transformer

Framework for Super-Labs Assessment- version 2

Deliverable No.:	D5.2
Project Acronym:	TRANSFORMER
Full Title:	
Designing long-term systemic transformation frameworks for regions. Accelerating the shift towards climate neutrality	
Grant Agreement No.:	101069934
Work package/ Measure No.:	WP5
Work package/ Measure Title:	
Evaluation & Impact Assessment	
Responsible Author(s): Georgia Ayfantopoulou, Maria Konstantinidou	
Responsible Co-Author(s):	
Date: 30.08.2024	
Status:	Final
Dissemination level:	Public

Funded by the European Union

transformer

Abstract

This deliverable includes the presentation of the Assessment Framework for Transition Super-Labs that builds on the first version delivered in M10 enriched and fine-tuned with the lessons learned from its implementation in the 4 TRANSFORMER TSLs. It covers the Transition Readiness Assessment, the Assessment of the Efficiency and Success of the Transition Process towards climate neutrality and an Evidence-based use case Impact Assessment Methodology.

Project Partners

Organisation	Country	Abbreviation
RUHR-UNIVERSITAET BOCHUM	DE	RUB
RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH	DE	RC
BUSINESS METROPOLE RUHR GMBH	DE	BMR
REGIONE EMILIA ROMAGNA	IT	RER
FONDAZIONE ISTITUTO SUI TRASPORTI E LA LOGISTICA	IT	ITL
FIT CONSULTING SRL	IT	FIT
Dolnoslaski Fundusz Rozwoju sp. z o.o.	PL	DFR
UNIWERSYTET WARSZAWSKI	PL	Uni Warsaw
Fundacja Dumni z Lubina	PL	Dumni z Lubina
ANKO DYTIKIS MAKEDONIAS A.E. - ANAPTYXIAKOS ORGANISMOS TOPIKIS AFTODIIKISIS	GR	ANKO
ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	GR	CERTH
TWENTY COMMUNICATIONS SRO	SK	TWE
EUROPEAN NETWORK OF LIVING LABS IVZW	BE	ENoLL

Document History

Date	Person	Action	Status	Diss. Level
09.08.2024	Konstantinidou Maria (CERTH)	Submission of the document to reviewers	Draft	WPL
09.08.2024	Thomas Meister (RUB)	Review	Draft	WPL
13.08.2024	Otar Nemsadze (RC)	Review	Draft	WPL
28.08.2024	Konstantinidou Maria (CERTH)	Final Review	Final	WPL
30.08.2024	Thomas Meister (RUB)	Approval	Approved	PC
		Submitted		PO

Status: Draft, Final, Approved, and Submitted (to European Commission).
Dissemination Level: WPL = Work Package Leader, PM = Project Manager, PC = Project Coordinator, PO = Project Officer

Funded by the European Union

transformer

Legal disclaimer

Funded by the European Union

transformer

Table of Contents

Funded by the European Union

List of Acronyms

AHP	Analytic Hierarchy Process
ICT	Information and Communication Technologies
ITS	Information Technology System
KPI	Key Performance Indicator
MCA	Multicriteria Analysis
MJ	Mega Joule
OIC	Open Innovation Community
QRAFT	Quantitative Regional Assessment Framework for Transition Super-Labs
RD&D	Research, Development & Demonstration
RES	Renewable Energy Source
SD	System Dynamics
SUMP	Sustainable Urban Mobility Plan
TSL	Transition Super-Lab

Table of Figures

Funded by the European Union

Table of Tables

Funded by the European Union

Executive Summary

This deliverable is dedicated to the presentation of the Assessment Framework of the Transition Super-Lab that covers different aspects of the assessment process including the Transition Readiness Assessment, the Assessment of the Efficiency and Success of the Transition Process towards climate neutrality and an Evidence-based use case Impact Assessment Methodology. It builds on the first version of Frameworks for Super-Labs Assessment delivered in M10 enriched and fine-tuned with the lessons learned from its implementation in the 4 TRANSFORMER TSLs.

Its objective is to establish a strong connection between the requirements of Transition Super-Labs (TSLs) and the goals of the transition. To facilitate this, a holistic framework was developed, allowing regions to engage in continuous self-assessment towards achieving their transition objectives. This framework includes processes that monitor the transition actions of TSLs and evaluate the impact of TSLs Pilot use cases on the decarbonisation transition of regions. Additionally, by identifying weaknesses and developing the most suitable transition pathways with the involved stakeholders, the transition readiness of the ecosystem within TSLs is enhanced.

The deliverable, developed within the WP ''Evaluation & Impact Assessment'' and more specifically Task 5.1 Assessment framework for Transition Super-Labs, starts with the presentation of the objectives and the methodological overview of the Assessment Framework in Chapter 2 and continues in Chapter 3 with the Transition Readiness Assessment Methodology describing the 6 elements and 22 sub-elements representing transition ecosystems characteristics. The elements of an ecosystem that can be characterised as transition-ready should cover aspects of governance & fusion, openness & greenness, transparency and cross-sectorial collaboration, regulations and economy, infrastructure, technology & tools and civil society and stakeholders. The qualitative assessment of readiness was performed through the Transition Readiness Self-Assessment Tool and the results of the transition readiness scores and the identification of the weak points for each TRANSFORMER region are presented.

Chapter 4 focuses on the TRANSFORMER Transition model and the Assessment of the Efficiency and the Success of the Transition process followed by the TSLs through milestones achievement monitoring. Chapter 5 provides detailed explanations of the Evidence-based use case Impact Assessment Methodology including both KPIs and CO_2 quantification. The results of the application of these two methodologies in TRANSFORMER TSLs are also included in the relevant chapters.

The deliverable concludes in Chapter 6, highlighting the contributions of the Assessment Framework in building a cohesive and integrated approach to evaluating and facilitating the transition towards climate neutrality. It discusses the future directions and the iterative nature of the framework, ensuring continuous refinement and adaptation of the region's transition strategies, objectives and activities based on real-time data and feedback.

Funded by the European Union

1 Introduction

To achieve climate neutrality, we must change the way the economies are organised. European regions face a wide range of risks and opportunities as a result of physical environmental change and societal responses to that change, especially climate change and the move toward a net zero emissions economic system.

A Transition Super-Lab is an ecosystem of actors organized to accelerate the transformation towards climate neutrality through innovation, and cross-sectorial synergies on a regional scale. It benefits from a collaborative governance, operates in accordance to systemic transformation principles and utilizes transition enabling methods and tools in order to create added value to cross-sectorial initiatives for economic transformation and to provide feasible solutions to complex regional transformation challenges.

The TSL approach adapts and applies enriched living lab methodologies in order to develop (co-create) together with all stakeholders from the quadruple helix and society a vision for a regional transformation and a portfolio of large-scale systemic solutions for climate neutrality, net-zero emissions and resilient future. The systemic transformation within TSL catalyzes large and diverse communities to innovate for systemic changes that accelerate transition at scale.

The systemic transformation will be achieved by developing and implementing a portfolio of connected solutions ("e.g., Pilot use cases") which engage multiple leverage points at the intersection of socio-technical regimes simultaneously in order to achieve a rapid and more efficient transformation[1]. Therefore, the adaptation of Living Lab methodologies to a large-scale and with a focus on systemic transformation can be regarded as the core characteristics of a TSL (Figure 1):

1. Adaptation and application of enriched Living Lab methodologies (co-creation, experimentation and evaluation)
2. Aiming at large-scale systemic solutions for a rapid sustainable transformation
3. Applying a portfolio approach of measures (experiments) and using multiple leverage points for systemic change simultaneously

[1] The definition and description of the TSL approach in this chapter was discussed and written jointly by the members of the TRANSFORMER Project Consortium. It is also included in deliverable D2.2.

