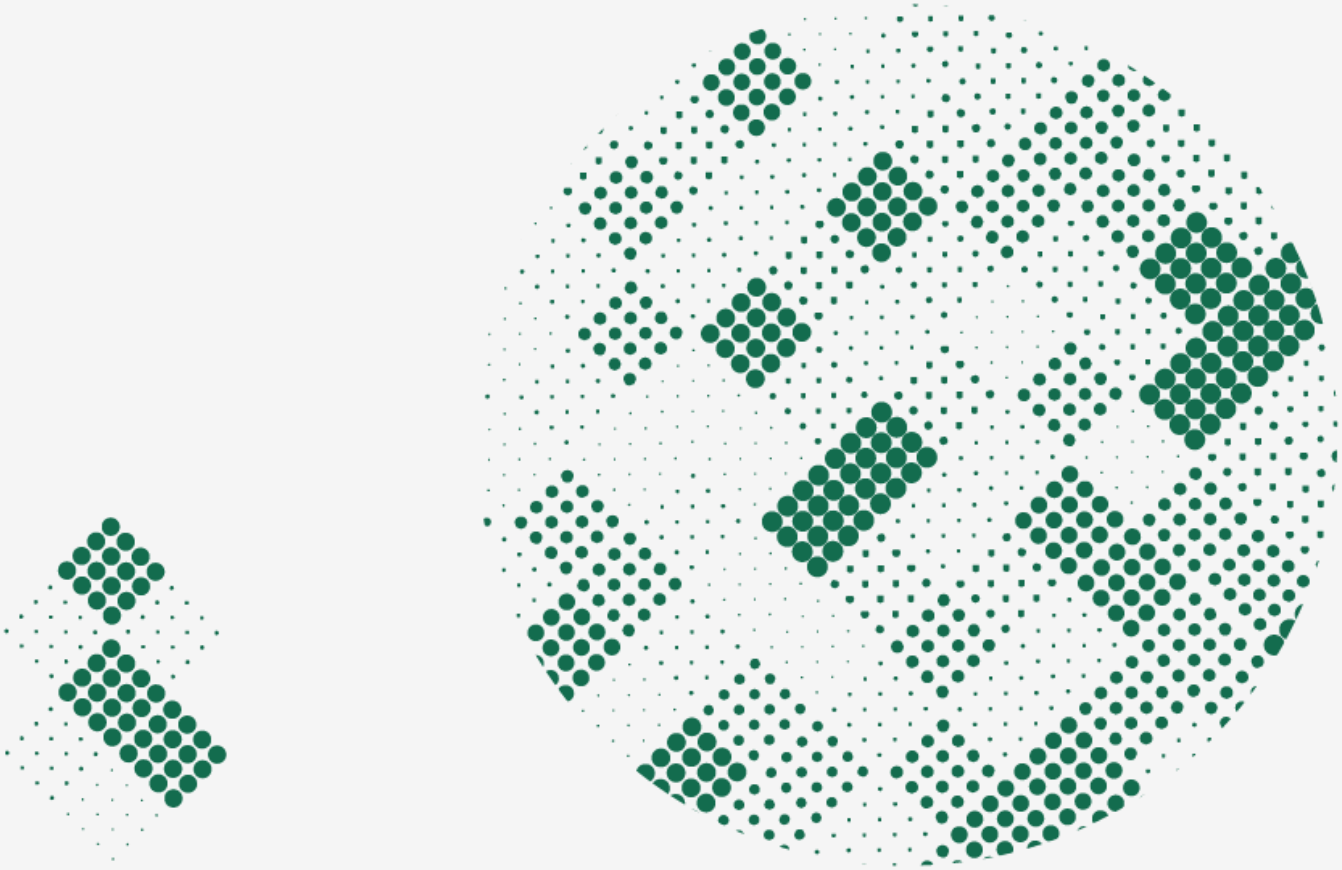
RESPONSIBLE RESEARCH AND INNOVATION IN TERRITORIES

RRI LEADERS

RRI AUDIT REPORT

Region of Western Macedonia



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List of acronyms / abbreviations used in this document

AIRR – Anticipation, Inclusiveness, Reflexivity, Responsiveness
ANKO - Organisation for Local Development Western Macedonia
CERTH - Centre for Research and Technology Hellas
DIADYMA - Waste Management Company of Western Macedonia
ERP - Enterprise Resource Planning
ETS - Emissions Trading System
EU - European Union
GIS – Geographical Information System
IIS - Integrated Information System
JDTP - Just Development Transition Plan
NGO- Non-Governmental Organisation
NSRF - National Strategic Reference Framework
PO – Protected Origin
PPC - Public Power Corporation
PSEC - Regional Council for Research and Innovation
RES – Renewable Energy Resources
RDF - Regional Development Fund
R&I – Research & Innovation
RRI – Responsible Research and Innovation
STEM - Science, Technology, Engineering and Mathematics
SWOT - Strengths, Weaknesses, Opportunities, Threats
TOWS – Threats, Opportunities, Weaknesses, Strengths

Executive Summary

This audit report seeks to deepen the study regarding the integration of the RRI-AIRR approach in the territorial policies of the Region of Western Macedonia. To do so, a survey was drawn up based on the findings from interviews and a focus group, as well as on a documentary analysis and the workshop, and brought to the fore the final conclusions regarding the integration of the RRI-AIRR approach into the territorial policies. The target audience of this report are all the relevant stakeholders from the quadruple helix, namely policymakers, academia, business, and civil society that seek insights on the integration status of the RRI-AIRR approach into the territorial policy areas of the region of Western Macedonia which in short are:

- Development of a stakeholder engagement strategy as an integral part of the post-coal energy transition road map.
- Strengthening policy-making systems involving different modes of territorial governance of the post-coal transition strategy.
- Development of a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'.

In addition, a detailed table maps all the participants who have participated in the research so far, capturing them in four different types in relation to Responsible Research and Innovation, namely interest, experience, influence, and power. In total, 46 stakeholders from the region of Western Macedonia have been mapped.

A SWOT/TOWS analysis follows, which reflects the level of integration of the RRI-AIRR approach in the selected policies of the region, giving an opportunity to identify specific strategic policy priorities. More specifically, regarding the three policy foci of the region, eleven strategic priorities were identified in total describing the RRI keys and AIRR dimensions already being embedded.

Finally, four focus groups with participants covering the quadruple helix stakeholders were conducted, outlining recommendations for RRI-AIRR approach integration towards the strategic priorities of the region. The problems and questions of interest identified are:

- Research and innovation should be integrated into all available solutions for the energy transition.
- There must be equal development of various sectors of the region which will allow businesses to adopt the necessary transition strategies by 2030.
- A drastic change of the production model towards an environmentally neutral, socially sustainable, and economically competitive region.
- The need to transform the current production model to an alternative one that is primarily based on RES.

Recommendations for RRI-AIRR approach integration towards the strategic priorities of the region of Western Macedonia revolve around the following:

- University research centres need to play an active role, delivering science education focused on research designed around the local-economy needs.
- Active collaboration of the academia members with the local business and policy-making actors and collaborations with relevant companies.
- Strong incentives to be given to attract investments in the region that are innovative and create jobs.
- Co-creation collaborations among business clusters in the region are to be encouraged in order to develop value-added products.

- In order to develop robust production chains in the region a regional model of cooperation should be developed which integrates valuable contributions from diverse businesses in the region.
- A public engagement that is structural in nature and will lead to a policy framework in the long term that implements solid cooperation at national and local level, in a multi-level transition governance approach.
- A clear anticipatory framework by the central policy makers is needed, considering all identifiable positive/negative effects of energy transition.

Introduction

The current audit report brings forth final conclusions regarding the perception and embeddedness of the RRI-AIRR approach in the territorial policies and practices of the Western Macedonia region.

The policy focus of the Region of Western Macedonia revolves around the following areas:

- Develop a stakeholder engagement strategy within the course of the post-coal transition roadmap.
- Strengthen policymaking systems involving different modes of territorial governance of the post-coal transition strategy.
- Develop a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'.

The initial steps taken were the mapping of the territorial R&I ecosystem and stakeholders, a documentary analysis identifying opportunities/areas for integration of the RRI-AIRR approach in the three selected territorial policy areas and a participatory workshop exploring participants' perception towards responsibility, and reporting on the RRI policy in the region.

The report is articulated upon:

- Identification of a vision and challenges in relation to the aforementioned policy focus areas.
- Critical analysis and synthesis of the experience related to RRI-AIRR in Western Macedonia.
- Stakeholder mapping in relation to the level of relevance (interest, experience, power, influence) with the RRI-AIRR approach.
- SWOT and TOWS reflection for the three chosen policy areas through a critical perspective.
- Identification of strategic policy priorities and policy pillars based on the SWOT/TOWS analysis.
- Findings from four focus-group discussions organised with quadruple helix actors.

The report ends with policy recommendations for the embeddedness of RRI-AIRR approach in the region, which will provide input to the upcoming Delphi study that will assess dissensus and barriers to reach consensus about possible and feasible future pathways for a better RRI integration in the territorial policymaking of the Region of Western Macedonia. The report will also provide input for the last stage in the RRI-LEADERS co-creation process where each territorial partner will develop a transformative outlook as an action plan for the integration of RRI-AIRR into territorial policymaking and will demonstrate how RRI-AIRR can be taken up as a policy framework in different territorial contexts and be applied to issues where science, technology and innovation require multi-actor approaches combined with a shared awareness of the future.

