Smart strategies for the transition in coal intensive regions

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Roadmap for the Region of Western Macedonia

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Contents

1 Introduction

The present report D6.4 of the TRACER Project consists of an analytical Roadmap addressing the energy related R&I and skills/training for the Region of Western Macedonia. The produced Roadmap consists of a tool on how to implement, initially until the year 2030 and as a next step until 2050, the provisions of:

a) the projections for the transition to 2030/2050 and the corresponding developed R&I strategies in all the target regions of TRACER project (Deliverable D6.1), and

b) the agreed strategies for re-skilling and re-training of the local workforce in the target regions (Deliverable D6.2).

The elaboration of the Roadmap has been established by accomplishing the three following steps:

1. The Research & Innovation strategy in the field of energy for the Western Macedonia Region, which has been clearly formulated in the frame of deliverable D6.2 - in the previous stages of the project - has led to a prioritization of the most crucial energy technologies to be included in the Roadmap. This prioritization has also been used as the base for the decision on / selection of the corresponding workforce that will need to be re-trained (presented in deliverable D6.3 - Report on strategies for re-skilling and re-training of the local workforce for the energy transition).
2. The process to be used in the Roadmap's development has been determined. More specifically, the major axes needed to accomplish the objectives of the Roadmap have been formulated, a number of measures under each one of main axes to overcome specific barriers have been proposed, while finally, the identified priority measures corresponding to specific actions have been decomposed and analysed.
3. The suggested measures are categorized into "High priority", "Medium priority" and "Low priority" ones, thus producing an assessment of the priority measures alternative scenarios.

The main objectives of the Roadmap creation is to contribute to the formulation of an optimal planning in order for the targets in view of the energy transition – in terms of having available the appropriately trained / skilled personnel that will work on the new, more clean, energy production technologies - to be achieved, as well as the R&I strategies on energy to be appropriately and efficiently implemented in the region of Western Macedonia. This objective shall be accomplished through the identification of a series of measures and actions that are required for the implementation of the suggested plan aiming at the achievement of the targets set within the R&I strategies for smart specialization of the target regions, including any possible barriers needed to be appropriately confronted.

The elaborated Roadmap could eventually provide for the relevant to the energy transition topic policy makers the appropriate set of guiding lines, contributing this way on the one hand to the enhancement of the legislative framework and on the other hand to the incorporation of the new suggested energy technologies and re-skilling/re-training schemes in the after coal era energy system. Furthermore, a considerable number of investments in low-carbon sectors could also be stimulated with the use of this elaborated tool by the policy makers.

The Roadmap is structured in three main sections (Chapters 2, 3 & 4), following the present introductory chapter. More precisely, in Chapter 2 the strategic approach for developing the Roadmap for Western Macedonia region towards two main directions, i.e. on the R&I and on

the re-training/re-skilling needs for the workforce of the region, is outlined. The prioritization for both the R&I activities for the selected energy technologies and for the local workforce reskilling / retraining needs are presented, while an analysis of the most important potential barriers faced concerning the implementation and the development of the roadmap is also included in this chapter. The information provided is mainly derived from the outputs of the previous work packages of TRACER, but also based on the relevant policy documents.

In Chapter 3, a series of recommendations for the measures that need to be taken in the Western Macedonia region are analytically presented. The measures included are necessary for the accomplishment of the objectives of the R&I strategy, and for the fulfilment of the needs of the local workforce retraining. Thus, the major axes needed for the accomplishment of the objectives of the R&I strategy, and for the fulfilment of the needs of the local workforce retraining are presented, followed by a set of measures associated with the defined major axes are contained in Chapter 3.

Finally, the last chapter (Chapter 4) consists of a final comprehensive Action Plan for the implementation of the Roadmap, summarizing the assessment and prioritization of the proposed measures. The specification of the set of actions that are required to implement the elaborated Roadmap in the Western Macedonia region is also presented in this Chapter.

2 Strategic approach for the development of the Roadmap

2.1 Prioritization of R&I activities for the selected energy technologies

The present Roadmap has been elaborated on the basis of a set of priority areas of the energy sector that, after a long and multi-aspect procedure including consultation meetings, discussions, etc. with the experts actively involved in the coal phase-out preparatory stages from the region of Western Macedonia, have been identified as these able of mostly satisfying and meeting the needs of the R&I potential in the region. The region of Western Macedonia presents the advantage of the natural landscape, being endowed with rich natural resources, which, combined with the rapidly growing level of education of the local population and the important presence of the research institutes/organizations, have shaped the region’s identity as the energy center for the entire country.

The energy related R&I landscape for Western Macedonia, as discussed and presented in deliverable D6.2 is characterised by a steadily increasing Human Resources for Science and Technology, at least since the year 2000. A number of educational or research institutes and/ or organizations, like the University of Western Macedonia (UoWM), having the natural sciences and engineering and technology as its main scientific activity fields, the Centre for Research and Technology-Hellas (CERTH), an important player in the field of R&D in Northern Greece initially dealing with the lignite industry yet gradually expanding its expertise to sustainable energy technologies, the Cluster of Bioeconomy and Environment of Western Macedonia (CLuBE), established as a platform for cooperation of the three pillars of the regional economy (i.e. the public sector, research and entrepreneurship), actually developing R&D and business activities in the fields of bioenergy and environment, as well as the Regional Development Company of Western Macedonia SA (ANKO), consist of some characteristic and dominating in the region proofs regarding the reinforcement of the regional research capacities.

In the region of Western Macedonia the Research, Technology Development and Innovation (RTDI) efforts of the above mentioned research organizations are mainly focused in the energy related topics such as the energy production, the clean energy technologies, the hydrogen and alternative energy sources, and the energy saving and related environmentally friendly technologies. The consultation procedure, led by CRES, which has taken place with a number of local experts contributed with important “additions” to the identification and analysis of the regional innovation potential and specialization, as also presented in deliverable D6.2.