Funded by the European Union

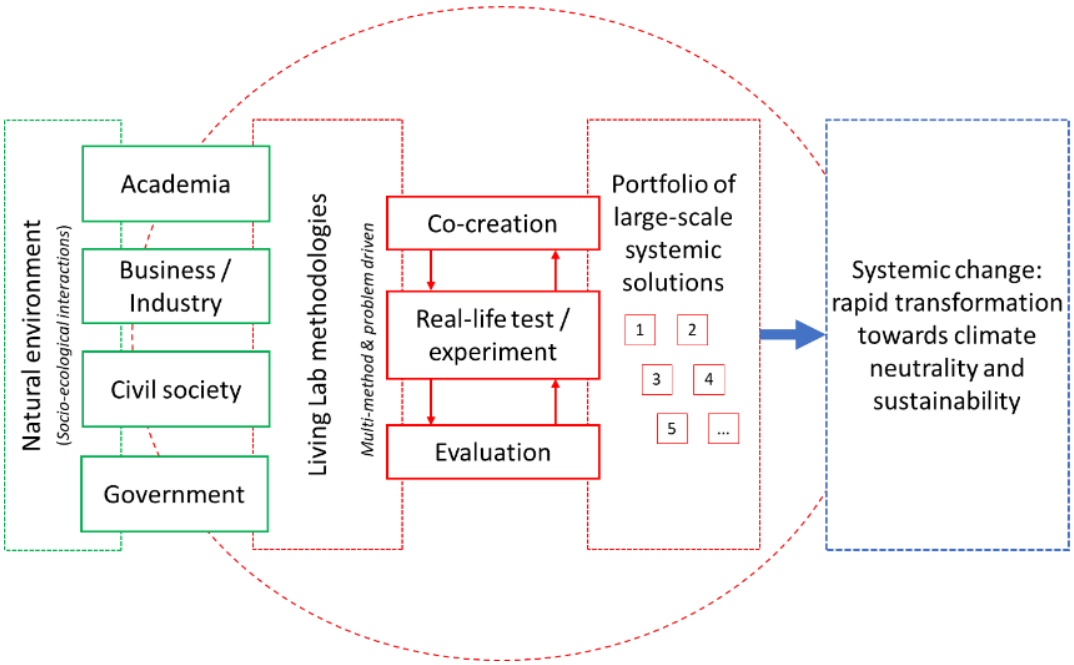

Figure 1: Elements of a Transition Super-Lab[2]

Many respected institutions, including the Bank of England[3], the G20 Financial Stability Board (FSB), and the European Systemic Risk Board[4], have recently raised concerns about the financial stability of regions that will follow a late and abrupt transition to a low-carbon economy. They have emphasized that the lack of appropriate data and the failure to use an Assessment Framework throughout the whole transition process will be a significant impediment to policy and decision-makers (among others) in properly understanding risks and impacts and responding to the transition challenges. Closing this significant gap is now an urgent priority.

This document presents a holistic Assessment Framework that will facilitate Transition Super-Labs to accomplish the transition towards climate neutrality. It is based on different aspects of assessment during the transition process that can provide a systematic overview of the change that is occurring (or not occurring) in critical underlying processes. It could be used for both reporting and planning purposes at the regional level, and the present document outlines where and how this should be done. This document describes the final structure of the Assessment Framework that builds on the first version delivered in

[2] TRANSFORMER Project, (2024). Deliverable 2.1 ''Summary of data collection on TSL predecessors'', Available at: https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D2.1_Summary-of-data-collection-on-TSL-predecessors.pdf

[3] Bank of England-Financial Policy Committee (2022). Financial Stability Report. Available at: https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-report/2022/financial-stability-report-july-2022.pdf

[4] European Central Bank, (2022). Financial Stability Review. Available at: https://www.ecb.europa.eu/pub/financial-stability/fsr/html/ecb.fsr202211~6383d08c21.en.html#toc15

Funded by the European Union

M10 enriched and fine-tuned with the lessons learned from its implementation in the 4 TRANSFORMER TSLs.

This deliverable is structured as follows: in a first step, the objectives of the Assessment Framework are presented and the methodological approach that was followed for developing the framework is described (Chapter 2). The methodologies that were developed to cover the three main elements of the Assessment Framework as well as the results of their application by the four TRANSFORMER TSLs within TRANSFORMER project are elaborated in detail in the following chapters: The Transition Readiness Assessment (Chapter 3), Assessing the Efficiency and Success of the Transition Process towards climate neutrality (Chapter 4) and the Evidence-based use case Impact Assessment Methodology (Chapter 5). The deliverable concludes with a reflection on the Assessment Framework and provides an outlook on further research needs (Chapter 6).

2 TRANSFORMER Assessment Framework for Transition Super-Labs

2.1 Objectives of the Assessment Framework

The assessment of the TSLs is an indispensable feature of the 'learning by doing approach' that will guide regions on how to achieve a speedy and successful transition.

The development of a common holistic framework for this assessment contributes to the coordination of all the transition activities, including assessment criteria, adaptation of assessment methods, and the refinement, and harmonization of data analyses methods and data management that can be used during the assessment of the pilot uses cases that were defined by the TSLs (WP3).

The Assessment Framework was built by combining valuable input collected through:

- the desktop research on LLs assessment methodologies and Transition assessment techniques
- the coalition building activities of WP3 (interviews, workshops, stakeholders mapping etc) and training activities performed by ENoLL (mapping canvas of the TSLs) that contribute to better understanding the pilots' context, needs, key parameters for success and cross-sectorial collaborations
- the Pilot use cases as they were defined in WP3
- the experience of TLS predecessors included in ''D2.1-Summary of data collection on TSL predecessors''
- the lessons learnt from the TSLs during the project

Funded by the European Union

The aim of the Assessment Framework isn't limited to impact assessment and the evaluation of supportive tools and structures but creates a bridge between TSLs requirements and transition goals and provides to TSLs a valuable asset that will enable regions to increase the transition readiness of their ecosystem and perform a continuous self-assessment towards the achievement of their transition objectives.

The objectives of the Assessment Framework are to:

- Create the bridge between TSLs requirements and transition goals
- Provide a holistic framework that will enable regions to perform a continuous self-assessment towards the achievement of the transition objectives by monitoring the TSLs transition actions through a customized lifecycle analysis
- Evaluate the impact of Transition Super-Labs on the decarbonization transition of regions
- Assess the Transition Super-Labs supportive tools and structures
- Increase innovation readiness of the ecosystem within the TSLs by defining weak points for directing the actions of stakeholders
- Guide regions on how to achieve a speedy and successful transition through the transition process assessment

The Transition Assessment Framework will guide TSLs through-out the assessment activities, providing a synopsis of methods, data analysis tools and data management processes for the evaluation and validation of the transition-related activities. Through the implementation of the Transition Assessment Framework, the TSLs will be able to coordinate their activities and set clear timelines, responsibilities and tasks for all participating parties, minimizing effort towards the achievement of the transition towards climate neutrality. Finally, the Assessment Framework will support TSLs in reporting their assessment processes and outcomes and ensure the harmonization of the assessment activities among TSLs to achieve and support cross-TSLs assessment.

2.2 Methodological Approach for developing the Assessment Framework

The Assessment Framework will cover:

- Transition Readiness Assessment
- Assessing the Efficiency and Success of Transition Process towards climate neutrality
- Evidence based use case Impact Assessment Methodology

The main questions that the TSL will be able to answer after the implementation of each of the above assessment methodologies are the following respectively:

- Is the region's ecosystem ready for delivering transition?
- Is the transition process performed by the ecosystem successful?
- Do the Pilot use cases contribute to the transition achievement towards climate neutrality?

Funded by the European Union

Evaluation Framework Methods: Different methods could be applied during the Evaluation Framework implementation such as baseline measurement, KPIs quantification, and Analytic Hierarchy Process (AHP).