The policy areas

The Region of Western Macedonia chose three policy areas:

- Develop a stakeholder engagement strategy within the course of the post-coal transition road map.
- Strengthen policymaking systems involving different modes of territorial governance of the post-coal transition strategy.
- Develop a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'.

Western Macedonia is dedicated to following the path of the post-coal transition roadmap, which includes improving policy-making mechanisms incorporating various types of territorial government. Western Macedonia's fair transition policies to the post-lignite age are important to build a new productive-consumer paradigm. The goal is to encourage regional networks and clusters to apply new ideas and policies to promote innovation, regional growth, and the improvement of public services for residents. To this aim, national policies and strategies must be impacted at all levels of governance in the direction of a more evolutionary approach to territorial policy.

The main policy vision for the future of Greek coal areas, and especially for the region of Western Macedonia, is to make them a better, more resilient, energy-efficient, and sustainable place. A fair transition plan will rely on the full support and participation of local communities to maximise the advantages for them while also promoting social cohesion by not leaving anybody behind. Policies will provide a new production model and a paradigm shift to the regional growth model.

The Just Development Transition Plan (JDTP) for Greece tackles all concerns emerging from the Greek government's strategic decision to retire all lignite power facilities by 2028, including extensive engagement with local stakeholders. The strategic priorities of the Region of Western Macedonia for the energy transition are summarised in five principles:

1. Create new employment opportunities in the local community.
2. Utilise the comparative advantages of the region, including high technical skill base of workforce, large potential for clean energy investment (solar PV, biomass, green hydrogen), prospects for sustainable tourism and smart agriculture, proximity to large urban centres, availability of district heating infrastructure, etc.
3. Ensure a fast transition with a focus on realistic and workable solutions.
4. Aim at sustainable development to promote social and environmental sustainability.
5. Promote research and innovation and integrate modern technology.

Western Macedonia is called upon not only to adjust its production model to the new requirements but also to proceed immediately to a comprehensive productive restructuring towards a full phase-out of lignite activities.

The main challenges that have been identified for the region with regards to the application of the RRI-AIRR approach are the following:

- Although public engagement and inclusion were applied to a large extent in the design of the energy transition framework of the region, the voice of the local community could be further strengthened by actively engaging it through diverse participatory approaches.

- All policy decisions relevant to the policy foci of the area were based on wider consultations with participation by the affected parties, but what was identified as a key shortcoming was a lack of a clear and effective evaluation process of all these policies.
- Taking into consideration that the currently applied model of policy design is the top-down model, there is a need for a new policy-design process which combines efficiency, decentralisation, transparency, and evaluation.
- To ensure efficient clean energy, a strategic change of the production model of the region is needed, and a pathway for new investments must be created.
- To tackle the unemployment that will arise in the post-lignite era, the workforce has to be retrained and integrated into new production activities, while entrepreneurship needs to be strengthened and promoted. Science education has an important role to play through the organisation of seminars, educational activities, and the promotion of innovation to tackle the challenges of the energy transition.
- Research and development need to relate to the modernisation of companies. To keep up with the changing globalised market model, research results and outcomes must be used and should follow the responsiveness of local markets, and vice versa, local firms must adapt to new trends and new market demands.

The policy area analysis concludes with some key considerations for the transformative outlooks / the political and societal transformation process in the chosen policy areas. The transformative outlooks will be linked to prior strategies adopted within the territorial level, and will seek to update, expand, and enrich relevant territorial policies for sustainable development, or outgoing smart specialisation strategies, or thematic segments thereof along with enhancing the linkages with AIRR dimensions, especially anticipation, reflexion and responsiveness. These key considerations are:

- Finding strategies to ensure inclusiveness, outreach, and active participation of particular vulnerable groups, such as teenagers, women, and other underrepresented groups. The value of existing consultative fora and approaches in the consultation strategy has been assessed by an external evaluator and the results of the evaluation were given to the region to proceed with further actions.
- The participatory governance strategy for the promotion of the policy focus of economic transition towards a low-carbon economy for the post-coal lignite period, which includes bringing together all stakeholders from the quadruple helix, has worked quite well so far but it needs more concrete linkages between the stakeholders of the policy focus to construct an inclusive transformation path.
- The value of RRI-AIRR in the energy transition of the Region of Western Macedonia can be appraised based on a significant number of stakeholders who collaborate and participate in this area, including research institutes, companies and the regional authority.
- Every component of the transition plan, from spatial planning to investor attraction and governance, needs particular policies. The plan's execution needs to be speedier, more cost-effective, and socially equitable.
- Strengthening and promoting entrepreneurship as well as re-skilling of human resources to combat the unemployment that will arise in the post-lignite era. The application of scientific education, more particularly STEM, can play an important role at this point, through the development of seminars, educational activities, and the promotion of innovation.
- The active participation of citizens in the energy markets, through the energy communities (in the clean energy package, energy communities are legal entities that organise collective and citizen-driven energy actions that will help pave the way for a clean energy transition, while moving citizens to the fore and engaging them to the processes of the energy transition). For this active participation

the added value of inclusiveness plays a significant role by integrating perspectives from a wide range of social actors (including non-organised citizens and non-institutionalised social groups) and involving them in co-creation processes.

- There is a need to promote local activities that can create jobs to replace those lost in the lignite industry while also promoting state of the art innovations that can contribute to a more efficient and effective regional economic development (e.g., smart agriculture, sustainable tourism, clean energy development).
- The promotion of knowledge-intensive activities is also proposed (e.g., hydrogen production, new manufacturing activities), hence investing in Research and Innovation and building synergies between the local community and the University of Western Macedonia is a critical success factor.
- The rehabilitation of depleted lignite mines, spatial planning, licensing simplification, the creation of local energy communities and the launch of big infrastructure projects are highlighted as important prerequisites by the stakeholders.

Synthesis of experiences related to RRI-AIRR

1. Most prominent RRI keys and AIRR dimensions reflected and practiced in the region: Open access, public engagement, inclusiveness, anticipatory governance

Open access

Open access is the most prominent RRI key that is reflected in almost all territorial policies and is practiced by the relevant territorial stakeholders of the quadruple helix. Through the current policies on clean energy for the successful elaboration of the Region's Policy Focus such as the open process of submission of non-binding investment proposals by the public sector since 2020 and public consultations for stakeholder engagement for the energy transition, Open access has improved in terms of people' access to, usage of, and quality of information and communication technology, as well as publicly available data and information'.

The field of digital governance has been crucial for the development of all the 13 Regions of the Greek state and for the transition to the new digital and technology era. The policies and actions are designed and implemented to digitise the whole state governance and support the digital transformation of the country in general. More specifically, for the Region of Western Macedonia this area includes e-government actions related to open data, digital accessibility, digital economy. Through the Regional Development Fund of Western Macedonia with its digital governance there is an ongoing support in the developmental planning, by providing the necessary data for the relevant services, and support the beneficiaries in the process of prioritizing the projects for their implementation, preparation, and integration into the respective operational programmes, as well as to support them during their execution until their completion. All those actions have largely improved the public open access to national, regional, and local data, policies and decisions.

Public engagement

Because the region's policy focus on engagement strategy, territorial governance and an alternative development paradigm towards a low-carbon economy has a direct impact on the society at large, another major and widely practiced feature is public engagement. Public consultation has been so far an important tool in the creation of policies towards the energy transition and intervention actions. Open public consultations on different areas of the policy focus such as clean energy development, industry manufacturing activities, actions for sustainable tourism, etc. were undertaken in connection with the open data, and all stakeholders were given the opportunity to share their thoughts.

Finding ways and means to assure outreach and active involvement of certain vulnerable groups, such as adolescents, women, and other groups not proportionally represented within current interest organisations, has received special attention. Existing consultative fora and techniques were mapped out and their value in the consultation strategy appraised.

Inclusiveness

The participatory governance model for the advancement of the policy focus for the post-coal lignite era has been very well maintained so far by bringing together all stakeholders relevant to the advancement of the energy transition such as academia, businesses of the region, regional policymakers and civil society. There is a collaboration and participation of many stakeholders for the advancement of the three policy areas such as the RIS Structure of Western Macedonia, Regional Authority with the Regional Development Fund, the local university departments and the national centre for research and technological development. There is also a crucial interaction of the research institutes of the region with other agencies and many collaborations with businesses such as PPC and business clusters such as the cluster of bioeconomy and environment of

Western Macedonia as well as ANKO Western Macedonia S.A. organisation for local development which is actively involved in the transition action policies, e.g., new district heating strategies.

The Transition Plan requires specific policies in every aspect, from spatial planning to investment attraction and the governance system. The concern is about the fact that the governance model, which outlines how people in authoritative positions hold themselves accountable to their stakeholders, and incorporates ethics, integrity, and a responsible code of conduct, largely ignores regional and local structure conditions, therefore a combined model of governance, with local and central actors is proposed in the Just Transition Development Programme for the plan to be faster, efficient, cost-effective, and socially fair.

Throughout the preparation of the master plan, regular and open dialogue with stakeholders was maintained, including the Municipal Councils, labour centres, chambers, trade unions, scientific bodies, the University of Western Macedonia, the Centre for Research and Technology Hellas (CERTH). The contribution of the academic community was mentioned as catalytic to co-shape the new upgraded role that the CERTH will have.