According to the new National Energy and Climate Plan (NECP, 2019), at the end of 2023 all (except one) of PPC lignite fuelled power plants will be withdrawn and the lignite mines will terminate their operation in the Western Macedonia region. The withdrawal of the lignite power plants will bring changes in the district heating of the neighbouring municipalities, as it is provided at a relatively low cost by the operation of the TPP units of PPC SA. In Western Macedonia, the district heating provided today by PPC in Amyntaio, Ptolemaida and Kozani will be able to continue to be provided under a common district heating scheme by the new unit Ptolemaida 5, as well as by a number of electric and natural gas boilers and a CHP unit that will be (or have already been) installed in the “closed” power plant of Kardia. At the same time, the Municipality of Amyntaio has constructed a new district heating unit with lignite and biomass fuel.

2.1.1 R&I in the RES sector

The **solar energy** consists of an important energy source in the region that could be exploited through the production of ***solar thermal energy*** for purposes of electricity production (implementation of concentrating solar power collectors or development of new heat storage materials and techniques), or of solar thermal energy for both heating and cooling applications (digitalization of solar thermal systems, development of hybrid systems in intelligent buildings, integration of solar thermal systems into smart grids, development of standardized solar thermal systems for heat generation in industrial processes).

Additionally, the solar energy has the potential of being exploited in the form of ***photovoltaic energy***. In this case, the main priority activities for the Western Macedonia region include the integration of PV systems into buildings or other infrastructures (e.g. industrial facilities), the development of high energy efficient multi-contact technology PV cells, as well as monitoring and operating systems for PV parks and installations (PV parks of a total of 1.9 GW installed capacity are planned by the partnerships of PPC and RWE, while a 204 MW PV park shall be immediately constructed in Kozani by ELPE and Juwi).

The construction of PV Parks further provides the possibility for the research and development in the field of **hydrogen** production units that will be connected to RES and for which there is already a huge investment interest expressed. It must be further mentioned that significant investments are expected in Western Macedonia by strong business players in renewable energy **storage**, which is the key to the green transition on the way out as a result of Greece’s decarbonization plan, as storage units such as those to be installed in Western Macedonia can provide the country's Electricity System with cleaner energy, with safety, flexibility, stability and also a reduction in the cost of electricity, for the benefit of Greek households and businesses (in the beginning of 2022 the new institutional framework was established with three categories of licenses for RES storage facilities).

Another really promising energy source expected to be used in the after-coal era is **biomass**, as the energy utilization of biomass shall offer a reliable solution to meet the heating needs

of the areas of Western Macedonia currently dependent on power plants (high efficiency heat and electricity cogeneration using biomass as fuel on a large scale) since a significant potential exists in the region. Another important priority action in the field of biomass and its sub products is the development, demonstration and scaling up of solid, liquid and gaseous bio-energy intermediates through biochemical / thermo-chemical / chemical conversion from sustainable biomass.

Apart from biomass, other RES that are expected to expand a lot in the area in the coming years are **wind energy**, with wind energy projects being in various stages of the licensing procedure in Western Macedonia amounting to around 2,132 MW of capacity. A focus shall be made on the operation and maintenance of wind farms with the use of digitalized systems, as well as on the small wind turbines. At last, there are strong thoughts about the integration of the **geothermal heat and electricity** into the energy system, through the development of a variable load geothermal power plant that could operate additionally to the production of wind or PV energy.

2.1.2 R&I in the Hydrogen sector

The exploitation of Hydrogen in Western Macedonia region consists one of the most crucial priorities of the R&I activities. As all R&I actions that have been identified as priority areas, the focus and future investment in hydrogen as a crucial source of energy in the after coal era, is in line with the Priority Areas identified in the NECP of Greece, intended also to meet the needs, capacities and specializations at the local level. It should be noted that the region of Western Macedonia is targeting at becoming an innovation “hub of hydrogen production” in the years to come, this being also a Regional goal for Western Macedonia.

The shift of the region to a status of green hydrogen is an entire socioeconomic challenge deriving from the process of the energy transition, thus it will on the one hand create primary and secondary employment, but, on the other hand, it requires the implementation of important R&I priority actions, in order for hydrogen itself to form a new innovative pathway for a hydrogen-based economy.

2.1.3 R&I in energy networks digitalization and smart grids

The energy networks in the region need to be improved in view of the upcoming reform of the current power grid, in order for these to constitute a properly operating energy system for the region and thus the entire country. The R&I is critical to focus on the strengthening of the electricity distribution networks as well as on the security of supply, with the smart grids’ development becoming a necessity. The smart services require the creation of an innovation environment. Furthermore, the electricity network has to be optimised with solutions on the table aiming at the increase of the observability and the controllability of the energy system.

The load profile management, the increase of the flexibility of all types of production, as well as the reduction of the cost of energy storage solutions through the minimizing of the total cost of the system, are in the first ranking positions of the R&I priority actions. In the same context, it is important for the region to be able to achieve the establishment of integrated local and regional energy systems, mainly by promoting the integration of RES at regional/local level and by creating an innovation environment for smart services where the role of the ICT solution providers will also prove quite significant.

2.1.4 R&I in energy storage systems

The lignite phase-out is a sea change in the national energy map, but also a huge and unique opportunity for the region of Western Macedonia. One of the main strategic policy priorities, as also set out in the NECP of Greece (NECP, 2019), is the development of strategic storage projects, the energy storage being also a crucial parameter for the security of the energy supply. The region intends to focus on the development of innovative energy storage applications and of CO_2 capture, storage and use technologies. In view of an efficient energy transition, it is essential for the years to come to develop an appropriate institutional framework for storage units of this type and have them introduced in the electricity market, since their participation is considered as crucial for attaining high shares of RES in the electricity market.

Thus, a number of R&I actions are required for the enhancement of the development of new and/or improved electricity or thermal energy storage technologies, while these are mostly needed in the field of electrochemical energy storage technologies, which relate primarily to RES applications for utilisation in non-interconnected electricity networks or in remote points in the electricity network.