3 Transition Readiness Assessment

The transition readiness assessment of a region is built upon the following elements:

- ✓ Systemic approach to cross-sectorial transition ecosystem definition *("what is a transition ready ecosystem?"*)
- ✓ Elements representing transition ecosystems characteristics (What we need to have for being a transition ready region?)
- ✓ Qualitative Assessment of readiness (benchmarking and qualitative assessment of the existence of enablers & of the absence of barriers of transition in different sectors)
- ✓ Weak points definition (what to do for accelerating readiness?)

3.1 Systemic approach to cross-sectorial transition ecosystem definition

The Transition Readiness Assessment follows an ecosystem-based approach to define a cross-sectorial transition ecosystem and identify the main elements of a region that affect its readiness and capability in deploying innovation and achieving a speedy and successful transition towards climate neutrality.

The concept of "ecosystem" originates from the field of ecology[5]. Biologists and natural scientists use this term to describe a system comprising a habitat, all living organisms, and all non-living physical and chemical elements in the observed environment. The comparison to a "system" is crucial because it ensures the comprehensive functioning of an ecosystem, driven by the following key characteristics: interaction among living organisms, management of assets that encompasses the stages of creation, operations, reuse, destruction, release, and abolishment of assets and objects within the habitat, the establishment of energy and nutrition cycles to support life and survival while preserving values and benefits for all ecosystem members.

According to Scott Slocombe (1993) ecosystem-based approaches contribute to improving regional-scale planning and management processes comprising interacting ecological, economic and social components[6] and moving away from a limited consideration of natural systems and society as separate entities[7]. Social-

[5] Flügge, B. (2017). The Mobility Ecosystem. In Smart Mobility - Connecting Everyone: Trends, Concepts and Best Practices (pp. 47–68). Available at: https://doi.org/10.1007/978-3-658-15622-0_3

[6] Scott Slocombe, D. (1993), Implementing Ecosystem-Based Management, BioScience, Vol. 43, No. 9, pp. 612-622, Oxford University Press. Available at: https://academic.oup.com/bioscience/article-abstract/43/9/612/257693?redirectedFrom=fulltext

[7] Delacámara, G., G. O'Higgins, T., Lago M. & Langhans S., Ecosystem-Based Management: Moving from Concept to Practice, Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity pp 39–60. Available at: https://link.springer.com/chapter/10.1007/978-3-030-45843-0_3

Funded by the European Union

ecological ecosystems are therefore complex ecosystems that should be analysed in a holistic, integrated way[8] and this explains the reason that the new EU Strategy on Adaptation to Climate Change identifies ecosystem-based approaches as a cross-cutting priority[9].

By representing TSLs within an ecosystem approach, it promotes collaboration, resource optimization, learning, and adaptive management. An ecosystem offers the ability to connect data, relationships, knowledge and expertise. This approach enhances the collective effort to accelerate the transition towards a sustainable and resilient future. It recognizes how these sectors are interconnected and interdependent, and their integration is crucial for achieving holistic and effective climate solutions. The ecosystem approach emphasizes the importance of collaboration and synergies among these sectors, leveraging their respective strengths and resources to drive sustainable transformations. By fostering a systemic view, the ecosystem approach ensures that efforts are coordinated, knowledge is shared, resources are accessible, and actions are aligned, leading to a more integrated and impactful approach to address climate challenges.

Thus, adopting the cross-sectorial ecosystem approach enables the TSLs to bridge the gap between all the stakeholders, processes and systems involved in every transition step and to facilitate a more efficient collaboration between them, with greater transparency, inclusiveness and better management processes[10, 11].

[8] Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science, 325(5939), 419–422. Available at: https://www.science.org/doi/10.1126/science.1172133

[9] European Commission (2021). Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. Available at: https://knowledge4policy.ec.europa.eu/publication/forging-climate-resilient-europe-new-eu-strategy-adaptation-climate-change_en

[10] Equus Software. (2018). Applying an Ecosystem Approach to Global Mobility Management. https://www.equusoft.com/wp-content/uploads/2018/05/Ecosystem-Approach-to-Global-Mobility-WP-1.pdf

[11] Rockström et al. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity, Ecology and Society 14(2): 32. Available at: https://pubs.giss.nasa.gov/docs/2009/2009_Rockstrom_ro06010m.pdf

Funded by the European Union

3.2 Elements representing transition ecosystems characteristics

Figure 2 depicts the elements and sub-elements that a transition-ready ecosystem consists of; specifically, it consists of 6 elements and 22 sub-elements.

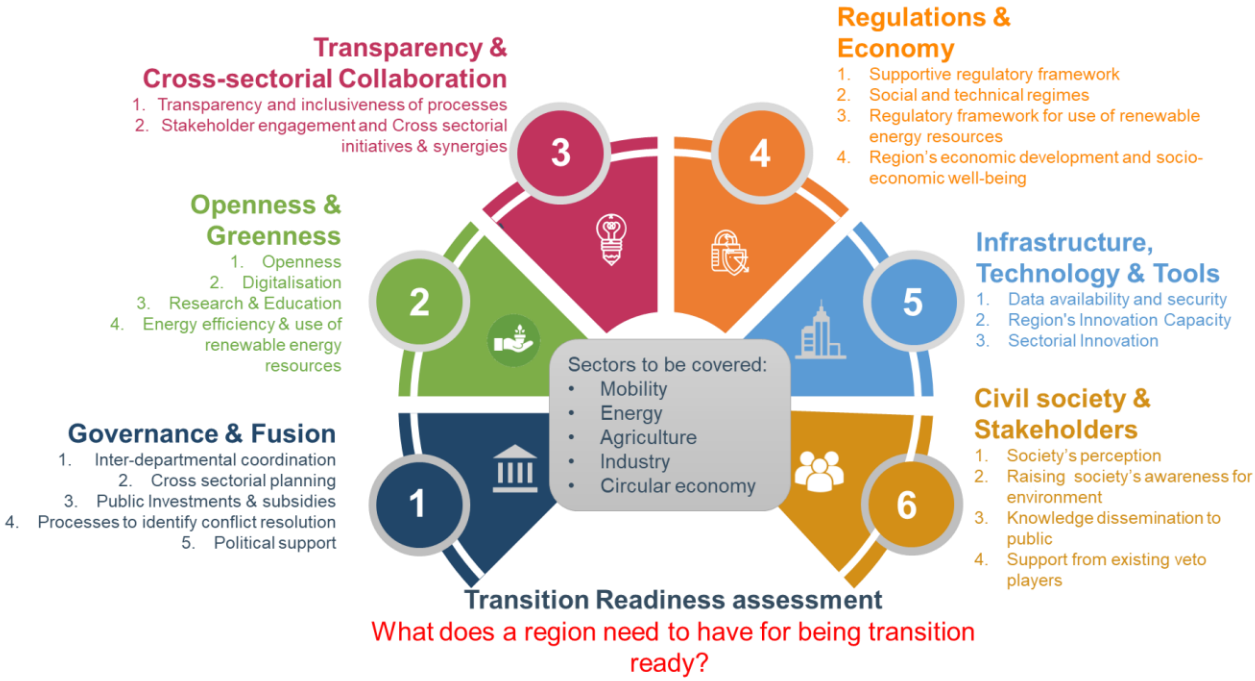

Figure 2: Elements and sub-elements of a Transition ready ecosystem (own design)

The elements of an ecosystem that can be characterised as transition ready should cover aspects of governance & fusion, openness & greenness, transparency and cross-sectorial collaboration, regulations and economy, infrastructure, technology & tools and civil society and stakeholders. Each element and sub-element were selected through extended literature review on what are the main characteristics of a sustainable ecosystem that aims to achieve systemic transformation through innovation. Many of these characteristics were also found in the experiences of TLS predecessors included in deliverable ''D2.1-Summary of data collection on TSL predecessors''[12] and/or they were identified by TRANSFORMER regions as current difficulties towards the development of a successful TSL. The elements and sub-elements are described in detail in the following subsections.