Since 2020 a Technical Committee was established, to evaluate the investment proposals and formulate a scientifically substantiated opinion. Non-public sector organisations have been invited to submit non-binding investment proposals and development plans in response to open invitations for the transition economy. Since July 2020, an open process of submission of non-binding investment proposals by the public sector has started. The Government Committee has approved a Special Transitional Fair Transition Programme which is designed specifically for the lignite areas and will be financed mainly by the NSRF 2014–2020, the Green Fund and the Recovery Fund. From September 2020, the Public Sector bodies that are active in the lignite areas were invited to submit proposals within the Special Transitional Fair Transition Programme (2020–2023), for the financing of projects and actions.

The Regional Operational Programme of Western Macedonia promotes the support for Higher Education Institutions and Collaborative Institutions for the development of entrepreneurship, innovation, and business maturity, with the aim of utilising research activity, inventions and new products and services developed in academia, strengthening the connection with the labour market and industry and the employability of graduates and researchers.

The Regional Operational Programme's activities provided an inclusive paradigm for business assistance actions for the application of innovations and/or research and technology outcomes. As a result, mechanisms that presently promote competitiveness, innovation, and business extroversion (incubator, regional framework for company growth) have been established, bringing together diverse stakeholders. Business support activities have resulted in the formation of collaborative schemes (clusters) and networks focusing on key areas, as well as extroversion-oriented business and cluster support actions focusing on local products and services.

2. RRI keys and AIRR dimensions not reflected, understood, lacking, or not practiced: Science education, reflexive governance

Science education

The transition towards a low-carbon economy also shifts the territorial priorities in the STEM field (Science, Technology, Engineering and Mathematics), as seen by the emergence of several new internet-based firms and a growing focus on STEM and robotics education. The investments, which include infrastructure and skills to support STEM-related activities in the Region of Western Macedonia will not be completely realised until 2030. Existing research infrastructure has been upgraded, and new research infrastructure has been created.

Western Macedonia has established a new campus (by 2020) to boost the region's research dimension, as well as upgrading secondary education facilities.

However, the gap between a smooth link between academia, business, and administration is still existent, with the biggest caveat being science education towards the general public. Moreover, science education is not fully supported through funds or concrete development action plans to boost innovation through STEM practices in the region.

Smart Specialisation Strategy is the development strategy of the Region of Western Macedonia, which focuses on exploiting the results of Research, Technological Development, and Innovation from the production sectors in which the region has or can acquire a competitive advantage. It is very important in the new programming period this strategy to focus smartly on those activities of industries, utilising the knowledge of the business and research world.

The Regional Council for Research and Innovation (PSEC) was established in the framework of the implementation of the Smart Specialisation Strategy in the Region, as an instrument to support research, technological development, and innovation development actions. Special emphasis from PSEC is given to the action of Fair Transition in Western Macedonia with the aim of the smooth transition of the region to the next post-coal era and the support of the local community. PSEC focused on the study of socio-economic impacts and challenges of fair transition. The goal of PSEC for the post-coal era is the creation of a dynamic and effective ecosystem of research, innovation, and entrepreneurship. Its role needs to be further strengthened.

The above can help the enhancement of the collaborative and networking actions between research institutions, educational institutions, and businesses in priority areas of the Region. Collaborative links from the aforementioned actors have been established but these established links need to maintain and provide a constant stream of new insights in order to help the region achieve its policy focus on energy transition in a low carbon economy. Science education is a major dimension to the success of the territory’s development and improving it has been highlighted as a critical component of the energy transition.

Reflexive governance

A variety of studies have been conducted on the economic activity, social conditions, and the region's energy profile. Support for de-lignified enterprises, as well as the reinforcement of existing and future investments, will be achieved through the provision of specific institutional incentives (financial, tax, insurance, and licensing), as well as the utilisation of all available resources. However, these provisions and incentives need further elaboration on how they will address each economic and developmental bottleneck of the Region’s economic force since societal circumstances rapidly change due to the nature of the energy transition and there is a need to reassess practices and adjust initiatives and have a more competent reflexive governance.

Assessing the overall RRI-AIRR approach, most of the dimensions are applied to various degrees. Open access, public engagement, inclusiveness and anticipatory governance are the most prominent RRI keys and AIRR dimensions reflected and practiced in the region of Western Macedonia. In terms of ethics formal institutions such as the university follows strict rules over the research processes, data management and other relevant issues concerned. Gender equality plans are established by law and are followed through the university’s committee on gender equality. Science education and reflexive governance are the two dimensions that lag behind. The existing barriers and drivers to integrating all the RRI-AIRR approach in the chosen policy areas of the region, in comparison to other coal-intensive regions, are the lack of progress in energy transition which includes a significant lack of response in terms of effective policymaking. The important transition to renewable energy resources without a thorough strategic and spatial planning along with environmental impact assessments, demonstrate a lack of reflexivity and anticipatory governance by regional and national policymakers. Significant delays in key anticipated investments are caused by a bureaucratic and ineffective public administration, demonstrating a lack of reflexivity and responsiveness.

Stakeholder's mapping: synthesis of experiences related to RRI-AIRR

In this section we identify stakeholders that are highly relevant to RRI-LEADERS' objectives in four areas:

1. stakeholders with **high levels of interest in relation to RRI in practice,**
2. stakeholders with **high levels of experience in RRI**,
3. stakeholders with **high levels of power**, and
4. stakeholders with **high levels of influence on RRI in practice.**

The table is presented in the Appendix.

SWOT/TOWS analysis

SWOT analysis

The section describes the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis for the three chosen policy areas in Western Macedonia. SWOT analysis has been used to identify possibilities for integrating RRI-AIRR approach in the low-carbon transformation in Western Macedonia, including the potential benefits and possible negative aspects of such integration. The main findings of the SWOT analysis are presented in the table below.

Table 1: SWOT analysis

Internal factors	
Strengths – territorial stakeholders and policy areas	**Weaknesses – territorial stakeholders and policy areas**
Stakeholders: (1): Open access is reflected in almost all territorial policies and therefore represents the most prominent RRI key. Open access is mainly practiced by the Academia, Business and Civil Society. (2): Business and policy making organisations consider ethics as fully implemented. They are also applying practises close to RRI keys and AIRR dimensions such as public consultation indicating inclusiveness. (3): The University and CERTH are the public bodies which implement RRI keys and AIRR dimensions in the most effective way, followed by the Regional Authority and the municipalities. **Local policy areas:** There are several policy documents fully relevant to the region's policy areas that reflect some of the RRI keys and AIRR dimensions (open access, science education, inclusiveness) to a high degree, and some RRI keys (public engagement) and AIRR dimensions (responsiveness) to a sufficient degree. (4): RRI/AIRR keys/dimensions are well-reflected in the following documents:	**Stakeholders**: (1): Lack of effective cooperation between societal, research and business stakeholders does not favour the generation of RRI-AIRR outputs. **Local policy areas:** (2): **The centralised institutional** setting of the state gives little room to regional and local actors to apply the AIRR dimensions of reflexive and responsive governance. (3): Science education and anticipatory governance are partially applied since research results are not sufficiently embedded in energy transition policymaking systems. Thus, there is a need for more targeted scientific research that can directly incorporate societal local needs. (4): The short coal phase-out timespan is considered by many local actors as adequate, which is contradictory to the existing notion that the timespan given for the transition is very short – this is an indication of a lack of anticipatory governance.

• "Develop a stakeholder engagement strategy within the course of the post-coal transition road map": Road Map for a Managed Transition of Coal-Dependent Regions in Western Macedonia (adopted in 2020). • "Strengthen policy-making systems involving different modes of territorial governance of the post-coal transition strategy": Regional Operational Programme for Western Macedonia (adopted in 2014). • "Develop a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'": Stakeholder Engagement Plan (SEP) for Western Macedonia (adopted in 2020) and Just Development Transition Plan (adopted in 2020).	
External factors	
Opportunities (of the external environment)	**Threats (of the external environment)**
(1): The energy transition is associated with a special emphasis on digital transformation policies, which is expected to help local enterprises benefit through accessing valuable information and networking opportunities, achieving maximum levels of open access. (2): The already-implemented post-coal practises from other coal intensive countries in energy transition can help the region to improve the integration of RRI-AIRR approach in territorial governance. (3): Just Transition fund and the Green Deal Strategy provide many opportunities for applying RRI-AIRR approach promoting responsive governance, by drastically strengthening the digital / innovative competences of the local workforce through skilling, upskilling and reskilling practices. (4): Extensive environmental restoration and land repurposing of the region involves a holistic green strategy which takes into consideration the perspectives of societal actors, promoting inclusiveness and regional anticipatory and accountable government.	(1): The region shows a step back and lack of progress in energy transition compared to other coal intensive regions in EU. This concerns public engagement strategies which seem to be less reflexive, responsive and inclusive, failing to comprise local governance conducted by local actors. (2): The critical shift in the development of measures such as photovoltaic installations and wind turbines that is currently being implemented, may harm the environment without contributing to new jobs. This is an indication of lack of reflexive governance and may need to be readdressed. (3): Limited open access of local societal segments in the public consultation takes place regarding post-coal transition. While the transition mechanisms foresee and implement full publication of both policy decisions as well as consultations, the implementation and evaluation process are absent. This leads to the possible exclusion of crucial policy remarks by the local peripheral and national actors in the post-coal transition, indicating lack of inclusiveness. (4): A bureaucratic and dysfunctional public administration leads to significant delays in critical scheduled investments that may jeopardise the whole just transition plan, indicating a critical lack of responsive governance and reflexivity.