2.1.5 R&I in the field of energy efficiency of buildings

In the frame of the energy efficiency improvement objectives included in the Greek NECP, there is a set of R&I priority activities targeted at the improvement of the energy efficiency of buildings and of industrial processes. Thus, there is an urgent need to step up research into new materials and innovative applications of heating and cooling systems, with an emphasis on improving their reliability and automated operation. At the same time, the maturation and integration of innovative energy-saving technologies that contribute significantly to improving energy efficiency need to be facilitated. The set of activities are addressing both the buildings and the industrial sector.

2.2 Prioritization of local workforce reskilling / retraining needs

In order to define the reskilling and/or retraining needs of the local workforce of Western Macedonia, an analysis of the current status was initially made. Taking under consideration then the current skills of the workforce and the prediction of future skills needed to cover the expected created jobs, a thorough analysis took place and the results were presented in the "*Report on the needs for workforce retraining*" (TRACER D6.3, 2022).

In the Report it was proven necessary to initially write down the current status of the region's workforce, demonstrating its specializations, education level, ages distribution, employment and unemployment indicators. Then, the national and regional plans towards decarbonization were presented, identifying the expected new jobs to be created through this process. The synthesis of these two sections of data collection and analysis concluded to the definition of the reskilling / retraining needs of the local workforce, in order to diminish unemployment and secure the covering of the needs of the future market. Focus and priority were given to RES related jobs, since the main target group to be reskilled are workers working currently in the coal energy sector who is expected to continue working to the new RES energy sector.

The Report combined other recent analyses on the sector (IRENA and ILO, 2021), (RES-SKILL / PORMEA, 2021) and identified the human resource requirements of the lower certification workforce (minimal formal training), the STEM, non-STEM and administrative professionals needed to work in the RES technologies sector. Furthermore, the occupational

profiles for coal industry and RES sectors and the essential skills for coal and RES workers were defined, in order to identify the required training as well as the time needed (TRACER D6.3, 2022). As already mentioned before, the RES sectors that are to be developed in Western Macedonia are basically PV, wind energy, biomass, solar thermal power plants, and the “green” hydrogen sector.

The study concluded that the current status of the workforce in Western Macedonia is characterized by high quality and specialized workforce, while there is an increasing index in the number of the university and post- graduate degrees. The retraining/ reskilling of the existing workforce is essential, in order to get the specialized employees and technicians the region will need. There is an identified gap in engineering, STEM or non-STEM professionals and in technical skills in some RES sectors hence, the retraining/reskilling should also be designed in order to cover not only the technicians’ skills gap, but the others related professions as well.

2.3 Barriers analysis

The efforts and coordinated activities aiming at the meeting of the targets set both on a regional and a national level for the region of Western Macedonia in view of the time horizon of 2030 and 2050 respectively, may potentially be either obstructed or limited/delayed by the existence of a number of significant barriers. These barriers, regarding both the development of R&I on the selected priority energy technologies and the reskilling/retraining of the existing workforce, could potentially – and in the short- to medium-term - limit the positive impact and/or success of the implemented activities that are related to R&I focusing on a series of energy technologies characterised as priority ones, as well as to the reskilling and retraining of the local current workforce.

The pointing out of the most common barriers consists of a necessary and crucial step on the path for the Roadmap elaboration, since their tracking may lead to a more proper confronting of them through the implementation of suitable and effective measures.

2.3.1 Barriers to the development of R&I priority energy technologies

In the frame of deliverable D6.2 of TRACER project (TRACER D6.2, 2022) a SWOT analysis of the regional innovation potential and specialization, also including the main outputs, as well as the conclusions derived by the online consultation meeting that took place with the local experts of Western Macedonia was carried out, pointing out the identified weaknesses and threats. The output was as follows:

Strengths	Weaknesses
• Natural endowments • Level of education of the population rapidly growing • Presence (even if recent) of regional academic research capacities • Key player in the energy production sector	• Quasi inexistent R&D investments by businesses • Very low level of overall R&D investment • Traditional structure of the economy • Low level of ICT diffusion and use • Low level of life-long learning practices • No data on patenting activities • Low level of science-business collaboration • Lack of innovation culture within firms

Opportunities	Threats
• Better incentives for business investments in R&D activities • Increased coordination of national and regional policies to support ICT diffusion • Smart specialisation in the energy area • Improved support to upgrading of SMEs technological capacity • Attraction of foreign direct investments	• Economic specialisation in low-tech sectors (agriculture, tourism) • Pollution and environmental damages associated to mining activities and energy production • Brain drain

The economy of the region of Western Macedonia, currently characterised as a rather traditional one, should intensify its efforts to direct itself towards higher value-added activities after a significant restructuring, while the R&D investment is an area that definitely needs strengthening with the absence of foreign direct investment and of that by businesses, which indeed consists of an important weakness. Furthermore, the structural deficiencies of the local economy, which is currently characterised by small companies, traditional industries, high unemployment rate and low competitiveness, have been even more magnified due to the economic crisis that the entire country has been experiencing during the recent years, but also because of the identified discontinuities in the regional R&I policies.

Another identified weakness regarding the R&I potential, relates to the low level of collaboration between the science and the business sectors. This collaboration – which is rather important - could profit of the important presence of regional academic capacities in the area.

On the other hand, there are still opportunities available to a bunch of improved incentives concerning the business investments in R&D activities, the development of the smart specialisation in the region or the attraction of foreign direct investments. Evidently, though, there is a number of worth noting threats that should be taken under consideration, including the economic specialisation in sectors characterised by a low technological level and the pollution and degradation of the natural environment resulting from decades of mining and energy production activities taking place in the area.