[12] TRANSFORMER Project (2024). Deliverable 2.1 '' Summary of data collection on TSL predecessors'', Available at: https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D2.1_Summary-of-data-collection-on-TSL-predecessors.pdf

Funded by the European Union

3.2.1 Governance & Fusion

The Governance & Fusion element of a TSL aims to orchestrate seamless cross-sectorial planning to develop holistic climate-neutral strategies and policies for designing and implementing climate initiatives. As region's challenges are interconnected and cannot be effectively addressed by a single sector, cross-sectorial planning breaks down silos and pave the way for a TSL to innovate and provide comprehensive and holistic solutions for addressing climate change challenges. Through cross-sectorial planning, the region optimizes outcomes and minimizes conflicts or unintended consequences that may arise from sector-specific approaches. This aspect is further enhanced through inter-departmental coordination mechanisms to oversee climate action implementation. To manage potential conflicts that might arise in such a complex setting, efficient and fair conflict resolution mechanisms should be further established for harmonizing stakeholders' objectives, identifying shared goals and aligning actions to achieve sustainable, inclusive, and smooth operation of a TSL. Finally, political support is critical for pushing forward ambitious climate agendas, influencing policy frameworks, and securing necessary resources through public investments and subsidies that incentivise and fund the TSL's transformational efforts and operation[13].

Definition: Governance & Fusion refers to the integration of various sectors in the planning, and the inter-departmental coordination for implementing climate-neutral solutions. It also encompasses aspects such as public investment, conflict resolution mechanisms and political support.

3.2.2 Openness & Greenness

Openness refers to the degree of the region's accessibility, interconnectivity, and permeability to external environment and ensures the uninterrupted flow of knowledge, ideas and resources between them and within the TSL. Openness could be interpreted as a combination of different dimensions including breadth and depth[14], freedom[15,16], number of phases and actors[17]. Networking with external national and international institutions that are characterised by heterogeneity in skills and high expertise and are free to participate and collaborate in more than one phase of the transition process would indicate the more

[13] Ciasullo, M.V., Troisi, O., Grimaldi, M. et al. (2020). Multi-level governance for sustainable innovation in smart communities: an ecosystems approach. Int Entrep Manag J 16, 1167–1195. Available at: https://doi.org/10.1007/s11365-020-00641-6

[14] Idrissia et al., (2012). SMEs' degree of openness: The case of manufacturing industries. Journal of Technology Management & Innovation, 7 (2012), pp. 186-210. Available at: http://dx.doi.org/10.1016/j.jenvman.2019.109564

[15] Herzog, (2008). Open and closed innovation – Different cultures for different strategies. Gabler. Available at: https://link.springer.com/book/10.1007/978-3-8349-8090-8

[16] Aslesen W.H. and Freel, M. (2012). Industrial knowledge bases as drivers of open innovation?. Industry & Innovation, 19 (2012), pp. 563-584. Available at: https://doi.org/10.1080/13662716.2012.726807

[17] Lazzarotti and Manzini, (2009). Different modes of open innovation: A theoretical framework and an empirical study. International Journal of Innovation Management, 13 (2009), pp. 615-636. Available at: https://www.worldscientific.com/doi/abs/10.1142/S1363919609002443

Funded by the European Union

far reaching and sustainable openness[18]. Digitalization plays a pivotal role in this regard, boosting connectivity through platforms and tools for efficient collaboration and facilitating data access and decision-making. As digital transformation removes silos and allows stakeholders to collaborate into innovation creation, the integration of digital technologies and infrastructures transforms and improves the connectivity and value creation within the ecosystem[19]. However, digital transformation may also create new borders and exclusion mechanisms that should be addressed and dealt with (e.g., citizens who don´t know how to use digital tools). Towards this direction, it is essential for a region to invest in educational programs that enhance stakeholders' and society's understanding for climate issues and potential solutions and in parallel increase their digital competence, keeping them informed and consequently engaged throughout the transition process[20]. Concurrently, focusing on research means having dedicated institutions for independent scientific advice on climate policy and institutions that conduct renewable energy RD&D activities as the transition should be supported by rigorous research and objective facts. Finally, to invest in "greenness", the region should increase the share of renewable energies in gross final energy consumption, aligning thus its operational practices with broader sustainability goals[21] (data based on the EU ranking of 2021)[22].

Definition: Openness & Greenness refers to region's networking with external environment, digital technologies to leverage collaboration and data access, research capacity and educational programs, and the use of renewable energy resources in the pursuit of climate neutrality.

3.2.3 Transparency & Cross-sectorial Collaboration

Transparency & Cross-sectorial Collaboration plays a crucial role in the functioning of a TSL. Transparent and inclusive governmental processes form the backbone of a TSL operation. Based on democratic principles, they empower stakeholders to be informed, engaged, and involved in shaping decisions that affect them, leading to more inclusive, participatory and sustainable TSL operations. Ensuring transparency in all transition steps as described in Chapter 4, guarantees that all actions and outcomes of each process are openly shared among stakeholders, fostering a culture of trust and accountability among

[18] Öberg, C. and Allen T. A., (2019). The openness of open innovation in ecosystems – Integrating innovation and management literature on knowledge linkages, Journal of Innovation & Knowledge, Vol. 4. Issue 4. pages 211-218. Available at: https://www.sciencedirect.com/science/article/pii/S2444569X18300131?via%3Dihub

[19] Robertsone, G., Lapiņa, I. (2023). Digital transformation as a catalyst for sustainability and open innovation, Journal of Open Innovation: Technology, Market, and Complexity, Volume 9, Issue 1. Available at: https://www.sciencedirect.com/science/article/pii/S2199853123001191

[20] Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M. and Scapolo, F., Towards a green and digital future, (2022) EUR 31075 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-52452-6, doi:10.2760/54, JRC129319. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC129319

[21] Wang, R., Li, F., Hu, D., & Larry Li, B. (2011). Understanding eco-complexity: Social-Economic-Natural Complex Ecosystem approach. Ecological Complexity, 8(1), 15–29. Available at: https://doi.org/https://doi.org/10.1016/j.ecocom.2010.11.001

[22] Eurostat (2021), Share of energy from renewable sources. Available at: https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_ren/default/table?lang=en

Funded by the European Union

all parties[23]. This transparency allows for a thorough examination, constructive critique, and collective learning, creating an environment conducive to innovative and effective climate solutions. A region that operates through transparent processes enforces stakeholders' engagement in participatory approaches and provides fruitful ground for the development of cross-sectorial initiatives and synergies that aim to bring together the transition-related stakeholders from the quadruple helix to work towards common goals and solutions. The integration of different perspectives, expertise, and resources from various sectors fosters a sense of ownership and commitment among stakeholders, enhancing the potential for the long-term success of the TSL 's initiatives[24]. By leveraging the strengths of different sectors, the TSL builds upon new ideas and opportunities, gearing the transition capacity of the ecosystem[25].

Definition: Transparency & Cross-sectorial Collaboration refers to the commitment to maintaining clear and open governmental processes, while fostering initiatives that enhance stakeholder's engagement and bridge different sectors to achieve synergistic solutions towards climate neutrality.

3.2.4 Regulations & Economy

The Regulations & Economy element of TSL highlights the critical role of policies, legal frameworks, and economic factors in facilitating a sustainable transition. A supportive regulatory framework for transition establishes an environment that aligns with the TSL's mission, providing guidelines and measures that accelerate the transition towards climate neutrality. Specific regulations regarding the use of renewable energy resources further reinforce the region's commitment to sustainability, encouraging the adoption of cleaner energy sources and facilitating the shift away from fossil fuels. Although transition characteristics vary between regions, the existing socio-technical regimes often block the way towards innovation. The opening-up -technical regimes is critical for the creation of new opportunities that will accelerate the transition towards climate neutrality[26]. Socio-technical transitions require changes not just in technology, but also in practices, rules, and shared assumptions across a variety of societal sectors (e.g., societal acceptance and behaviour change). Moreover, the region's economic development, socio-economic well-being, prosperity and resilience should be assessed for ensuring the economic viability of the climate transition actions. The Regulations & Economy element provides the structural and economic foundation that supports the region's transformative agenda[27].

