 'Project Ireland 2040' funds, with EUR 4 billion over a ten-year period. One of the four, the Climate Action Fund, will be fully dedicated to activities relevant to Ireland's NECP. A detailed technology analysis will assist with prioritising the targeting of energy R&I investment so as to achieve targets in 2030 and 2050. [129]<br>The production and use of hydrogen are expected to have a key role to play in Ireland's transition to a low carbon economy and society. [129] |
| **Involvement in the SET Plan** | Ireland is involved in eight IWGs of the SET Plan:<br>• Offshore wind energy;<br>• Deep geothermal energy;<br>• Ocean energy;<br>• High Voltage Direct Current (HVDC)<br>• Energy systems;<br>• Energy efficiency in buildings;<br>• Energy efficiency in industry;<br>• Batteries. |
| **Innovation performance** | Ireland continue to improve in international innovation rankings, most recently climbing from 10th place in 2013 to 8th place in 2015 in the EU Innovation Union Scoreboard. Ireland is a Strong Innovator [30]. |
| | According to new methodology Ireland remained a Strong Innovator in 2022 climbing at 6th place [6]. |
| **Total R&D expenditure** | Ireland committed to increasing public and private investment in R&D to reach Ireland's intensity target of 2.5% of GNP by 2020 [129] |
| | In 2017, R&D intensity reached 1.25% of GDP [13]. |
| | In 2018, R&D expenditure was 1.17% of GDP [13]. |
| | In 2021, R&D expenditure was 1.06% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.29% of GDP [13]. |
| | In 2018, the public funding level constituted 0.29% of GDP [13]. |
| | In 2021, the public funding level constituted 0.23% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.93% of GDP [4]. |
| | In 2018, business expenditure in R&D was 0.85% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.84% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.213% of GDP (2018) is higher than the EU average - 0.196% of GDP [131]. |
| **Academia-business links** | Cooperation between firms and public research centres continues to develop but faces challenges. The first two calls for collaborative project proposals under the Disruptive |

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| | Technologies Innovation Fund in 2018 and 2019 allocated €140 million for 43 projects involving collaborative partnerships (comprising of 159 organisations) between industry and SMEs, and public research bodies, in applying industrial research under the six themes of the revised Research Priority Areas, in areas such as health, climate action, food, ICT and manufacturing. Also, Innovation 2020 aims to double private funding of R&D in the higher education sector to €48 million by 2020. However, although collaboration between Science Foundation Ireland (SFI) and the business sector rose between 2013 and 2017, an increasing share of this collaboration has gone to multinational firms while the share of SMEs has declined. [128] |
| | In 2020, public-private scientific co-publications was 9.1% a bit higher than the EU average of 9.05% [131]. |
| **R&D policy coordination** | Foreign firms operating in Ireland tend to benefit more from public sector R&D support. Stronger linkages between multinationals and domestic firms could help improve the diffusion of innovation throughout the economy. In addition, cooperation between firms and public research centres is improving although much work lays ahead in this area. New initiatives are being launched to foster business research and innovation. [135] |
| | While there are many strong elements in Ireland's research and innovation system, some weaknesses need to be addressed. In particular, this concerns the amount of R&D funding, the structure of public support for business R&D and cooperation between firms and research bodies [128]. |
| | While the R&D tax credit provides valuable support, more priority for direct funding instruments could help stimulate research and innovation and improve productivity of Irish firms especially SMEs [128]. |
| **Funding from Horizon 2020** | Ireland is among successful countries in terms of Horizon2020 budget share per inhabitant (rank 7 out of 28), it received 1.76% of the overall Horizon2020 funding (budget share rank is 13 out of 28) [17]. |
| **Research infrastructures roadmap** | National roadmap with identified ESFRI projects was published in 2007 [31]. |

|  **PORTUGAL** | **Desk 6** |
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| | **Responsible partner: UCD** |

**Document history:**

| No. | Content / Changes | Partner | Date |
|---|---|---|---|
| 1. | Development of "Progress towards the Energy Union objectives" | IPE | 18.03.2020 |
| 2. | Content update from [11], [12], [13], [14], [136] | IPE | 06.04.2020 |
| 3. | Content update from NECP [137] | IPE | 18.01.2021 |
| 4. | Content update from [11], [12], [13], [14], [16], [6], [17], [18], [138], [139], [140] | IPE | 18.04.2023 |