2.3.2 Barriers to the local workforce retraining/reskilling

According to what was developed in the section related to the Region of Western Macedonia of the report D6.3 of the TRACER project (TRACER D6.3, 2022), the main barriers to the retraining and reskilling of the workforce dealing with coal in the region will be the following:

- The existing VET centres (either the Centres for Training and Life Long Learning and/or the Vocational Training Institutes, but also, and as regards the formal post-secondary education, the vocational upper secondary schools–EPAL, and Vocational Training/Apprenticeship Schools) don't support many relevant RES courses, hence extra preparation would be necessary.
- The former workers in the coal industry may not be eager to participate to training courses and to change jobs.
- Lack of certified trainers in the relevant topics in the region,
- Lack of existing previous experience in the reskilling procedure, including the technicalities and the respond of the society/ workers

- There are not yet supporting measures to ensure that the Region will withstand the transition and ensure the support of the workforce through the reskilling
- The reskilling should be effective and practical and it should guarantee the absorption of the workforce to the new work market
- Older members of the workforce usually resist and react to learning new skills.
- Society needs time to adjust to new status and to react to change. The families and social surroundings of the workforce should be supported through the change.

3 Recommendations for Measures

3.1 Major axes needed to accomplish the objectives of the R&I Strategy

In this section, the major axes that will constitute the guiding lines for the achievement of the objectives of the Roadmap addressing the R&I priority actions as already mentioned and further analysed in TRACER's report D6.2 (TRACER D6.2, 2022) are presented. Therefore, according to the analysis performed in the above mentioned report, the promotion of R&I in the energy sector in the region of Western Macedonia should be performed through the active involvement of all the market players, apart from the R&TD institutes, while the key word for an efficient implementation of the suitable strategy is the establishment of fruitful "synergies" between the public and the private (i.e. enterprises) sector (energy, research and competitiveness) policies and financing tools, the involvement of all the market players in the implementation of research or pilot projects, as well as the promotion of the creation of partnerships among stakeholders for the facilitation of the know-how transfer.

In the frame of the pointed out most crucial necessities, three Major Axes could be defined in view of the accomplishment of the objectives of the R&I strategy in Western Macedonia:

1. Enhancement/reconstructuring of the regional research bodies / institutes
2. Strengthening of the synergies and cooperation between research bodies/centers and business
3. Empowering of the role of all the market players in their involvement in projects implementation

3.2 Major axes needed to fulfill the needs for workforce retraining

In order to obtain the required workforce in the region of Western Macedonia, including well trained professionals in STEM and non-STEM sectors which could be imported from other regions of the country, the respective activities resulting from the following axes should be designed and implemented:

1. Develop respective training courses to fill the knowledge, skills and competences gap of the existing workforce of the region.
2. Up–skill training for engineers or other STEM and non- STEM professionals or even new RES professionals (e.g. in the hydrogen sector).
3. Informing the regional and national market and the existing and future workforce on the jobs and training/ reskilling potential.

4. Supporting the transition during the reskilling, for both the workforce and the local community/ market.

3.3 Measures proposed under each one of main axes to overcome the barriers

3.3.1 R&I Strategy

- **Axis 1**: Enhancement/reconstructuring of the regional research bodies / institutes

Measure 1: Creation of new and / or reconstructing of existing R&I facilities

Measure 2: Implementation of exchange programmes among collaborating universities/ institutes

Measure 3: Improvement of the qualification and/or skills of the researchers in the energy sector

- **Axis 2:** Strengthening of the synergies and cooperation between research bodies/ centres and business

Measure 1: Establishment of a link between the R&I research institutes, universities, the business and the local society to enhance the access to R&I outputs and/or achievements

Measure 2: Alignment of visions, goals and means for both research institutes and business

Measure 3: Implementation of awareness events on a two-fold basis on the activities of the research institutes and the business goals and plans

- **Axis 3:** Involvement of the energy sector stakeholders in the business discovery process

Measure 1: Promotion of the partnerships between stakeholders, by supporting advisory and networking actions

Measure 2: Empowering of the role of all market players in their involvement in projects implementation

3.3.2 Reskilling/ retraining Strategy

- **Axis 1:** Develop respective training courses to fill the knowledge, skills and competences gap of the existing workforce of the region

Measure 1: Create the respective curriculum, design the training course and identify the trainers' profile.

Measure 2: Ensure the respective capacity building of the existing VET infrastructures (for instance, providing the laboratories with the necessary equipment)

- **Axis 2:** Up–skill training for engineers or other STEM and non- STEM professionals or even new RES professionals (e.g. in the hydrogen sector)

Measure 1: Develop up-skilling courses and promote master courses for engineers and other RES professionals

Measure 2: Provide engineers and professional unions with the necessary information, support and material to diffuse to their members, pointing out the need for experts in the respective domains.

- **Axis 3:** Informing the regional and national market and the existing and future workforce on the jobs and training / reskilling potential.

Measure 1: Create an informative campaign for schools nationally (e.g. through school vocational guidance) addressing the issue and presenting the upcoming opportunities both in technical and higher education level.

Measure 2: Informing the regional market on the potentials resulting the decarbonized period and era.

- **Axis 4**: Supporting the transition during the reskilling, for both the workforce and the local community / market

Measure 1: Create initiatives which would enable the existing workforce to attend the training and to choose the appropriate course.

Measure 2: Provide the local market / community with financial incentives to support the transition through the retraining of the workforce (for instance, support the families of the trainees by giving them priority in the job market, during the training period).

4 Action Plan of the Roadmap

The logical procedure for the determination of an Action Plan aimed at supporting the Roadmap's implementation, as it was conducted, is graphically presented in Figure 4.1. As a first step, three major axes were formulated, over which emphasis should have been given, to accomplish the objectives of the Roadmap.

At a second phase, these axes were specialized and a number of measures with the purpose of overcoming specific barriers are proposed, corresponding to each one of the defined axes. The third step of the entire procedure was that the priority measures identified were decomposed and analysed to a series of specific actions, thus providing a detailed Action plan towards 2030-50, completing this way the elaboration of the Roadmap for Western Macedonia Region.