TOWS analysis

In this section the **TOWS** (inversed SWOT matrix) analysis is presented. The TOWS matrix is action-oriented and is focused on identifying dependencies and linkages between internal and external factors so as to outline development strategies and propose actions to take advantage of identified opportunities, leverage existing strengths, and focus on minimising/mitigating external threats and addressing internal weaknesses.

The main findings of the TOWS analysis are presented in the table below.

Table 2: TOWS analysis

	External opportunities (O)	**External threats (T)**
	(1): The energy transition associated with digital transformation policies, sparks open access. (2): The experience gained from other coal intensive countries can improve the integration of RRI-AIRR approach. (3): Just Transition Fund and the Green Deal Strategy provide many opportunities for applying RRI-AIRR approach. (4): Environmental restoration and land repurposing involves a holistic green strategy promoting inclusiveness, anticipatory and accountable governance.	(1): The region shows a step back in public engagement, reflexivity and responsivity compared to other coal-intensive regions in EU. (2): The massive shift in photovoltaics and wind turbines without contributing to new jobs, indicates a lack of reflexive governance. (3): Limited access of local societal groups to public consultation during the implementation and evaluation processes. (4): Bureaucracy may jeopardise the just transition indicating a lack of responsive governance and reflexivity.
Internal strengths (S)	Strengths-Opportunities strategy (S-O) **(Maxi-Maxi strategy)**	Strengths-Threats strategy (S-T) **(Maxi-Mini strategy)**
(1): Open access is reflected particularly in Academia, Business and Civil Society. (2): Business and policy making	(1-S)-(1-O): Digital transformation may be formed into a multi-functional open-access database. (2-S)-(1-O): Ethics is incorporated as a primary RRI-AIRR prerequisite to all digital measures. (3-S)-(1-O): Research institutions are actively involved in the digital transformation and RRI-AIRR approach. (4-S)-(1-O): Energy transition programmes involve digital transformative initiatives and RRI-AIRR measures. (1-S)-(2-O): The incorporation of open access practices implemented in other coal areas contributes to the effective implementation of RRI-AIRR principles. (2-S)-(2-O): Ethics can improve an ex-transition practises framework, by incorporating ethical issues (equal access, environmental protection) in an already effective framework.	(1-S)-(1-T): Initiate a broader engagement strategy spectrum that allows a fast exploitation of stakeholders' perspectives. (2-S)-(1-T): Ethics is embedded in a holistic transition framework that will promote equal participation of local societal segments. (3-S)-(1-T): UoWM is actively involved in the implementation of energy transition. (4-S)-(1-T): Mature and well-developed transformational initiatives with significant magnitude of investments are implemented. (1-S)-(2-T): Open access to decision making allows an effective social consultation on massive shift in photovoltaics and wind turbines. (2-S)-(2-T): The assimilation of ethics in transition strategy, restricts the over-development of investments such as photovoltaics and wind turbines that do not create new jobs. (3-S)-(2-T): University/CERTH promote the scientific research on more valuable energy sources such as Hydrogen etc.

organisations consider ethics in particular as fully implemented. (3): The University and CERTH are the ones that primarily implementing RRI keys and AIRR dimensions to the most effective way (4): RRI/AIRR keys/dimensions are well-reflected into the key policy documents referring to Western Macedonia	(3-S)-(2-O): The University of Western Macedonia and CERTH contribute to the transfer of experience gained in other countries. (4-S)-(2-O): Strategic action programmes are enriched by practises gained from coal-transition regions. (1-S)-(3-O): Open access foreseen in Just Transition Fund and the Green Deal Strategy, promote an innovative capacity building involving skilling, upskilling and reskilling practices (2-S)-(3-O): The Just Transition strategy incorporates ethics, taking into consideration business and all societal actors. (3-S)-(3-O): University/CERTH lead the development of a holistic educational framework for the post-coal future workforce. (4-S)-(3-O): Just transition programmes incorporate innovative competences for the local scientists and workforce. (1-S)-(4-O): Restoration and land repurposing foresee full open access as well as public consultation and engagement for local key-actors. (2-S)-(4-O): Land restoration focuses on impacts, affecting all societal segments. (3-S)-(4-O): UoWM/CERTH scientifically supports the environmental restoration. (4-S)-(4-O): Environmental restoration is incorporated in all energy-transition programmes.	(4-S)-(2-T): The Regional Operational Programme foreseen diversified green energy sources. (1-S)-(3-T): Open access in evaluation procedures is initiated, actively promoting the participation of societal actors. (2-S)-(3-T): Ethics is embedded in all phases of public consultation by clearly addressing open access to all strategic documents. (3-S)-(3-T): UoWM/CERTH develop open platforms for the evaluation of the transition strategy and actions. (4-S)-(3-T): Transition Programmes foresee a broader participation of all quadruple helix segments. (1-S)-(4-T): Open access platforms limit the negative effects of bureaucracy. (2-S)-(4-T): Ethics is incorporated in public administration in terms of accountable governance to societal needs. (3-S)-(4-T): University develops an innovative governance model for energy transition. (4-S)-(4-T): The transition funds accelerate the implementation of the proposed investments and transformations, overcoming bureaucracy.
Internal weaknesses (W)	Weaknesses-Opportunities (W-O) **(Mini-Maxi strategy)**	Weaknesses-Threats (W-T) **(Mini-Mini strategy)**
1): Lack of effective cooperation between societal, research and business stakeholders does	(1-W)-(1-O): An effective digital transformation favours cooperation between the stakeholders. (1-W)-(2-O): Incorporation of already-implemented practises in other coal-regions, contributes to effective cooperation. (1-W)-(3-O): Just Transition Fund and the Green Deal Strategy encourage innovative approach of cooperation. (1-W)-(4-O): Environmental restoration strategy involves societal actors such as	(1-W)-(1-T): The lack of cooperation is minimized by setting a clear roadmap, distinct duties and effective governance model. (1-W)-(2-T): The development strategy of photovoltaics and wind turbines promote an effective cooperation among societal actors. (1-W)-(3-T): Open debates and referendums on transition strategy and key investments are applied.

not favour the generation of RRI-AIRR outputs. (2): The centralised institutional setting of the State gives little room to regional and local actors to apply reflexive and responsive governance. (3): Science education and anticipatory governance are partially applied without incorporating societal local needs. (4): The short coal phase out time span is not considered by most local actors as unrealistic indicating a lack of anticipatory governance	farmers and producers in the consultation and the decision making. (2-W)-(1-O): Decentralisation of the consultation and the decision making models is supported through digitalisation. (2-W)-(2-O): Practises from ex coal intensive regions include local decision making and place-based approaches. (2-W)-(3-O): The implementation rules of the Just Transition Fund encourages the decentralisation of the State in the particular area. (2-W)-(4-O): The implementation of a holistic green strategy advocates decentralisation policies. (3-W)-(1-O): Societal needs are incorporated into scientific research through extensive digitisation. (3-W)-(2-O): Scientific research and anticipatory governance are taking into account best practises from other coal regions. (3-W)-(3-O): Local societal needs are sufficiently embedded into Just Transition Fund and the Green Deal Strategy. (3-W)-(4-O): Scientific research is focused on environmental restoration taking into consideration societal local needs. (4-W)-(1-O): Digital transformation eases the negative consequences of a short time span of coal phase out. (4-W)-(2-O): The negative consequences of the short time span are mitigated by integrating the experience in other coal regions. (4-W)-(3-O): Just Transition Fund quickly transforms the local workforce to become capable to find alternative jobs in the short period. (4-W)-(4-O): Environmental restoration and land repurposing is implemented shortly, aligned with the time span.	(1-W)-(4-T): Emphasis on digitization is decreased bureaucracy and increase the effectiveness of cooperation. (2-W)-(1-T): Decentralisation in decision making speeds up the implementation of energy transition. (2-W)-(2-T): Decentralisation brings investments more directed to local needs, apart from photovoltaic and wind turbines. (2-W)-(3-T): The evaluation of scientific results at a local level connects scientific research to local needs. (2-W)-(4-T): A clear distinction in administrative procedures and competences between the State and the local level, enhances the effectiveness of post-coal strategies. (3-W)-(1-T): Research is focused on transitional needs aiming to speed up the implementation of post-coal strategy. (3-W)-(2-T): Scientific studies of alternative energy solutions such as energy storage, hydrogen and biomass contributes to a more balanced energy mix. (3-W)-(3-T): Science results of the local university are evaluated on the basis of benefits to the local communities. (3-W)-(4-T): Science research that takes into consideration local needs and anticipatory governance practices decrease bureaucracy. (4-W)-(1-T): An extension to coal phase out road map brings the necessary time for a smooth transition. (4-W)-(2-T): A more balanced energy mix by including not only photovoltaic and wind turbine but also other energy solutions, contributes to a realistic phase out and smooth transition. (4-W)-(3-T): A large part of the evaluation of the transition plans is attributed by local bodies rather central entities. (4-W)-(4-T): Simplifying the investment requirements and invest on digitization overcome bureaucracy and accelerate the transition plan.

Identification of strategic policy priorities

The chosen policy areas are a part of a broader strategy of energy transition, which is focused in articulating the following strategic policy pillars which were taken into consideration for the implementation of the SWOT/TOWS analysis. The strategic policy pillars are:

- Energy transition – climate neutrality.
- Empowerment and promotion of entrepreneurship.
- Just transition and strengthening human capital.
- Agri-food and farming sector.
- Adjustment of land reuse – circular economy.