---

[23] Baccarani, C., & Golinelli, G. M. (2014). Le parole dell'innovazione (The words of innovation). Sinergie, 94 (May-Aug), 9–14. Available at: https://ojs.sijm.it/index.php/sinergie/article/view/170/170

[24] Oomens, I. M. F., & Sadowski, B. M. (2019). The importance of internal alignment in smart city initiatives: An ecosystem approach. Telecommunications Policy, 43(6), 485–500. Available at: https://doi.org/https://doi.org/10.1016/j.telpol.2018.12.004

[25] Reggi, L., Dawes, S. (2016). Open Government Data Ecosystems: Linking Transparency for Innovation with Transparency for Participation and Accountability. In: ,et al. Electronic Government. EGOV 2016. Lecture Notes in Computer Science, vol 9820. Springer, Cham. Available at: https://doi.org/10.1007/978-3-319-44421-5_6

[26] Geels, W.F. (2020). Transformative innovation and socio-technical transitions to address grand challenges, European Commission- Directorate-General for Research and Innovation (Working paper). Available at: https://op.europa.eu/en/publication-detail/-/publication/24c4a811-a9f9-11ea-bb7a-01aa75ed71a1/language-en

[27] Wang, R., Li, F., Hu, D., & Larry Li, B. (2011). Understanding eco-complexity: Social-Economic-Natural Complex Ecosystem approach. Ecological Complexity, 8(1), 15–29. Available at: https://doi.org/https://doi.org/10.1016/j.ecocom.2010.11.001

Funded by the European Union

Definition: Regulations & Economy refers to the integration of supportive regulatory frameworks, social and technical regimes, and regulations related to the use of renewable energy resources, while considering the region's economic development and socio-economic well-being, in the pursuit of climate neutrality.

3.2.5 Infrastructure, Technology & Tools

The Infrastructure, Technology & Tools that a region can utilise in its operations are included among the facilitators of the transition towards climate neutrality, creating a dynamic and enabling environment for the collaborative creation of sustainable, climate-neutral solutions[28]. Data availability plays a critical role in the context of climate transition and digitalisation as it contributes to the identification of the region's challenges and the development of suitable solutions for addressing the region's needs through data-based decision making and tracking progress processes. To ensure data availability and security, the region needs to establish a secure, trustworthy, and resilient digital infrastructure that protect data privacy through suitable methods (e.g., anonymization) and empowers end users to understand how their data is used and the added value for them. Data governance regulations must also be defined to ensure clarity about data ownership and accessibility[29]. A rich data pool supported by reliable and robust data infrastructure increase region's capacity for innovation enabling its ability to exploit existing knowledge, skills and resources that can create a sustainable competitive advantage by driving innovation activities in a constantly changing environment towards the achievement of climate transformation. To address the causes or the impacts of climate change and achieve a successful transition towards climate neutrality innovative technologies relied on knowledge from different fields are required. Due to the technological complexity, there is high degree of risks and uncertainties[30]. This could be eliminated if the technologies are well embedded in sectorial innovation enabling the technological advancements and the development of cross-sectorial solutions[31].

Definition: Infrastructure, Technology & Tools refer to the essential physical and digital assets and advanced technologies that facilitate innovation. This encompasses the availability of secured data, the innovation capacity of the region, and the potential for innovation within various sectors.

---

[28] Ahlers, D., Wienhofen, L.W.M., Petersen, S.A., Anvaari, M. (2019). A Smart City Ecosystem Enabling Open Innovation. In: Lüke, KH., Eichler, G., Erfurth, C., Fahrnberger, G. (eds) Innovations for Community Services. I4CS 2019. Communications in Computer and Information Science, vol 1041. Springer, Cham. Available at: https://doi.org/10.1007/978-3-030-22482-0_9

[29] Reggi, L., Dawes, S. (2016). Open Government Data Ecosystems: Linking Transparency for Innovation with Transparency for Participation and Accountability. In: ,et al. Electronic Government. EGOV 2016. Lecture Notes in Computer Science, vol 9820. Springer, Cham. Available at: https://doi.org/10.1007/978-3-319-44421-5_6

[30] Wu Y., F. Gu, Ji, Y., Guo, J. and Fan, Y. (2020), Technological capability, eco-innovation performance, and cooperative R&D strategy in new energy vehicle industry: evidence from listed companies in China, Clean. Prod., 261, pp. 121-157. Available at: https://www.sciencedirect.com/science/article/pii/S095965262031204X?via%3Dihub

[31] Ahlers, D., Wienhofen, L.W.M., Petersen, S.A., Anvaari, M. (2019). A Smart City Ecosystem Enabling Open Innovation. In: Lüke, KH., Eichler, G., Erfurth, C., Fahrnberger, G. (eds) Innovations for Community Services. I4CS 2019. Communications in Computer and Information Science, vol 1041. Springer, Cham. Available at: https://doi.org/10.1007/978-3-030-22482-0_9

Funded by the European Union

3.2.6 Civil Society & Stakeholders

The Civil Society & Stakeholders play a vital role in the broader societal engagement for achieving climate neutrality. The perception of society is a crucial factor that can influence the acceptance and effectiveness of climate initiatives. Therefore, understanding and positively influencing these perceptions are essential aspects in the transition process. Increasing society's environmental awareness is another key component, involving educational efforts aimed at enhancing understanding of climate change and the imperative for action. A crucial part of this effort also involves the knowledge dissemination to the public. By fostering the diffusion of a shared vision and sustainable goals towards the achievement of climate neutrality, public awareness is enhanced and fostering societal buy-in for the transformation[32]. Finally, involvement and support of existing veto players[33], defined in transition as influential individuals or groups capable of significantly impacting[34].

Definition: Civil Society & Stakeholders refer to the engagement of the broader society and all relevant stakeholders in the process of achieving climate neutrality. This includes understanding and shaping society's perception, raising environmental awareness, disseminating knowledge to public and identifying and engaging veto players.

3.3 Validation steps of Transition Readiness Assessment Framework

The finalisation/validation of the Transition Readiness Assessment Framework took part in different steps:

- Validation of the elements and the sub-elements: An expert workshop including partners from RUB, RC, BMR, FIT and ENoLL was organized by CERTH in October 2023 to assess if the elements and the sub-elements of the Transition Readiness Assessment framework cover all the aspects that a region needs to have in order to be transition-ready. The workshop was structured as an interactive discussion among the participants focused on the following questions:
  - According to your knowledge and expertise, is there any element that a transition-ready region needs to have, that is NOT covered in the Transition Readiness Assessment Framework? Is any element missing?
  - Do you think that the sub-elements cover all the aspects of each element, describing what a region needs to have for being transition-ready? Is there overlapping between some sub-elements?

[32] Kourtit, K., Nijkamp, P., & Arribas-Bel, D. (2012). Smart cities perspective-a comparative European study by means of self-organizing maps. Innovation: The European Journal of Social Science Research, 25(2), 229–246. Available at: https://doi.org/10.1080/13511610.2012.660330

[33] In game theory "A Veto player is a stakeholder whose utility maximization objective has the most prominent impact on the outcome of a conflict".

[34] Darbandsari P, Kerachian R, Malakpour-Estalaki S, Khorasani H. (2020). An agent-based conflict resolution model for urban water resources management. Sustain Cities Soc, Vol 57. Available at: https://doi.org/10.1016/j.scs.2020.102112

Funded by the European Union

- Each sub-element is covered by question(s) with 5 qualitative levels of answers. Do you think we should reduce the levels/answers or group them (for example in 3 levels instead of 5)?
- Do you think that the question(s) is/are relevant to each sub-element? Are the levels/answers clear, without overlapping? Do they adequately describe an individual situation? Are the first (lower) level and the last (higher) level of each question representative of the worst and best situation respectively in relation to what the question asks for?
- Does the Transition Readiness Assessment Framework achieve its objective?