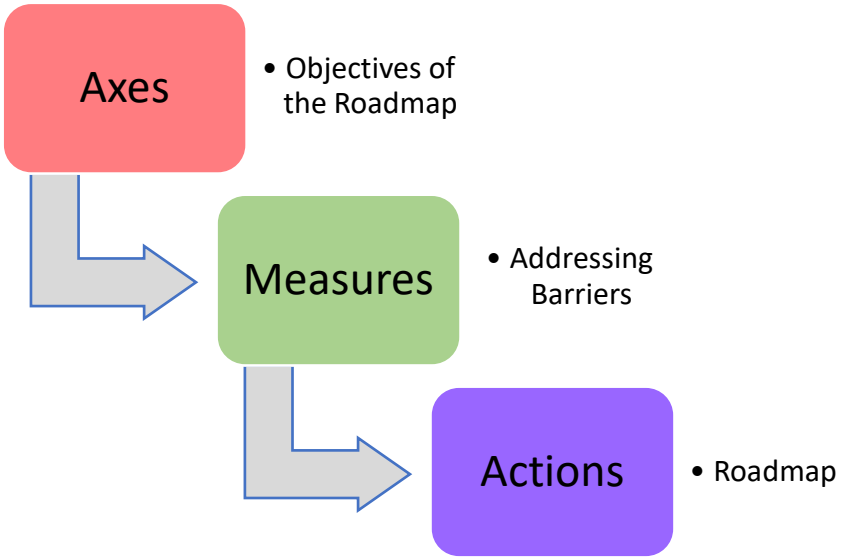

Figure 4.1: The three stages determining the Action Plan under the Roadmap for Western Macedonia Region

4.1 Assessment and prioritization of the proposed measures

The procedure of both the evaluation and the prioritization of the series of measures that have been suggested in the frame of each one of the three axes, consists of a core procedure leading to the provision of a fair and solid background for the various measures and their comparative importance, so as to confront the identified barriers in the most efficient way. During the prioritization process the parameters of both the viability and the theoretical impact of each treated measure were taken into consideration.

At an **initial stage**, following the online consultation meeting with a number of thirteen (13) in total interested stakeholders from the region of Western Macedonia, addressing the R&I strategy on the energy use and the relevant analyses by CRES experts, the process and the evaluation methodology of the Roadmap's measures were decided, with the use of a commonly accepted evaluation system. This system consists of three general dimensions that lead to the fabrication of the evaluation criteria, as shown in Figure 4.2.

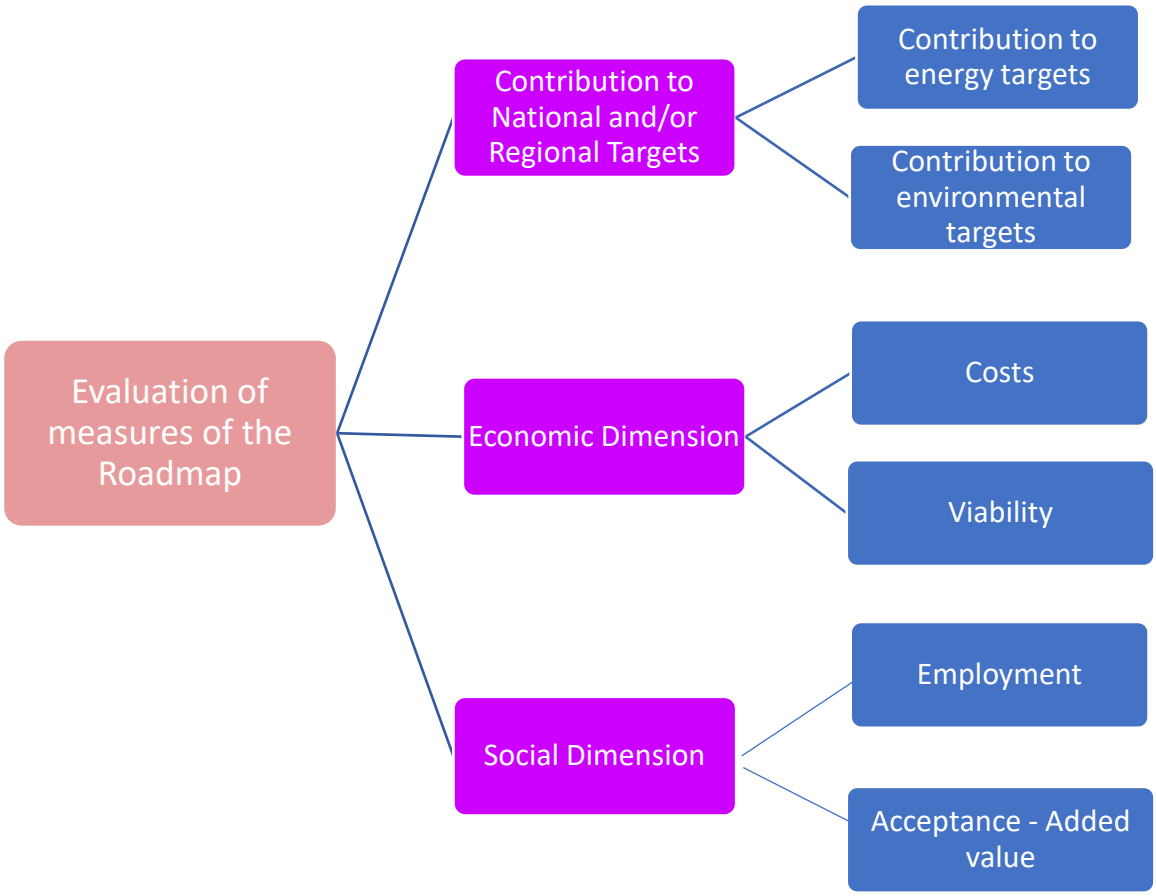

Figure 4.2: Dimensions and evaluation criteria of the measures within the Roadmap for Western Macedonia

The dimensions selected for the integrated evaluation of the proposed series of measures are the following:

I. The measure's contribution to the national objectives regarding the energy and environmental issues of concern of Greece, as well as those at the regional level;

II. The economic dimension, referring to both the cost of the measures and the economic benefits arising from their implementation, and

III. The fulfilment of the national social needs.

Each dimension is next divided into the individual evaluation criteria that constitute it. These criteria, in order to be in accordance with the multicriteria theory, are required to be preferentially independent to the decision makers and to respect the monotonicity property (strictly increasing - decreasing).