| Category | Description |
|---|---|
| **1. Climate action, decarbonising the economy** | |
| **1.1 Decarbonisation and energy strategies** | |
| **National energy related strategies** | Portugal's "Roadmap for Carbon Neutrality 2050" main objective is to identify and analyse the implications associated with technically feasible, economically viable and socially accepted alternative trajectories, thus allowing the Portuguese economy to reach the objective of carbon neutrality by 2050 [141]. |
| | Portugal has developed a 7 billion EUR National Hydrogen Strategy, aiming at increasing the share of hydrogen in the final energy consumption to 5% by 2030 [139]. |
| **GHG 2020 target** | Non-ETS GHG emission reduction target is maximum 1% increase in 2020 compared with 2005 [141]. |
| | According to the latest national projections based on existing measures, non-ETS emissions will decrease by 17 % between 2005 and 2020 [141]. |
| | In 2020, GHG emissions decreased by 19% relative to the 2005 levels [139]. |
| **GHG 2030 target** | Effort sharing regulation requires Hungary to reduce its non-ETS emissions by 17% by 2030 relative to 2005 levels [17]. |
| | Portugal plans a total GHG emission reduction compared to 2005 of -45% to -55% in 2030 [137]. |
| **"Fit for 55"** | The revision of Effort Sharing Regulation in-line with "Fit for 55" includes new non-ETS GHG emission reduction target: -29% by 2030 [131]. |
| **1.2 Uptake of RES** | |
| **RES 2020 target** | Portugal is above the indicative trajectory to meet its 2020 binding target of 31% renewables share in final energy consumption [141].<br>In 2017, Portugal's share of renewable energy was 30.6% [11]. |
| | In 2018, Portugal's share of renewable energy was 30.2% [11]. |
| | In 2021, Portugal's share of renewable energy was 34% [11]. |
| **RES 2030 target** | In the NECP, Portugal has set a contribution to the EU renewable energy target of at least 47% in gross final consumption of energy for 2030, significantly above the 42% share that results from the formula of Annex II of the Governance Regulation [137]. |
| **RES in transport** | The penetration of renewable energy in transport sector in Portugal in was 2017 was 7.9% [11], whereas 2020 target is 10%. |
| | In 2018, the penetration of renewable energy in transport was 9% [11]. |
| | In 2021, the penetration of renewable energy in transport was 8.6% [11]. |
| **RES in electricity** | In 2017, share of RES in electricity was 54.2% [11]. |
| | In 2018, share of RES in electricity was 52.2% [11]. |
| | In 2021, share of RES in electricity was 58.4% [11]. |
| **2. Energy Efficiency** | |
| **Energy consumption** | Indicative energy efficiency target for 2020: 22.5Mtoe expressed in primary energy consumption and 17.4Mtoe expressed in final energy consumption [18]. |

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| | In 2017, Portugal's primary energy consumption was 1.3% higher than the target level (22.8Mtoe). Regarding the final energy consumption, Portugal seems to be 4.9% below the target for 2020 (16.6Mtoe). Portugal still need efforts to keep energy consumption in check in the coming years and ensure that the levels of primary and final energy consumption remain below the indicative national 2020 targets [141]. |
| | In 2021, primary energy consumption was 22.7Mtoe, final energy consumption was 16.9Mtoe [5]. Therefore, Portugal still need efforts to keep energy consumption in check in the coming years and ensure that the levels of primary and final energy consumption remain below the indicative national 2020 targets [136]. |
| | In 2021, primary energy consumption was 19.5Mtoe, final energy consumption was 15.7Mtoe [5]. |
| **2030 target** | The contribution to the EU-level 2030 target is of modest ambition and amounts to 21.5Mtoe of primary energy consumption, translating into 14.9 of final energy consumption [137]. |
| **Energy savings** | In 2020, Portugal has reached 74% of total cumulative savings required by 2020 [16]. |
| **3. Energy security and interconnection** | |
| **Interconnection** | The planned interconnection level by 2030 is 15% (10% in 2020), with a focus on implementing key infrastructure projects, notably projects of common interest and several grid reinforcement projects to accommodate further renewables capacity [137]. |
| **Energy security** | Portugal has notably set the objective of reducing energy import dependency to 65% by 2030, which is quite ambitious [137]. |
| **Trade deficit** | Portugal's energy dependence fell from 89% in 2005 to 72% in 2017 [12]. |
| | In 2018, Portugal's energy import dependency was 76% [12]. |
| | In 2021, Portugal's energy import dependency was 67% [12]. |
| **4. Integrated electricity market** | |
| **Wholesale electricity market** | Electricity is traded between generators and suppliers in the common Iberian electricity market, MIBEL. The Iberian Electricity Market – MIBEL resulted from the cooperation between the Portuguese and Spanish Governments with the aim of promoting the integration of both countries' electrical systems. OMIE is the nominated electricity market operator (NEMO) for managing the Iberian Peninsula's day-ahead and intraday electricity markets. |
| **Retail electricity market** | The liberalisation of the electricity sector in Mainland Portugal has progressed gradually, with the liberalised market consolidating its position, mainly due to the process of extinguishing regulated tariffs that, in January of 2013, started to cover all the clients, including household customers [142] |
| **Smart metering** | Total smart meter penetration rate (as of 2018) was 25%. [56]. |
| **5. Research, innovation and competitiveness** | |
| **R&I strategy** | Since the late 1980s, the R&I strategies have built on European Union Support Frameworks (CSF), which shape the R&I policy measures toolkit and the required financial commitments. The CSF currently in place, Portugal 2020, covers the period 2014-2020 and includes four thematic areas and seven regional programmes. [29] |
| | PERIN (Portugal in Europe Research and Innovation Network) Strategy 2021 – 2027 aims at reinforcing and double Portugal's participation within the framework of the Multiannual Financial Framework 2021-2027, and promoting the use of Structural Funds as a national counterpart in all instruments providing for co-financing. The main objectives are:<br>• Double, in 2021-2027, the Portuguese participation in European Union funding Programmes;<br>• Attract around two billion euros for Research and Innovation in 2021-2027;<br>• Tripling the number of students in mobility in Higher Education, compared to 2014-2020. [140] |
| **Smart specialisation priority areas** | Portugal is one of several countries which has defined 2027-2030 priorities.<br>1. Great Natural Resources - Forest, Sea & Space<br>2. Green Transition<br>3. Materials, Systems and Production Technologies<br>4. Digital Transition<br>5. Health, Biotechnology and Food Systems<br>6. Society, Creativity and Cultural Heritage [18] |