Thus, in addition to the representativeness of the elements and sub-elements, the experts were asked to validate the content of the questions. More specifically, the experts were asked to evaluate if the description of the answers provided in each qualitative question is the most appropriate for each level (1: lower level to 5: higher level) based on their knowledge and expertise. For example, if an answer's description provided in level 5 does not portray the best possible scenario for a region, the experts have the option to redefine it.

The experts provided valuable feedback that was used for the refinement of the Transition Readiness Assessment Framework. One of the most important outputs of the workshop was the identification of the need to create a two-level assessment framework. This will enable regions that do not have the capacity of answering the full set of questions to use the Transition Readiness Assessment Framework.

- Assignment of the weights to the elements/sub-elements that will be used during the calculation of the transition readiness score of each region. An exercise based on the methodology of the Analytic Hierarchy Process (AHP) was presented to the experts of RUB, RC, BMR, FIT and ENoLL. The experts were asked to perform pairwise comparisons and determine the relative importance of each element/sub-element. The results of the exercise were used by CERTH team to calculate the weight of each sub-element utilizing the AHP framework. By incorporating expert judgments using established methodologies like AHP, we ensure that the quantitative assessment framework reflects the relative significance of the elements/sub-elements in driving the transition readiness, enhancing the accuracy and robustness of the assessment.
- Validation of the importance of the elements and the sub-elements for the TSLs in terms of achieving their transition vision and goals, the content of the dedicated questions for each sub-element and their representativeness to what it is aimed to be measured for this sub-element. A dedicated file was created by CERTH and delivered to TSLs in November 2023 to collect the relevant input. The analysis of the collected results led to the prioritization of the sub-elements and the identification of the most important common ones for all TSLs. Therefore, the results were used for restructuring the Transition Readiness Assessment Framework in two levels. The sub-elements that were considered as important by all TSLs were included in the 1st level of the Transition Readiness Self-Assessment Tool.

Funded by the European Union

- Finally, during the consortium meeting in Western Macedonia in March 2024, an interactive session about the Transition Readiness Assessment Framework was performed. The goal of the session was to identify the most appropriate stakeholders from each TSL that would be able to answer each question. Moreover, the self-explanatory character of the answers was assessed and suggestions for improvement were made by the TSLs and the partners.

This participatory approach provided a collaborative environment for experts to discuss and reach a consensus on the Transition Readiness Assessment Framework. It also gave the opportunity to TSLs to get familiar with the Transition Readiness Assessment Framework before its use and learn how they could benefit from the results of the assessment. By promoting the collective understanding, it is ensured that the chosen elements and sub-elements are considered important by the expert panel and the TSLs, enhancing the credibility and validity of the subsequent Transition Readiness Assessment.

3.4 Assigning weights

The assignment of a specific weight to each sub-element was determined through the Analytic Hierarchy Process (AHP). More specifically, 5 TRANSFORMER experts (from RUB, BMR, RC, FIT and ENoLL) participated in this process and were asked to prioritise the above mentioned 22 Transition Readiness sub-elements: 1 expert from RUB, 1 expert from BMR, 1 expert from RC, 1 expert from FIT and 1 expert from ENoLL.

The first step of the AHP was the creation of a matrix (Figure 3) in which the Transition Readiness sub-elements (22 in total) were added to the rows and columns creating pairs of two different sub-elements. TRANSFORMER experts voted: i) which of the sub-element is more important and ii) how much more important it is with a score between 1-9 (Table 1).

Funded by the European Union

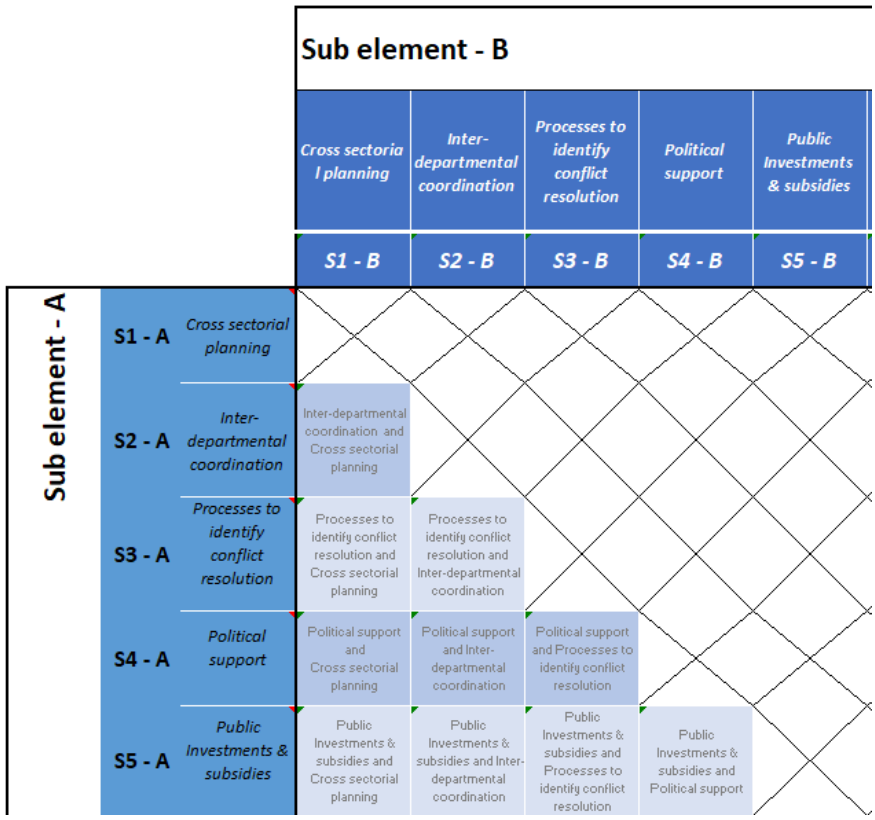

Figure 3: A part of the matrix for the pairwise comparison of the sub-elements

The score range is described in following table (Table 1):

Table 1: The scale range and the description of each value, used for AHP

Intensity of importance	Definition	Explanation
1	Equal importance	Two sub elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one sub element over another
5	Strong Importance	Experience and judgment strongly favor one sub element over another
7	Very strong importance	One sub element is favored very strongly over another, its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one sub element over another is of the highest possible order of affirmation

** 2, 4, 6, 8 can be used to express intermediate values*

Funded by the European Union

Then, the AHP was applied to the individual expert responses and the consistency ratio, and the weight of the sub-elements were calculated in each case. An example of the steps of the AHP is illustrated in Figure 4.