The **second stage** consists of the assignment of scores of each individual measure on the set criteria. Then, these scores-ratings are aggregated evenly to extract each suggested measure's score on the dimensions level. The contribution of each measure over any defined criterion and dimension is expressed qualitatively, in a three stage distinct and ordered scale, with the aid of linguistic variables, as symbolized in Table 4.1.

Table 4.1: Rating scale of the measures to export priorities

Rating	Contribution
+	Low
++	Medium
+++	High

The discrete and ordered scale with linguistic variables technique is widely used worldwide in a variety of classification problems due to the immediacy and clarity of the final results it provides.

The **third and final stage** of the evaluation procedure consists of the aggregation of the individual ratings for each measure, as extracted in the second stage, to an overall one for each measure. Depending on their total scores over the three dimensions, the measures were finally classified into **3 categories**:

(1) Measures of high priority,

(2) Measures of medium priority, and,

(3) Measures of low priority.

4.1.1 Assessment and prioritization of the proposed measures to meet the objectives of the R&I Strategy

R&I	Assessment		Prioritisation
Axis 1: Enhancement/reconstructuring of the regional research bodies / institutes			
Measure 1: Creation of new and / or reconstructing of existing R&I facilities	● Contribution to national targets (energy and environmental) ● Economic dimension (costs and viability) ● Social dimension (employment)	☑ ☑ ☑	**+++**
Measure 2: Implementation of exchange programmes among collaborating universities/institutes	● Contribution to national targets (energy and environmental) ● Economic dimension (costs and viability) ● Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**

R&I	Assessment		Prioritisation
Measure 3: Improvement of the qualification and/or skills of the researchers in the energy sector	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**
Axis 2: Strengthening of the synergies and cooperation between research bodies/centres and business			
Measure 1: Establishment of a link between the R&I research institutes, universities, the business and the local society to enhance the access to R&I outputs and/or achievements	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**
Measure 2: Alignment of visions, goals and means for both research institutes and business	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☐	**+++**
Measure 3: Implementation of awareness events on a two-fold basis on the activities of the research institutes and the business goals and plans	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	
Axis 3: Involvement of the energy sector stakeholders in the business discovery process			
Measure 1 Promotion of the partnerships between stakeholders, by supporting advisory and networking actions	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**
Measure 2: Empowering of the role of all market players in their involvement in projects implementation	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**

4.1.2 Assessment and prioritization of the proposed measures to meet the reskilling / retraining needs of the workforce

Reskilling / Retraining	Assessment		Prioritisation
Axis 1: Develop respective training courses to fill the knowledge, skills and competences gap of the existing workforce of the region			
Measure 1: Create the respective curriculum, design the training course and identify the trainers' profile.	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☐ ☑ ☑	**+++**
Measure 2: Ensure the respective capacity building of the existing VET infrastructures- for instance, providing the laboratories with the necessary equipment	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☐ ☑ ☑	**+++**
Axis 2: Up–skill training for engineers or other STEM and non- STEM professionals or even new RES professionals (e.g. in the hydrogen sector)			
Measure 1: Develop up-skilling courses and promote master courses for engineers and other RES professionals	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**
Measure 2: Provide engineers and professional unions with the necessary information, support and material to diffuse to their members, pointing out the need for experts in the respective domains.	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☐ ☑ ☑	**+**
Axis 3: Informing the regional and national market and the existing and future workforce on the jobs and training/reskilling potential			
Measure 1: Create an informative campaign for schools nationally (e.g. through school vocational guidance) addressing the issue and presenting	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	**+++**

Reskilling / Retraining	Assessment		Prioritisation
the upcoming opportunities both in technical and higher education level.			
Measure 2: Informing the regional market on the potentials resulting the decarbonized period and era.	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	++
Axis 4: Supporting the transition during the reskilling, for both the workforce and the local community/ market			
Measure 1: Create initiatives which would enable the existing workforce to attend the training and to choose the appropriate course.	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☑ ☑ ☑	+++
Measure 2: Provide the local market/ community with financial incentives to support the transition through the retraining of the workforce (for instance, support the families of the trainees by giving them priority in the job market, during the training period).	• Contribution to national targets (energy and environmental) • Economic dimension (costs and viability) • Social dimension (employment and acceptance)	☐ ☑ ☑	++

4.2 Specification of the set of actions required to implement the Roadmap

4.2.1 Measures regarding the R&I Strategy

Axis 1	Enhancement/reconstructuring of the regional research bodies / institutes
Measure 1	**Creation of new and / or reconstructing of existing R&I facilities**
Action 1	**Establishment of new laboratories:** ➔ The creation of suitable mechanisms to support the establishment of new laboratories in research bodies/institutes, appropriately equipped to meet the needs of R&I priority technologies
Involved bodies	Universities (University of Western Macedonia), Research Centres/ Institutes, Ministry of Education and Religious Affairs

Timeframe	**2023 - 2030**
Funding mechanisms	Public Investment Program, ESP Regional Operational Program, European Research Area & European R&I Programs
Action 2	**Provision of financial incentives for the creation and/or refurbishment of R&I facilities :** ➔ Development of a series of new financial incentives to encourage the investment in R&I facilities
Involved bodies	Universities (University of Western Macedonia); Research Centres/ Institutes, Ministry of Education and Religious Affairs;
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investment Program, ESP Regional Operational Program, European Research Area & European R&I Programs
Measure 2	**Implementation of exchange programmes among collaborating universities/institutes**
Action 1	**Establishment of exchange programs** ➔ Development of exchange programs among universities at postgraduate level ➔ Encouragement of the process for the exchange of students that follow a doctoral thesis
Involved bodies	Universities (University of Western Macedonia); Research Centres/ Institutes, Ministry of Education and Religious Affairs; Vocational Centers and Schools, Companies in the energy field, SMEs
Timeframe	**2023 - 2030**
Funding mechanisms	European Research Area & European R&I Programs
Measure 3	**Improvement of the qualification and/or skills of the researchers in the energy sector**
Action 1	**Implementation of capacity building activities related to R&I addressed to academia and research entities** ➔ Organisation of workshops, conferences, best practices exchange addressed to scientists and researchers for the enhancement of their ability to meet the needs of supporting and implementing projects in the market field ➔ Resources for the financial supporting of the various capacity building activities (in both public and private sectors)
Involved bodies	Universities (University of Western Macedonia); Research Centres/ Institutes, Ministry of Education and Religious Affairs, Vocational Centres and Schools, companies in the energy field, SMEs, regional and local public authorities in the field of education and training
Timeframe	**2023 - 2030**
Funding mechanisms	European Research Area & European R&I Programs