1st Policy focus: Develop a stakeholder engagement strategy within the course of the post-coal transition road map

The most effective policy priorities for the stakeholder engagement strategy within the course of energy transition can be exported from several distinct policy documents that have already been prepared by the policy makers for that specific cause. Taking into consideration the strategic policy pillars and the strengths/weaknesses/opportunities/threats/ accruing from the SWOT/TOWS analysis, a strategic policy priority is: "***Development of supportive digital infrastructures and services of smart communities".*** This policy priority would identify, promote, and implement the necessary digital infrastructures that are necessary for the characterisation of a community as "smart". These infrastructures concern the region's public infrastructures as well as business and home infrastructures of the communities. They can include high speed net based on digital/optical fibre networks, electric mobility installations, sophisticated web services, enterprise resource planning (ERP) systems for public and private organisations, GIS systems, sophisticated sensors' city networks, etc. All the above would critically strengthen the post-coal transition road map, allowing stakeholders from all quadruple helices to get engaged in favourable terms and cope with the harsh post-coal challenges, promoting inclusiveness at an effective way.

The next strategic policy priority is focused on offering the local communities and workforce a total framework of strengthening their own capabilities, to cope with the challenges occurred by the energy transition. This is: ***"Upgrading the skills and retraining (upskilling & reskilling) of the employees of the companies that need support for their transition to the economy of zero pollutants".*** This is initially focused on empowering local workforce with new and innovative skills to be able to either change their current occupation or stay within it with increased capabilities. Those competences will be included in a holistic educational framework that includes digital/internet competences, RES, and alternative energy sources (for current / ex-employees of the PPC S.A.), innovative entrepreneurship and start-up establishment (counselling/mentoring programmes). University and CERTH will play a primary role in establishing this priority, promoting reflexivity by the policy making sector in directing the framework on their exact needs.

Following the previous rationale of the highest possible inclusiveness of all engaged actors, anticipatory governance in setting clear policy targets and reflexivity directed to the exact needs of stakeholders and the region in total, the next policy priority is: ***"Development of a social safety framework".*** The main aim of this policy is to directly help local community with financial, insurance and employment motives to cope with immediate effects of post-coal transition. This policy is implemented through direct payments, subsidies, compensations for current and past coal workers, decommissioning work status or transfer to another public organisations, early-stage or voluntary retirement status and indirect compensations (tax reductions, loan

provisions, etc.), fully implementing reflexivity/responsiveness in societal needs and inclusiveness regarding all actors.

The next policy priority deals with the environmental consequences of the past-implemented coal activity in the region and the future investment prospects. The policy is: ***"Restoration of degraded areas and facilities and change of their use".*** It can be implemented through the necessary soil restoration and land use adjustment regarding the ex-coal mines, air pollution and biodiversity monitoring, energy crops on degraded land, free provision of land to local entrepreneurs, RES investments promotion, geothermal energy, or hydropower applications in the degraded areas. This is a sample of Reflexive Governance, engaging science in researching scientific approaches for all the above and promoting a responsive approach to the environmental degradation.

2nd Policy focus: Strengthen policy-making systems involving different modes of territorial governance of the post-coal transition strategy

The following policy priority reflects the reforms/upgrades that must take place in the administrative/ legislative framework of the post-coal region indicating the effectiveness of the whole post-coal transition plan itself. The policy priority is: ***"Development of an effective just transition governance system with the involvement of regional structures in governance"***. The implementation of this policy priority can take place through the improvement of the current legislation framework to a more flexible one (lift of bureaucratic burdens), the initiation of a Just Transition Observatory that will record plan's progress, the development of a multilevel governance system that will involve all actors, and the shift of the decision-making system of the transition plan to a local basis.

The next policy priority deals with the energy consumption in the region and the promotion of investments/technologies that contribute into that direction. The policy priority is: ***"Strengthen innovative energy technologies".*** The policy includes energy consumption monitoring which will be implemented through the development of smart energy systems, an H2 Innovation Hub promoting Hydrogen technologies, the construction of heating / cooling units with heat pumps and RES for the energy needs of the region of Western Macedonia and the development of storage and energy supply networks. These technologies will occupy scientific institutions as a research field, local/national businesses as an investment field and local/national authorities as an administration field, benefiting local society through all three fields. Inclusiveness is secured through the involvement of all actors and reflective governance through the satisfaction of needs regarding clean energies.

The following policy priority is connecting research with production, promoting scientific research, start-up entrepreneurship, and the creation of research-business synergies. The name of the priority is: ***"Linking research with production, promoting start-up entrepreneurship, and creating spin-offs".*** The priority includes an Innovation Zone and an Academy Institutes creation, the establishment of an open access green datacentre containing all scientific and professional research regarding green technologies and the mass promotion of start-ups and university spin-offs.

The strategic policy priority of ***"Development of an effective social dialogue between the actors of the quadruple helix (***policymakers, academia, business and civil society)***"*** is predominantly concerned with the active involvement of all actors of the helix in the energy transition plan, from the evaluation to the implementation phase. The implementation activities behind this policy include the establishment of an open access database where all actors can consult, take decisions, and evaluate progress of the on-going scientific, legislative, and entrepreneurial activities regarding the transition plan. Inclusiveness is the primary AIRR dimension of this priority, with responsiveness by the side of central policy makers for the local needs to follow.

3rd Policy focus: Develop a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'

The next policy is primarily focused on enhancing local businesses coping with the strict obligations for green activities. It consists of combination of measures regarding financial support on digital infrastructures (exclusively for businesses), investment incentives and supplementary organisations exclusively focused on zero-emission economy. The policy is: ***"Transforming and strengthening the competitiveness of existing companies that need support for their transition to a zero-emission economy by 2030".*** It is implemented through an effective Carbon dioxide ETS and an Integrated Information System (IIS) system evaluating organisation's carbon levels, and the creation of green clusters, promoting low-carbon economy. Anticipatory Governance is secured through the expected green outcomes of the implemented policies, the level of inclusiveness concerns Green private businesses, while responsiveness is expressed through the implementation of measures that can satisfy the strict low-carbon EU prerequisites.

The following policy provides a holistic development framework for the attraction of innovative companies lead to transformation of the existing production model. The policy is: ***"Establishment and attraction of new companies that create jobs and lead to economic diversification, modernisation and transformation of the existing production model".*** The policy consists of all necessary measures to diversify the existing production model of the region to a new, innovative one that can afford that harsh coal-transition in the long term. It is implemented through the promotion of IT, bio- & nanotechnology, and medicine facilities, the empowerment of current research institutes and innovation zones and active relocation of existing local businesses to innovation parks. This policy is articulated on the STEM-based RRI key of science education, to perform the necessary research and the inclusiveness of the highest possible number of companies to the aforementioned policies by the policy makers, reflecting the local entrepreneurial needs.

The final policy priority concerns the energy upgrade specifically in the public infrastructures of the region. It involves a total energy efficiency empowerment in the local public infrastructure including office buildings and production units from municipal and other local authorities and supporting energy communities on the public local level. The policy is: ***"Improving energy efficiency in public buildings and strengthen energy communities".*** The primary AIRR dimension implemented at this case is reflexivity to the green needs of the synchronous business environment as well as the national and EU legislations. Direct financial support of energy investments by the public policy makers will activate local stakeholders (from business and community) to follow and adopt green practises.

Summary of focus group discussions

In this section we briefly summarise the main points arising from the discussions of the four focus groups.

Focus group: Academia

The vision

The focus group of the stakeholders from academia was held as an online discussion among 14 participants. Concerning the vision for the territorial development in the policy area of energy transition and decarbonisation by 2030 in the region, there were two main views. On the one hand, the participants stated that there is a lack of concrete communication of the implementation steps for the transition plan of the region. This left the participants with a blurred understanding of what this energy transition strategy is and therefore they do not have a clear vision for the future. On the other hand, several participants shared that research and innovation should be integrated into whatever solution is going to be implemented for the energy transition. Changing the situation from threat to opportunity should go through innovation. In the complexity of the whole transition process there is a pressure that comes from above (the national level and also the EU level) for decarbonisation of coal intensive regions, but also a benefit that concerns the global level. Therefore, the region of Western Macedonia needs to absorb this pressure in a way that benefits the local community that sees this process as a threat.

Necessary changes and strategies arising from the region's vision

The focus group participants agreed that to achieve this transformation in the context of research and innovation, an evaluation framework should be included. This evaluation framework will have to be participatory and incorporate many dimensions to identify ineffectiveness, inefficient units, and inefficient groups. In addition, the changes the region must implement to achieve this vision have a common denominator according to the participants: public engagement is viewed as the foundational key to support the transformation process of the region. To achieve this, it is good to implement the **public consultations** in a strategic and thematic way i.e., to have a coordination within specific topics and to create the appropriate strategic planning or consultation groups on specific issues.

Transformation & collaboration

Regarding the perceived role of the academia in the process of this transformative change, participants stressed the importance of the university for disseminating knowledge and providing key research for pressing issues of the region. The university and all its academic personnel along with its research institutions are crucial for bridging the research and development weakness of the businesses in the region through strategic synergies and by enhancing scientific education through their work and collaboration with the region's stakeholders and the public. In academia, a new term has emerged – the so-called institutional viability. That is, for a project or process to be implemented properly it must have social, economic, environmental, and institutional viability.