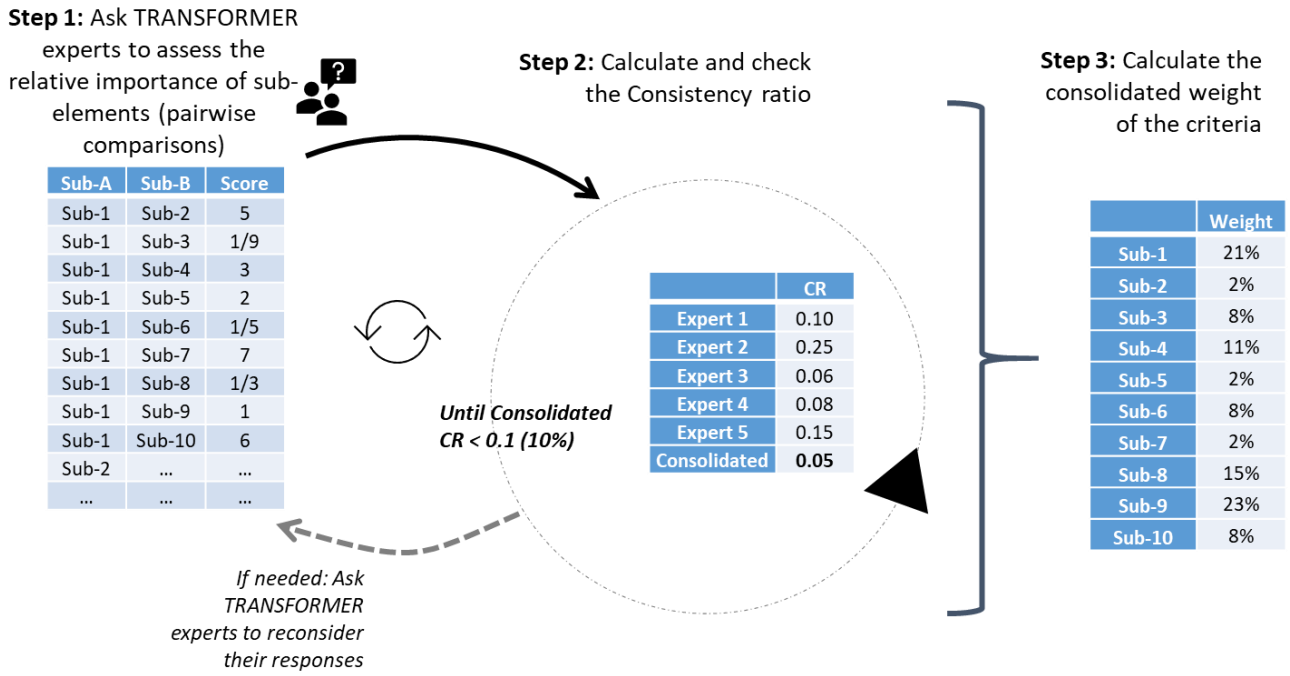

Figure 4: The steps of the AHP procedure

The individual results of each TRANSFORMER expert are presented in Annex A: Assigning weights to the Transition Readiness sub-elements, while Table 2 presents the consolidated results. The consolidated consistency ratio[35] of the AHP procedure was about 4.25%.

[35] The consolidated ratio in the Analytic Hierarchy Process (AHP) is a measure used to evaluate the consistency of the judgments made by decision-makers when comparing different elements pairwise. If the CR is less than or equal to 0.1 (or 10%), the judgments are generally considered to be acceptably consistent (Saaty, T.L. 2012)

Funded by the European Union

Table 2: The weight of the Transition Readiness sub-elements of a transition ready ecosystem

Transition Readiness Sub-elements	Weights
Inter-departmental coordination	7.95%
Cross sectorial planning	7.75%
Public Investments & subsidies	3.00%
Processes to identify conflict resolution	8.12%
Political support	1.38%
Openness	5.50%
Digitalisation	7.50%
Research & Education	2.40%
Energy efficiency and use of renewable energy resources	3.34%
Transparency and inclusiveness of processes	8.76%
Stakeholders engagement & Cross-sectorial initiatives & synergies	5.38%
Supportive regulatory framework	2.23%
Social and technical regimes	5.22%
Regulatory framework for use of renewable energy resources	2.47%
Region's economic development and socio-economic well-being	3.12%
Data availability and security	5.35%
Region Innovation Capacity	1.90%
Sectorial Innovation	4.57%
Society's perception	3.21%
Raising society's awareness for environment	3.61%
Knowledge dissemination to public	4.32%
Support from existing veto players	2.92%

According to the experts, Transparency and inclusiveness of processes was weighted as the most important sub-element. Processes to identify conflict resolution, Interdepartmental coordination and cross-sectorial planning are also proved valuable. On the other hand, Political Support scored the lowest weight close to Region Innovation capacity.

Funded by the European Union

3.5 Definition of the weak points of the transition readiness

The Transition Readiness scores are calculated for each region, and general statistics such as the mean, median, standard deviation, minimum, and maximum are derived from these scores (Figure 5). The scores of the elements and sub-elements for each region are calculated by comparing their respective scores with the mean minus the standard deviation. Elements and sub-elements with scores below this threshold are identified as weak areas requiring attention and improvement while points with values over the mean plus the standard deviation are identified as strong points.

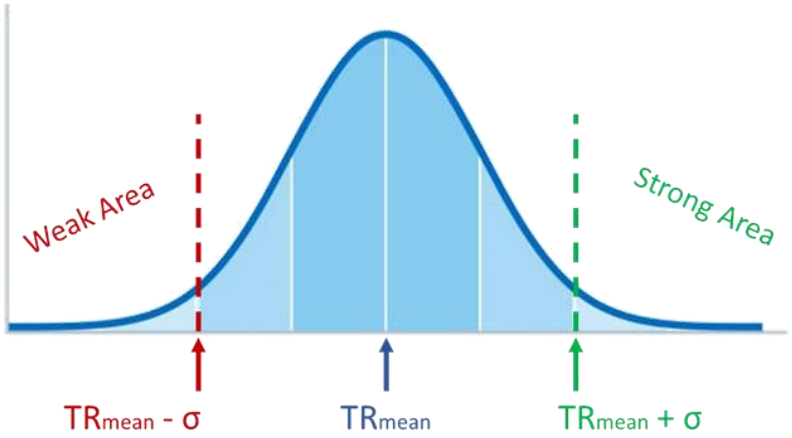

Figure 5: Weak and strong points identification based on their Transition Readiness score

This analysis allows for a comparative assessment with benchmark and other region's transition readiness, highlighting areas of concern that fall below the average performance and providing best practices of the most transition ready regions. This latest provided valuable input for the Knowledge Hub (Task 4.3) to guide TSLs on how to achieve a speedy and successful transition.

3.6 Qualitative Assessment of readiness

The Transition Readiness Assessment provides a structured framework to evaluate what a region needs to have for being transition-ready. It considers various dimensions such as governance structure, policy framework, stakeholder engagement, technological infrastructure, economic and social readiness as they are analysed in the previous section. Through dedicated questions for each sub-element the region is able to assess its technological capabilities and social awareness, the level of the cross-sectorial collaboration, and transparent processes, as well as its policy alignment and stakeholder inclusivity through a Transition Readiness Self-Assessment Tool. In total, 26 questions (Table 3) were developed based on the literature review.

Funded by the European Union

Table 3: The questions selected to assess the Transition Readiness score of a region

Sub-element	Question	
Inter-departmental coordination	Q1	What is the level of inter-departmental coordination for implementing climate actions? (Region authority or functional region area may be considered)
Cross sectorial planning	Q2	What is the level of cross-sectorial planning?
Public Investments & subsidies	Q3	At what level the region has the competence for fund raising for innovation (PP schemes, …)? What is the level of public investments for smart innovative policy making?
Processes to identify conflict resolution	Q4	At what level is the stakeholder analysis mature?
Political support	Q5	What is the level of political support in climate transition?
Openness	Q6	What is the level of (inter)national synergies with neutral partners (research institutions, universities) and other regions and organisations for knowledge transfer (e.g., POLIS, Eurocities, EIT)?
Digitalisation	Q7	What is the level of availability of physical/digital infrastructure & services offered in the region?
Research & Education	Q8	Can the region be characterised as a region with research & innovation activities on climate neutrality?
	Q9	What is the region's educational level and digital competence?
Energy efficiency and use of renewable energy resources	Q10	What is the share of renewable energies in gross final energy consumption and production?
Transparency and inclusiveness of processes	Q11	What is the level of smartness, inclusiveness and transparency of the region's government processes (e-tools, e-Governance practices, data transparency, mechanisms for citizen participation, awareness of changes that are happening)?
	Q12	Is the region's data open-source, safe and easily accessible?