Axis 2	Strengthening of the synergies and cooperation between research bodies/centres and business
Measure 1	**Establishment of a link between the R&I research institutes, universities, the business and the local society to enhance the access to R&I outputs and/or achievements**
Action 1	**Launching of the link among the research bodies and business actors at regional level:** ➔ Suggesting the implementation of various activity programs to be implemented by cooperation between research bodies/institutes and business of the private sector
Involved bodies	Universities (University of Western Macedonia), Research Centres/ Institutes, Ministry of Education and Religious Affairs, Vocational Centres and Schools, companies in the energy field, SMEs, regional and local public authorities in the field of education and training
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program, the Regional OP of Western Macedonia
Action 2	**Creation of links between the R&I "community", the business and the local society:** ➔ Focus on the entrepreneurial activity, by enhancing the training in it, targeting at more skilled workforce for supporting the higher business development rates ➔ Awareness raising regarding various opportunities for investing in business (through the implementation of awareness rising events, workshops, seminars, etc.) ➔ More intense involvement of young potential entrepreneurs in the business sector ➔ Facilitation of a frequent coordination between the public and private sector and the research community ➔ Joint undertaking ➔ Exploitation and incorporation outputs form R&I activities within various sectors
Involved bodies	Universities (University of Western Macedonia), Research Centres/ Institutes, Ministry of Education and Religious Affairs, Ministry of Environment and Energy, Vocational Centres and Schools, companies in the energy field, SMEs, regional and local public authorities in the field of education and training, SMEs
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program (NSRF), the Regional OP of Western Macedonia
Measure 2	**Alignment of visions, goals and means for both research institutes and business**
Action 1	**Elaboration of common lines in training and setting of goals for research institutes and business:** ➔ Clear setting of goals and visions for both research institutes and business

	➔ Ongoing employee training and development to build and / or improve skills and knowledge for a better alignment with research institutes goals ➔ Enhancement of resources and tools ➔ Regular cooperation and exchange of feedback between research institutes and business
Involved bodies	Universities (University of Western Macedonia), Research Centres/ Institutes, Ministry of Education and Religious Affairs, Ministry of Environment and Energy, Vocational Centres and Schools, companies in the energy field, SMEs, regional and local public authorities in the field of education and training, SMEs
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program (NSRF), the Regional OP of Western Macedonia, European Research Area & European R&I Programs
Measure 3	**Implementation of awareness events on a two-fold basis on the activities of the research institutes and the business goals and plans**
Action 1	**Assurance of the necessary means for the implementation of awareness events:** ➔ Enhancement of funding resources for the implementation of awareness raising events ➔ Elaboration of tools and mechanisms for the monitoring of the events efficiency
Involved bodies	Universities (University of Western Macedonia), Research Centres/ Institutes, Ministry of Education and Religious Affairs, Ministry of Environment and Energy, Vocational Centres and Schools, companies in the energy field, SMEs, regional and local public authorities in the field of education and training, SMEs
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program (NSRF), the Regional OP of Western Macedonia, European Research Area & European R&I Programs

Axis 3	**Involvement of the energy sector stakeholders in the business discovery process**
Measure 1	**Promotion of the partnerships between stakeholders, by supporting advisory and networking actions**
Action 1	**Establishment of formal communication links:** ➔ Establishment of links among a large pool of stakeholders from various fields ➔ Enhancement of knowledge – sharing in all spheres of the market area ➔ Coordination for the limitation of the fragmentation of the domestic R&I landscape

Involved bodies	Companies in the energy field, SMEs, Universities (University of Western Macedonia), Research Centres/Institutes
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program (NSRF), the Regional OP of Western Macedonia
Measure 2	**Empowering of the role of all market players in their involvement in projects implementation**
Action 1	**Enlightening the field for market players/business/enterprises**: ➔ Provision of clarity to business enterprises about the future R&I landscape in the fields of energy/environment ➔ Provision of resources for the business sector to contribute to the increase of the activities of those already undertaking R&I initiatives and / or mobilise other companies unfamiliar with this support ➔ Enhancement of public-private partnerships
Involved bodies	Companies in the energy field, SMEs, Universities (University of Western Macedonia), Research Centres/Institutes
Timeframe	**2023 - 2030**
Funding mechanisms	Public Investments Program, ESPA National Operational Program (NSRF), the Regional OP of Western Macedonia

4.2.2 Measures regarding the local workforce retraining / reskilling needs

Axis 1	**Develop respective training courses to fill the knowledge, skills and competences gap of the existing workforce of the region**
Measure 1	**Create the respective curriculum, design the training course and identify the trainers' profile**
Action 1	**Establishing a network of training experts specialized on energy** ➔ Creation of a Network of training experts and a focus group of stakeholders from the RES market, in order to define specifically the qualifications of the needed workforce ➔ Creation of a focus group of stakeholders from the RES market, in order to define specifically the qualifications of the needed workforce ➔ The Network and the Focus Group work together in order to define the curriculum and the trainer's profile
Involved bodies	Ministry of Education, National Organisation for the Certification of Qualifications & Vocational Guidance (EOPPEP), Centers for Training and Life Long Learning/KEDIVIM, vocational training institutes (IEK), Manpower Employment Organization (OAED), Ministry of Development and Investments, Ministry of Economy, Ministry of Labour and Social Affairs, Relevant university schools, relative trade unions, regional and local public authorities in the field of education and employment, SMEs, corporations.
Timeframe	**2023 - 2030 with a horizon to 2050**

Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), Horizon Europe
Measure 2	**Ensure the respective capacity building of the existing VET infrastructures - for instance, providing the laboratories with the necessary equipment**
Action 1	**Identify the most suitable VET infrastructures and upgrade them, if necessary** ➔ Registry of the existing equipment in the VET facilities in the region (and in selected cities) and of the infrastructures ➔ The training experts Network will decide the suitability of the existing infrastructures and indicate the missing equipment of the laboratories
Involved bodies	Ministry of Education, National Organisation for the Certification of Qualifications & Vocational Guidance (EOPPEP), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), vocational training institutes (IEK), Centres for Training and Life Long Learning/KEDIVIM, Manpower Employment Organization (OAED), regional and local public authorities in the field of education and employment, Unions.
Timeframe	**2023 - 2025**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Horizon Europe, possible corporate funding (from RES companies, DEPA)

Axis 2	**Up–skill training for engineers or other STEM and non- STEM professionals or even new RES professionals (e.g. in the hydrogen sector).**
Measure 1	**Develop up-skilling courses and promote master courses for engineers and other RES professionals**
Action 1	**Action needed in order to:** ➔ Engage the network of training experts specialized on energy for the training courses ➔ Engage the respective VET centres for the training courses ➔ Promote the courses in order to get the trainees started.
Involved bodies	Ministry of Education, National Organisation for the Certification of Qualifications & Vocational Guidance (EOPPEP), Centers for Training and Life Long Learning/KEDIVIM, Manpower Employment Organization (OAED), Ministry of Labour and Social Affairs, regional and local public authorities in the field of education and employment.
Timeframe	**2023 - 2030 with a horizon to 2050**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), Horizon Europe
Action 2	**Design Master courses or relevant postgraduate short courses for engineers or other STEM and non-STEM professionals in order to expertise in the RES industry**

Involved bodies	Ministry of Education, National Organisation for the Certification of Qualifications & Vocational Guidance (EOPPEP), Centers for Training and Life Long Learning/KEDIVIM, Universities, regional and local public authorities in the field of education and employment.
Timeframe	**2025 - 2030 with a horizon to 2050**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Research funding, self-funded (tuitions)

Axis 3	**Informing the regional and national market and the existing and future workforce on the jobs and training/ reskilling potential**
Measure 1	**Create an informative campaign for schools nationally (e.g. through school vocational guidance) addressing the issue and presenting the upcoming opportunities both in technical and higher education level**
Action 1	**Prepare a campaign (leaflets and through internet) for youth or people interested in career changing** ➔ Prepare the informative material ➔ Sent it to VETs, schools, Professional orientation centres, job finding offices, OAED etc. ➔ Organise info days for youngsters in schools, VETs and other training/ educational institutions
Involved bodies	Ministry of Education, Manpower Employment Organization (OAED), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), Ministry of Development and Investments, Ministry of Labour and Social Affairs, Centres for Training and Life Long Learning/KEDIVIM, vocational training institutes (IEK), Relevant university schools, relative trade unions, regional and local public authorities in the field of education and employment, schools, marketing.
Timeframe	**2023 - 2026**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Horizon Europe Supporting mechanisms: Ministry of Education, Manpower Employment Organization (OAED)
Measure 2	**Informing the regional market on the potentials resulting the decarbonized period and era**
Action 1	**Organisation of a workshop/ conference in the region** ➔ Invitation of stakeholders, authorities (from ministries, and regional bodies) and experts (from the scientific and business community) ➔ Presentation of relevant success stories ➔ Analyse of the current and future working opportunities and challenges ➔ Underlying of the benefits of the decarbonization in economical, societal and environmental sectors

Involved bodies	Ministry of Development and Investments, Ministry of Economy, Ministry of Labour and Social Affairs, RES companies, Relevant university representatives, relative trade unions, regional and local public Authorities, SMEs, corporations.
Timeframe	**2022 - 2025**
Funding mechanisms	NSRF, National funding, Horizon Europe, RES companies sponsors

Axis 4	**Supporting the transition during the reskilling, for both the workforce and the local community/ market**
Measure 1	**Create initiatives which would enable the existing workforce to attend the training and to choose the appropriate course**
Action 1	**Activities in support to the provision of training on the needed skills:** ➔ Provision of vouchers (for attending the training/ for covering supermarket or other basic needs) ➔ Consultancy service to the workforce for their career reorientation
Involved bodies	Ministry of Education, Centers for Training and Life Long Learning/ KEDIVIM, Manpower Employment Organization (OAED), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), Ministry of Development and Investments, Ministry of Economy, Ministry of Labour and Social Affairs, relative trade unions, regional and local public authorities, SMEs, corporations, regional market (businesses/ companies).
Timeframe	**2023 - 2030**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Horizon Europe, national funding, RES companies sponsors
Measure 2	**Provide the local market / community with financial incentives to support the transition through the retraining of the workforce (for instance, support the families of the trainees by giving them priority in the job market, during the training period)**
Action 1	**Creating supporting initiatives for the local community in order to assist the decarbonization process:** ➔ Provision of benefits to the local companies who are hiring family members of former workers in the coal industry ➔ Provision of vouchers or recognition of contribution to the decarbonization of the region
Involved bodies	Manpower Employment Organization (OAED), Youth and Lifelong Learning Foundation (I.NE.DI.VI.M), Ministry of Development and Investments, Ministry of Economy, Ministry of Labour and Social Affairs, relative trade unions, regional and local public authorities, SMEs, corporations, regional market (businesses/ companies).
Timeframe	**2023 - 2030**
Funding mechanisms	NSRF, Erasmus+ Programme (2021-2027), Horizon Europe, national funding, RES companies sponsors

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