Recommendations for RRI / AIRR approach integration

Finally, **recommendations for integrating the majority of RRI keys and AIRR dimensions** into defined strategic policy priorities were made by the focus group participants. Changes must be made in order to have effective **public engagement and science education**. The university research centre needs to play an active role. Essentially all the strategies of the programme at the level of the university research centre need to be successfully disseminated. Each institute needs to transfer to the university community all these strategies and to seek collaborations with specific companies that want to be involved in the transition. Businesses with

the help of the university research centre will be able to take actions to implement the vision and strategy for the transition.

Focus group: Business

The vision

The focus group of the business stakeholders took place online with 8 participants. Regarding the vision for the territorial development in the policy area of energy transition and decarbonisation by 2030, all participants mixed optimistic with pessimistic views. Business stakeholders follow with great interest the region's effort for development planning and what they have called a fair development transition. Much of the region's wealth came from the lignite mining and the business vison is that the atrophic RIS sectors (agri-food, health-medicines, ICT, energy, environment and sustainable development, transport, materials – construction, tourism-culture-creative industries) for the region of Western Macedonia must be rejuvenated. At the moment, a desperate effort is made in the sense of time pressure because the region is in the process of changing its production model, going into the path of clean energy and trying to lead other sectors of the economy that will bring added value for the region. In order for businesses to adapt in such a short time, very robust measures and transformative design must be made and there must be equal development of various sectors of the region in order to have a transformative process.

Necessary changes and strategies arising from the region's vision

Regarding the strategic priorities to be followed, the focus group participants agreed that to achieve this transformation there is an urgent need to change the production model in a targeted way depending on the know-how and potential new added values that each business affected by the transition could bring. For example, some businesses in the agri-food sectors (especially in the field of medicinal herbs) had discussions with the region as representatives of the field to participate in processes of making the region's lavender sector protected agricultural origin. At the moment, the business sector of the region has a pool of specialised personnel only linked to PPC and with the energy transition this pool of personnel will be unskilled to be assimilated in new production models or specialties. The region must consider this well so that it does not become desolate, and the local workforce stays in the area. What is therefore needed is to retrain and reskill the staff and integrate them into the other branches of the economy that will be developed in the region.

Transformation and RRI keys

Most of the focus group participants stressed that for this transformation process, the commitment to participation and public engagement is crucial because this transition affects all stakeholders and citizens. Regarding the perceived role of the businesses in the process of this transformative change, panellists underlined their role in incorporating local workforce in the various provinces of the Region of Western Macedonia due to internal immigration caused by job losses from the energy sector and the search for new job opportunities in the area. Businesses are helping in assimilating new recruits and try to apply a form of reskilling to the extent allowed by their business resources. However, their role as business stakeholders must be seen as complementary and they need the help and guidance from the other stakeholder groups in the process of this transformative change. The panellists expressed their concerns that the links between business and academic institutions must be strengthened because businesses can collaborate with the research institutions to provide innovative outputs for the region and contribute better to the transformative model with the help of the academic know-how and research on a regional level. The role of the Regional Authority plays an important role in the transformative process because it can help local businesses with financial schemes to help in their production model change and give new incentives for in-house investments

in the region from the currently existing local business sector. Administrative ameliorations and optimised procedures to lessen the bureaucratic bottlenecks for local investment procedures must be done by the Regional Authority.

Recommendations for RRI / AIRR approach integration

The focus group participants made recommendations for integrating RRI keys and AIRR dimensions into defined strategic policy priorities and how the process of transformative change can be organised. Strong incentives should be given to attract investments in the region that will generate wealth and attract workforce in the region. In addition, there should be a differentiation of the production base, considering all the other sectors along with the social impact, the environmental footprint they have in the area and considering the participatory processes combined with entrepreneurship beyond the production of wealth. Local entrepreneurship must be enhanced through incentives because it creates added value in final products or in services of the region. Another strong recommendation put on the table was the synergies. Every company should be interested in its development through synergies with research institutions, universities, etc. These participatory processes and public engagement must exist so that everyone contributes from their own sector of expertise and gives their contribution to the region's economy and move forward to a sustainable development beyond economic development. This can mostly be achieved through participatory processes, collaborations among business clusters of the region for the development of value-added products for the region and the adoption of all these research and development results. The primary sector needs support because for some businesses to shift in the agri-food sector, which is considered for the region an industry that needs support, they must be supported with incentives and regulatory frameworks. That is, there is a need to create an integrated model with various elements to have a production chain that can maintain a circular efficient feedback loop of the elements.

Focus group: Policymakers

The vision

The policymakers' focus group took place online with 8 participants. The political decisions for the rapid delignification of Greece until 2028 formed the vision for a just transition in Western Macedonia. The region has already entered a process of transformation, which is rapid and with significant economic, social, and environmental implications. This vision in practice focuses on a drastic change of the production model towards an environmentally neutral, socially sustainable, and economically competitive region. This vision however, even though it was reflected in important programmatic texts such as the Just Development Transition Plan of Western Macedonia, in practice it has not become "property" of the local actors and society yet, as it was largely imposed from above. As a result, it was not sufficiently understood that we are called upon to manage a problem of historical proportions.

Necessary changes and strategies arising from the region's vision

The necessary changes resulting from the above vision are the turn to green energy and transition to a zero-emission economy to attract critical size new investments, while linking companies with research organisations and promoting internationally competitive products and services. Changes also need to be done in active labour market support policies, such as the acquisition of new skills (skilling), the upgrading of existing ones (upskilling) and the retraining (reskilling). Finally, actions for soil restoration in the areas of former lignite mines and upgrading of the natural and cultural environment are needed.

The necessary strategies arising from the above vision:

- ⇒ Entrepreneurship Strategy
- ⇒ Research and Innovation Strategy
- ⇒ Energy Strategy
- ⇒ Environmental Regeneration Strategy
- ⇒ Human Resources Strategy
- ⇒ Digital Transition Strategy

Transformation and RRI keys

RRI keys should be the basis of transformation and change. Public engagement, however, has not been achieved at a satisfactory level in practice, as much of the consultation that has taken place, has been largely veiled to legitimize the planned policies. For the public engagement to work effectively, more place-based approaches and a more decentralised transition governance system are needed. In this way, the co-shaping of transition policy specialisation could be achieved, through the active and responsible involvement of critical local actors. The keys of open access and scientific education could also contribute to the change process if the relevant data, studies, and research results are uploaded on public platforms and repositories. At the same time, the calls of the relevant programmes could make as an obligatory condition the open access and uploading of the results in common repositories.

Transformation and AIRR dimensions

There is a need for flexible design which should be open to change of course if the need arises, incorporating the responsiveness dimension. To achieve this however, bottom-up models are necessary which should not be designed centrally. There is also considerable gap for further integration of the dimension of anticipation as well as reflexivity in policy design, analysis, and evaluation, in an environment that is rapidly changing environmentally and technologically.

Transformation and collaboration

It has been found that the partnerships have not developed to the extent that they should, active participation and effective collaboration in the direction of co-forming a common vision. This problem lies not only in the top-down approach of the transition governance, but also in the inability of key players at the local level to find a common ground, often due to a different or competing agenda. In this context, the convergence of goals and priorities between policy makers, researchers, businesses, and civil society requires confidence-building strategies, sound arguments, credible data, and technocratic support.

Recommendations for RRI / AIRR approach integration

The integration of the RRI / AIRR approach into the selected policy areas requires a policy engagement that is structural in nature and will lead to a policy framework in the long term. This requires a solid cooperation at national and local level, in a multi-level transition governance approach. To achieve this, a mobilization of policy co-shaping dynamics at the regional and local level, towards the realization of a long-term vision that has not been imposed from above. This outline could create favourable conditions for integrating a more effective RRI / AIRR approach in the transition process.

Focus group: NGOs

The focus group of the NGOs' stakeholders took place online and had only 1 participant.

Vision

The NGO panellist spoke about the need to transform the current production model of the region to an alternative one that is primarily based on RES. However, the way this will be implemented and the benefits to the local society and economy are not clear to the broader public. This leads to the conclusion that further clarification to the wider local public is needed.

Necessary changes and strategies arising from the region's vision

The most prominent changes that are accrued from the current vision for the development of the region of Western Macedonia are the need for a change of the local production model to a RES. In addition, the current legislation framework needs to be simplified to remove obstacles for investments. There must be a provision of clear incentives for investments in the region, such as direct subsidies and tax motives as well as a better communication towards an effective public consultation, based on quadruple helix approach.

Transformation and RRI keys

The participant expressed that even though there are only a few NGOs in the region, they can play an important role as they can operate on a local scale to promote social or political change. The NGOs are vital to the development of society, the improvement of communities, and the promotion of citizen engagement in the transformative processes of the region. The proper implementation of the RRI keys should be the primary mean of the transformation of the existing production model and energy transition. However crucial keys have not been applied at an adequate level. First, public engagement has not been adequately implemented since the largest part of the public consultation that has already been conducted did not include key quadruple helix segments. So, for the remaining part of the public consultations it is vital to address the aims and the objectives of all actors. Likewise, the key to open access has to be implemented properly, especially in the decision-making part where the local society has not agreed or accepted many of the proposed investments (e.g., very large photovoltaic projects that are not labour-intensive). Moreover, the key to science education in the region should be connected directly with real economy rather than remain in theoretical level.

Transformation and AIRR dimensions

The practice of the energy transition so far has indicated that there is a need to enhance the distinct AIRR dimensions that have not been implemented at a sufficient level. Anticipatory governance has to be strengthened in the direction of foreseeing the positive and negative effects that the current transition model may bring to all participating actors. Responsiveness must by enhanced at an even greater level. The reflexivity of the central policy makers should be expressed in addressing major local concerns such as the timeframe of the proposed energy transition plan, which for a large portion of the participating actors is considered very limited.