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| **R&I objectives related to the Energy Union** | Portugal has also established sub-targets for investments of 0.2% of GDP in research and innovation in energy, and 0.2% of GDP in research and innovation in water and climate, by 2030. Portugal is committed to develop actions to ensure its leadership in the deployment of renewable energy sources and new low carbon technological solutions. The NECP identifies relevant areas for research and innovation in national programmes: (i) energy management smart systems and new infrastructures; (ii) energy storage; (iii) low-carbon technologies; (iv) energy efficiency; (v) hydrogen as an energy carrier. [137] |
| **Involvement in the SET Plan** | Portugal is involved in ten IWGs of the SET Plan:<br>• Concentrated solar power/Solar thermal electricity;<br>• Offshore wind energy;<br>• Deep geothermal energy;<br>• Ocean energy;<br>• High Voltage Direct Current (HVDC)<br>• Positive energy districts;<br>• Energy efficiency in buildings;<br>• Energy efficiency in industry;<br>• Batteries;<br>• Renewable fuels and bioenergy. |
| **Innovation performance** | Portugal was a Moderate Innovator in 2019 [30]. |
| | According to new methodology Portugal remained a Moderate Innovator in 2022 [6]. |
| **Total R&D expenditure** | The government's goal is to reach an R&D intensity of 1.8 % of GDP by 2020 [141]. |
| | A 2018 resolution adopted by the Portuguese government established the pillars for a national strategy on 'technological and business innovation' that includes revised targets for public and private investment in R&D: 3% R&D intensity by 2030 with an ambitious share of one third public and two thirds business driven [141]. |
| | In 2017, R&D expenditure was 1.32 % of GDP [13]. |
| | In 2018, R&D expenditure was 1.24% of GDP [13]. |
| | In 2021, R&D expenditure was 1.66% of GDP (EU average – 2.23%) [13]. |
| **Public R&D expenditure** | In 2017, the public funding level constituted 0.67% of GDP [13]. |
| | In 2018, the public funding level constituted 0.69% of GDP [13]. |
| | In 2021, the public funding level constituted 1% of GDP (EU average – 0.75%) [13]. |
| **Business expenditure in R&D** | In 2017, business expenditure in R&D was 0.63% of GDP [4]. |
| | In 2018, business expenditure in R&D was 0.63% of GDP [4]. |
| | In 2021, business expenditure in R&D was 0.64% of GDP (EU average – 1.49%) [4]. |
| | Public support for business enterprise expenditure on R&D of 0.264 % of GDP (2018) is higher than the EU average - 0.196% of GDP [139]. |
| **Academia-business links** | Portugal is supporting internationalisation and science-business cooperation in the circular economy and improving the implementation of its national and regional smart specialisation strategies. However, as concerns the latter, cooperation between the national and regional levels, along with a lack of smart specialisation skills among public and private actors, lead to governance bottlenecks. [136] |
| | In 2020, public-private scientific co-publications was 5.5% below the EU average of 9.05% [139]. |
| **R&D policy coordination** | Mutual trust between academia and business is not wide-spread, entrepreneurial research is not incentivised and knowledge transfer is not duly considered. To improve framework conditions for collaboration, Portugal has launched Interface Programme. Collaborative Laboratories were identified under the Interface scheme and the country's cluster policy was strengthened in 2017 to cover advanced technological sectors in the Competitiveness Clusters initiative. Moreover, 'Portugal 2020' launches call for co-promotion projects, establishing joint research and innovation centres, demonstration projects and pilot lines. [141] |
| **Funding from Horizon 2020** | Portugal is a moderate performer in terms of Horizon2020 budget share per inhabitant (rank 17 out of 28), it received 1.69% of the overall Horizon2020 funding (budget share rank is 14 out of 28) [17]. |
| **Research infrastructures** | National roadmap with identified ESFRI projects was published in 2014 [31]. |

## 7.2 List of Figures



## 7.3 List of Tables

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