Recommendations for RRI / AIRR approach integration

A clear anticipatory framework by the central policy makers is needed, which would clearly foresee all possible positive and negative effects of the current transition plan. Moreover, this framework should be strengthened in the direction of reflexivity and responsiveness by adopting the major concerns and requests by the societal and research actors, such as the inclusion of all participating actors in the decision making, the more effective communication of the Just Transition Plan principles to the wider public and the initiation

of financial motives to the local businesses to cope with the harsh in- and just-after transition business environment.

Analytical resume

This section summarises the discussion and findings from all focus groups that were conducted. First, all the stakeholders held similar opinions on the necessity of shifting the region's present production model to an alternative that will incorporate the new emerging needs of the energy transition. Opposing views were identified in the linkages that should exist between the stakeholders and what would be the most effective way to achieve a robust networking. Businesses can engage with research institutions to offer creative outputs for the region and contribute better to the transformational model with the support of academic know-how and research on a regional level. Businesses without their own research and development department need the help and access to academia through research institutions to make collaboration for business growth, research consultations and innovations. The regional authority's participation is critical in the transformation process because it may assist local firms with financing schemes to aid in the shift of their production model and provide new incentives for in-house investments in the region from the existing local business sector. Administrative improvements and processes must be implemented to reduce bureaucratic bottlenecks in local investment procedures, with the Regional Authority playing a vital role in this. This issue stems not just from the top-down approach to transition governance, but also from major individuals at the local level's failure to establish common ground, frequently owing to conflicting or opposing agendas. In this setting, confidence-building tactics, good arguments, trustworthy statistics, and technical assistance are required for policymakers, researchers, corporations, and civil society to align their aims and priorities.

Regarding the common ground that can be found for advancing the RRI-AIRR approach, the integration of the RRI / AIRR methodology into the relevant policy domains necessitates a structural policy engagement that will result in a long-term policy framework. Strategic, tactical, and operational actions are widely split, with each activity having its own players, objectives, and tactics that co-evolve, this necessitates strong collaboration at the national and local levels. To do this, policy co-shaping processes at the regional and local levels must be mobilised to realise a long-term vision that is not imposed from higher levels. This plan may make it easier to include a more effective RRI / AIRR strategy into the transition process. Public engagement is the foundation that needs to be enhanced in the region to achieve the desired transformation. Anticipatory governance must be reinforced to predict the good and bad consequences that the existing transition model may have on all stakeholders. Central policymakers' reflexivity should be demonstrated in resolving key local issues, such as the planned energy transition plan's timescale, which is deemed severely constrained by a big number of the involved actors. Finally, through targeted networking and partnerships with the region's stakeholders and the public, scientific education can be improved by creating strategic synergies with the stakeholders and include more active public interaction in the agenda.

The following conclusions can be made from the four focus groups:

- There is a necessity of shifting the region's present production model to an alternative that will incorporate the new emerging needs of the energy transition (anticipatory and reflexive governance).
- Collaboration between business and academia is considered crucial to the development of a transformational model (science education).
- Quadruple helix engagement is critical in the transformation process (inclusiveness).
- Integration of the RRI-AIRR methodology into the relevant policy domains necessitates a structural policy engagement that will result in a long-term policy framework.

- Multi-level transition governance model, with strong collaboration at the national and local levels.
- Reinforcement of anticipatory governance and responsiveness is considered as a necessity for the new governance model of the post-coal transition strategy.

Policy recommendations and conclusions

The RRI audit report for the region of Western Macedonia brings forth the following conclusions regarding the embeddedness of RRI-AIRR approach in the regional policy discourse:

The most prominent RRI keys and AIRR dimensions reflected and practiced in the region are open access, public engagement, inclusiveness and anticipation. Open access is the most prominent RRI key reflected in almost all territorial policies and practiced by the relevant territorial stakeholders of the quadruple helix. More precisely, open access has improved in terms of people's access to, usage of, and quality of information and communication technology, as well as publicly available data and information. Public engagement is also widely practiced in the region, with public consultation constituting an important tool in the creation of policies towards the energy transition. The participatory governance model for the advancement of the policy focus for the post-coal lignite era has been very well maintained so far by including all stakeholders relevant to the advancement of the energy transition such as academia, businesses of the region, regional policy makers and civil society. Moreover, mechanisms that presently promote competitiveness, innovation, and business extroversion (incubator, regional framework for company growth) have been established, bringing together diverse stakeholders.

On the other hand, science education and reflexive governance are not applied or practiced sufficiently. Although there are investments in the region which include infrastructure and skills to support STEM-related activities, there is still a big gap concerning a smooth link between academia, business, and administration. Moreover, science education is not fully supported through funds or concrete development action plans to boost innovation through STEM practices in the region. Regarding reflexive governance, the findings call for a need to reassess practices, to adjust initiatives and thus have a more competent reflexive governance.

The evidence of SWOT/TOWS analysis and four focus groups provide a clearer picture on the level of RRI-AIRR integration. The TOWS analysis identified a total of eleven strategic priorities among the policy areas of the region in which RRI-AIRR elements are already embedded and could be further strengthened. Those strategic priorities are listed below:

Table 3: Embeddedness of RRI-AIRR approach in the strategic policy priorities of the region of Western Macedonia

Policy Focus	Strategic policy priorities	RRI-AIRR approach embedded
1st Policy focus: Develop a stakeholder engagement strategy within the course of the post-coal transition road map	Development of supportive digital infrastructures and services of smart communities	Public engagement, inclusiveness
	Upgrading the skills and retraining (upskilling & reskilling) of the employees of the companies that need support for their transition to the economy of zero pollutants	Science education
	Development of a social safety framework	Anticipatory governance, reflexivity, responsiveness

	Restoration of degraded areas and facilities and change of their use	Reflexive governance, science education, responsive governance
2nd Policy focus: Strengthen policy-making systems involving different modes of territorial governance of the post-coal transition strategy	Development of an effective just transition governance system with the involvement of regional structures in governance	Inclusiveness, responsive governance
	Strengthen innovative energy technologies	Inclusiveness
	Linking research with production, promoting start-up entrepreneurship, and creating spin-offs	Open access
	Development of an effective social dialogue between the actors of the quadruple helix	Open access, inclusiveness, responsiveness
3rd Policy focus: Develop a methodology aiming to a smooth and innovative transition from the coal value chain towards an alternative development 'paradigm'	Transforming and strengthening the competitiveness of existing companies that need support for their transition to a zero-emission economy by 2030	Anticipatory governance, inclusiveness, responsiveness
	Establishment and attraction of new companies that create jobs and lead to economic diversification, modernisation and transformation of the existing production model	Science education, inclusiveness
	Improving energy efficiency in public buildings and strengthen energy communities	Reflexivity

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Appendix

Table 4: Stakeholders mapping synthesis of experiences related to RRI-AIRR

	Stakeholders with high levels of interest in RRI-AIRR approach	Stakeholders with high levels of experience in RRI-AIRR approach	Stakeholders with high levels of influence on RRI-AIRR approach in practice	Stakeholders with high levels of power
Name of stakeholder	**Policymakers**			
RIS Structure of Western Macedonia	Interested in science education	Experience with public engagement, ethics, open access, and gender equality Experience with anticipation	Influence regarding reflexivity and responsiveness	
Region of Western Macedonia (RWM)	Interested in science education	High experience with public engagement, ethics, open access and gender equality. Region is a local government organisation that follows legal framework and state rules related to the above issues.	High level of influence in anticipation, reflexivity and responsiveness. It has the overall role and responsibility for the design and implementation of the development plans at a regional level.	The Region of Western Macedonia is a secondary organisation of local government of the Greek state with full budgetary and administrative power to support the implementation of the necessary policies.
Vice Governor Unit for Energy, Infrastructure and Environment	High interest in science education especially concerning renewable energy sources and also the hydrogen technology	High experience with public engagement, ethics, open access and gender equality.	High level of influence in anticipation, reflexivity and responsiveness. Region of Western Macedonia has the responsibility for the regional "just transition plan" in cooperation with the local and national authorities in cooperation with the Vice Governor for development transition plan. Also, the overall responsibility for the environmental issues in the transition to the post lignite era.	
Vice Governor Unit for Developmental Transition Planning	Interest in science education	High experience with public engagement, ethics, open access and gender equality	High level of influence in anticipation, reflexivity and responsiveness. He has the overall responsibility on the matters of the "Territorial	

			Plan for Fair Transition of the Region", for the activation of energy communities and in general the new model of clean energy in cooperation with the Vice Governor of Energy.	
Vice Governor Unit for Rural Development	High interest in science education especially for innovative rural development programmes	High experience with public engagement, ethics, open access and gender equality	High level of influence in anticipation, reflexivity and responsiveness. He has the overall responsibility on the Regional Rural development plan 2021-2025	
Regional Development Fund (RDF)	Interested in science education	High Experience with public engagement, ethics and open access. Follows local law and formal procedures. Experience with gender equality. experience with anticipation, reflexivity and responsiveness		Power to support the organisational and administrational functions of the Region of Western Macedonia. Power to control the utilisation of Regional, National and European resources.
Municipality of Kozani	Interested in science education	High experience with public engagement, ethics, open access and gender equality as a local organisation that follows legal framework and state rules related to the above issues.		The Municipality of Kozani is a public administration entity and a primary local government organisation with budgetary and administrative power to support the implementation of the necessary policies.
Waste Management Company of Western Macedonia (DIADYMA SA)	Interested in science education and inclusiveness	Experience with public engagement, ethics, gender equality and open access. High experience with anticipation, reflexivity and responsiveness according to their important role as active members of the energy community and the actions related to the energy transition.		
Development Company of Western Macedonia SA (ANKO)	Interested in science education	Experience with ethics and gender equality. High experience with public engagement and open access.	Influence in anticipation, reflexivity and responsiveness	

		The company has undertaken the role of technical consultant for the post coal transition in the region.		
Research and Academia				
Unit of Academic Issues of the University of Western Macedonia	Interest in open access Interest in public engagement	High level of experience with gender equality, ethics and public engagement according to the gender equality committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation on academic issues	High level of influence regarding science education	High level of power in science education and open access
Institute of Civil Protection	Interest in public engagement	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in inclusiveness and public engagement on civil protection issues	High level of influence regarding public engagement and inclusiveness	High level of power in public engagement
Institute of Economic Analysis and Entrepreneurship	Interest in open access Interest in public engagement and science education	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation and responsiveness on economic and entrepreneurship issues	High level of influence regarding anticipation	High level of power in science education and open access
Department of Chemical Engineering of the University of Western Macedonia	Interest in open access Interest in responsiveness	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation on research issues (energy communities and Green University)	High level of influence regarding inclusiveness and responsiveness	
Air and Waste Management Laboratory-AWMA Lab	Interest in open access Interest public engagement	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has.	High level of influence regarding inclusiveness	Air and Waste Management Laboratory-AWMA Lab

		High level of experience in reflexivity and inclusiveness on research issues (Air and Waste Management)		
Environmental technology laboratory	Interest in open access Interest in responsiveness	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation on research issues (Energy Communities and Green University)	High level of influence regarding reflexiveness	Environmental technology laboratory
Laboratory of Alternative Fuels & Environmental Catalysis, LAFEC	Interest in open access Interest in responsiveness	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation on research issues (Alternative Fuels and Catalysis)	High level of influence regarding responsiveness	
Department of Mechanical Engineering	Interest in open access Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (energy and new technologies)	High level of influence on inclusiveness and responsiveness	
Laboratory of Fluid Mechanics and Turbomachinery	Interest in open access Interest in reflexiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with responsiveness on the research issues (Fluid Mechanics and Turbines)	High level of influence on responsiveness	Laboratory of Fluid Mechanics and Turbomachinery
Energy and Pollution Control Systems Engineering Laboratory	Interest in open access Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has.	High level of influence on responsiveness	

		High level of experience with responsiveness on the research issues (Energy and Pollution Control Systems)		
Laboratory of Mechanical Processes and Quality Control	Interest in open access Interest in science education	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in responsiveness on research issues (Mechanical Processes and Quality Control)	High level of influence regarding responsiveness	
Laboratory of Quantitative Methods of Operations Research and Statistics in Engineering (MORSELab)	Interest in open access	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in anticipation and responsiveness on research issues (Quantitative Methods of Operations Research and Statistics in Engineering)	High level of influence regarding anticipation and responsiveness	
Centre for Renewable & Alternative Energy Sources & Rational Use of Energy	Interest in open access Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (RES and Alternative Energy)	High level of influence on science education and responsiveness	
Centre for Testing of Materials and Constructions	Interest in open access Interest in anticipation	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with reflexivity on the research issues (Material Testing and Constructions)	High level of influence on inclusiveness and responsiveness	
Laboratory of Vibration & Machine Dynamics	Interest in open access Interest in science education	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the	High level of influence regarding reflexivity and responsiveness	

		Committee/ Code of Conduct the University has. High level of experience in responsiveness and reflexivity on research issues (Vibration and Machine Dynamics		
Laboratory of Magnetic and Electric Analysis for Non-Destructive Evaluation (Meander)	Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (Non distractive Testing)	High level of influence on reflexiveness	
Department of Electrical and Computer Engineering (ECE)	Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (new technologies)	High level of influence on inclusiveness because of the interaction with the regional authority, other domestic and foreign universities, and businesses. High influence on responsiveness regarding the implementation of new technologies in the post coal phase.	
Laboratory of Applied and Computational Electromagnetism	Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (Computational Electromagnetism)	High level of influence on Inclusiveness because of the interaction with the regional authority, other domestic and foreign universities, and businesses.	Laboratory of Applied and Computational Electromagnetism
Laboratory of Electronic Health and Biomedical Technology	Interest in open access Interest in public engagement	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with inclusiveness and responsiveness on the research issues (Electronic Health and Biomedical Technology)	High level of influence regarding inclusiveness and responsiveness	

Internet Lab of Things and Applications	Interest in open access Interest in public engagement	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with inclusiveness and responsiveness on the research issues (IoT and Applications)	High level of influence regarding responsiveness	
Laboratory of Networks and Advanced Services	Interest in anticipation	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (Networks)	High level of influence on responsiveness	
Laboratory of Robotics, Integrated and Integrated Systems	Interest in responsiveness	High level of experience with the issues of gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience with anticipation on the research issues (Robotics)	High level of influence on inclusiveness because of the interaction with the regional authority, other domestic and foreign universities, and businesses.	
Department of Regional Development and Cross Border Studies	Interest in open access Interest in science education	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in inclusiveness and science education on the research issues (Regional Development and Cross Border issues)	High level of influence regarding science education	High level of power in science education and open access
Management of Technology Research Lab	Interest in open access Interest in public engagement	High level of experience with gender equality, ethics and public engagement according to the Gender Equality Committee and the Committee/ Code of Conduct the University has. High level of experience in inclusiveness and responsiveness on the research issues (Management of Technology)	High level of influence regarding responsiveness and anticipation	

National Centre for Research and Technological Development (CERTH)	Interest in open access	Experience with the gender equality, ethics and public engagement. High level of experience with inclusiveness.	Influence regarding anticipation, reflexivity and responsiveness. The research centre has a critical role to the post-coal phase in issues related to the change of the energy mix, the implementation of new technologies and the needed constant updating and forecasting of strategies and actions.	
Businesses				
Public Electricity Company (PPC)	High interest in anticipation, reflexivity and responsiveness. The PPC company has a central role in the post-coal era, following a business transformative plan.	Experience with gender equality, ethics, public engagement.		Power to support the future actions of the energy transition based on its know-how and experience in energy issues as a leading company on the energy factor in Greece
Cluster of Bioeconomy and Environment of Western Macedonia (CluBE)	Interest in responsiveness and science education. Interest in anticipation, reflexivity and responsiveness.	High levels of experience with gender equality, ethics, public engagement and open access (the requirements of the European Programmes the Cluster is involved in).		
BELLIS SA	Interest in public engagement, open access, gender equality, ethics and scientific education	Experience with anticipation, reflexivity and responsiveness		
BAGATZOUNIS MARKOS & SONS SA	Interest in public engagement, open access	High experience with gender equality and ethics, following a code of conduct. High experience with science education by the continuous collaborations with scientific bodies and significant achievements in recycling and the pharmaceutical uses of their products. Experience with anticipation, reflexivity and responsiveness.		

ETHELEO LP	Interest in public engagement, open access, gender equality, scientific education	High experience with ethics by following a code of conduct and certifications of product quality. Experience with anticipation, reflexivity and responsiveness.		
B&T COMPOSITES	Interest in gender equality, open access, science education	High experience with public engagement and ethics. The company is certified by multiple ISO certifications, by official European product certifications and European materials certifications. Experience with anticipation, inclusiveness reflexivity and responsiveness.		
ALFA WOOD GROUP	Interest in open access, gender equality	High experience with public engagement and ethics. The company focuses on recycling biomass waste from the production process, as well as its waste. Also, promotes and supports the use of renewable energy. The company is certified by state organisations as well as international organisations. High experience with anticipation, inclusiveness, reflexivity and responsiveness. Adheres to strict standards and commitments for its production line, comply with applicable legal requirements.		
ALFA	Interest in open access, gender equality, science education	High experience with public engagement and ethics. The company has awards as a traditional Greek Company and on the Marketing and Communication sector. Also, an Innovation Award. High experience with anticipation, reflexivity and responsiveness.		
DIOSCURIDES	High Interest in open access and science education. There is a cooperation with organic farmers, with agricultural cooperatives and with educational & social	High experience with public engagement and ethics, inclusiveness by following a code of conduct and certifications of product quality. Experience with anticipation, reflexivity and responsiveness		

	Institutions. Also, a collaboration with the Agricultural University of Athens.			
PITENIS BROS SA	Interest in open access, gender equality, science education	High experience with public engagement and ethics by following a code of conduct. Is certified by and implements the System Assurance & Quality Management and awarded with Quality Award. High experience with anticipation, reflexivity and responsiveness. The company has high quality production and modern facilities. Also has a high level of exports.		
KAMKOUTIS	Interest in gender equality and science education	High experience in open access, public engagement. It has modern/ innovative facilities and mechanical equipment by following strict controls. There are many visitors to the winery since 2006 and many winery events, workshops, receptions, etc. Experience with anticipation, reflexivity and responsiveness.		
NGOs				
"Social Cooperative Enterprises" ZEIDORON	Interest in open access, public engagement, gender equality.	Experience with anticipation, reflexivity and responsiveness.		It promotes local and collective interest, employment through vocational rehabilitation of vulnerable social groups, social cohesion and strengthens local regional development.