Funded by the European Union

Stakeholders engagement & Cross-sectorial initiatives & synergies	Q13	Does the region follow stakeholder engagement practices for co-creation and co-design of innovative solutions?
	Q14	Is the region open to deploy and test new business models? Is the triple helix for innovation applied for smart solutions?
Supportive regulatory framework	Q15	Does the region follow a regulatory framework for achieving climate neutrality?
Social and technical regimes	Q16	To what extent is socio-technical change taking place in the region?
Regulatory framework for use of renewable energy resources	Q17	Does the region have a regulatory framework for the use of renewable energy resources?
Region's economic development and socio-economic well-being	Q18	What is the level of region's economic development? (Economic performance: GDP per capita, employment rate, income levels, business climate. Socio-economic well-being: poverty rate, quality of life)
Data availability and security	Q19	How mature and smart is the data collection for understanding the current situation of different sectors (Smart infrastructure, ITS, survey)?
Region Innovation Capacity	Q20	To what extent is the current region's policy-making data and evidence driven?
	Q21	Does the region have skilled workforce on innovative solutions?
Sectorial Innovation	Q22	How wealthy is the region in terms of number of big innovators and high-tech start-up companies?
Society's perception	Q23	To what extent are citizens adopting new services and green solutions?
Raising society's awareness for environment	Q24	What methods does the region use to raise environmental awareness?
Knowledge dissemination to public	Q25	At what level is the knowledge disseminated to the public?
Support from existing veto players	Q26	To what extent is the region aware of the veto players in climate neutrality action?

Funded by the European Union

The TSLs were asked to respond to the questions based on their current state using the Transition Readiness Self-Assessment Tool. Each question can be answered using 1-5 scale, with 5 representing the highest score for an element and 1 representing the lowest. To avoid collecting misleading results or conflicts over what each scale means, a detailed description of each scale was provided. The continuum of performance of each scale was also one of the main outcomes of the extended literature review implemented for defining each sub-element. The identified questions and the related responses for assessing transition readiness in a region can be found in Table 13 in the Annex B: Questions of the Transition Readiness Assessment Framework .

Finally, the Transition Readiness score was calculated as a weighted average of the responses to each question, reflecting the readiness of the region at the overall, element and sub-element levels and the weak points of each region were detected. This comprehensive scoring approach allows for a thorough assessment, enabling targeted interventions to enhance specific areas of readiness.

For calculating the final score per region, the weights assigned by the TRANSFORMER experts need to be taken into consideration. Table 4 presents the weights assigned to each element, sub-elements and question. In cases where there is more than one question for a specific sub-element, the weight of the sub-element is equally split among the different questions.

Based on the AHP analysis, the Governance & Fusion is the most important element, followed by the Openness & Greenness and Transparency & cross-sectorial collaboration. When it comes to the sub-elements, the Transparency and inclusiveness of processes is the most important, while the Political support was the least important.

Funded by the European Union

Table 4: The weight of elements and sub-elements of a Transition ready ecosystem

Transition Readiness Element	Element Weight	Transition Readiness Sub-element	Sub-element Weight	Question	Question Weights
Governance &Fusion	28.20%	Inter-departmental coordination	7.95%	Q1	7.95%
		Cross sectorial planning	7.75%	Q2	7.75%
		Public Investments & subsidies	3.00%	Q3	3.00%
		Processes to identify conflict resolution	8.12%	Q4	8.12%
		Political support	1.38%	Q5	1.38%
Openness & Greenness	18.73%	Openness	5.50%	Q6	5.50%
		Digitalisation	7.50%	Q7	7.50%
		Research & Education	2.40%	Q8	1.20%
				Q9	1.20%
		Energy efficiency and use of renewable energy resources	3.34%	Q10	3.34%
Transparency & cross-sectorial collaboration	14.14%	Transparency and inclusiveness of processes	8.76%	Q11	4.38%
				Q12	4.38%
		Stakeholders engagement & Cross-sectorial initiatives & synergies	5.38%	Q13	2.69%
				Q14	2.69%
Regulations & economy	13.04%	Supportive regulatory framework	2.23%	Q15	2.23%
		Social and technical regimes	5.22%	Q16	5.22%
		Regulatory framework for use of renewable energy resources	2.47%	Q17	2.47%
		Region's economic development and socio-economic well-being	3.12%	Q18	3.12%
Infrastructure, Technology and Tools	11.82%	Data availability and security	5.35%	Q19	5.35%
		Region Innovation Capacity	1.90%	Q20	0.95%
				Q21	0.95%
		Sectorial Innovation	4.57%	Q22	4.57%
Civil society and Stakeholders	14.07%	Society's perception	3.21%	Q23	3.21%
		Raising society's awareness for environment	3.61%	Q24	3.61%
		Knowledge dissemination to public	4.32%	Q25	4.32%
		Support from existing veto players	2.92%	Q26	2.92%

Funded by the European Union

3.7 Transition Readiness Self- Assessment Tool

The Transition Readiness Self- Assessment Tool (

Figure 6) consists of two levels, to be used by the regions depending on their data availability:

- the first one includes a small set of questions that can be easily answered by the TSLs (see Table 12 in Annex B: Questions of the Transition Readiness Assessment Framework), while
- the second level includes the full set of questions that require a broader knowledge of different regional aspects (see Table 13 in Annex B: Questions of the Transition Readiness Assessment Framework).

The tool is available here: Transformer - Transition Readiness Tool (imet.gr).

The four TRANSFORMER TSLs answered both levels. However, as the second level provides more detailed results the next section presents the results of the second level.

Funded by the European Union

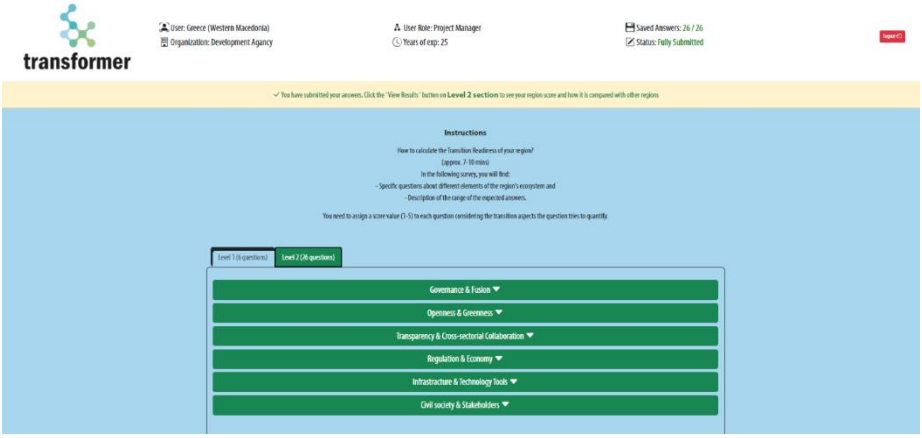

Figure 6: Screenshots of the Transition Readiness Self-Assessment Tool

The following steps were completed by all the TSLs to use the Transition Readiness Self-Assessment Tool:

- At the first step, all TSLs created an account completing the requested information and receiving their credentials by email. At this stage, one account can be created per region. The next version of the tool, beyond the project, will allow multiple users or actors from the same region with different expertise to use it, thus reducing the bias in the answers given.
- Using their credentials, the TSLs accessed the tool and the two levels of questions. The first level consists of 6 questions, easy to be answered by all TSLs. The second level incudes the full set of the questions and at the end it provides more detailed results. The TSLs are not obliged to answer all the questions at once. They can answer gradually as the answers are saved for the next time. However, as soon as the TSLs submit their answers they are not able to edit them further. All TSLs answered both levels.

The results provide valuable insights about the region's total transition readiness score, the score per element/sub-element, benchmarking results with other regions as well as recommendations per sub-element on how to increase the region's transition readiness. Through different graphs the Transition Readiness Self-Assessment Tool provide regions with a comprehensive understanding of their strengths and weaknesses compared to other regions (
Figure 7). Also, for the areas of concern that fall below the average performance the tool provides recommendations related to each element and linked to the transition model/Transition Super-Lab Roadmap on how to speed up the transition towards climate neutrality.

Funded by the European Union

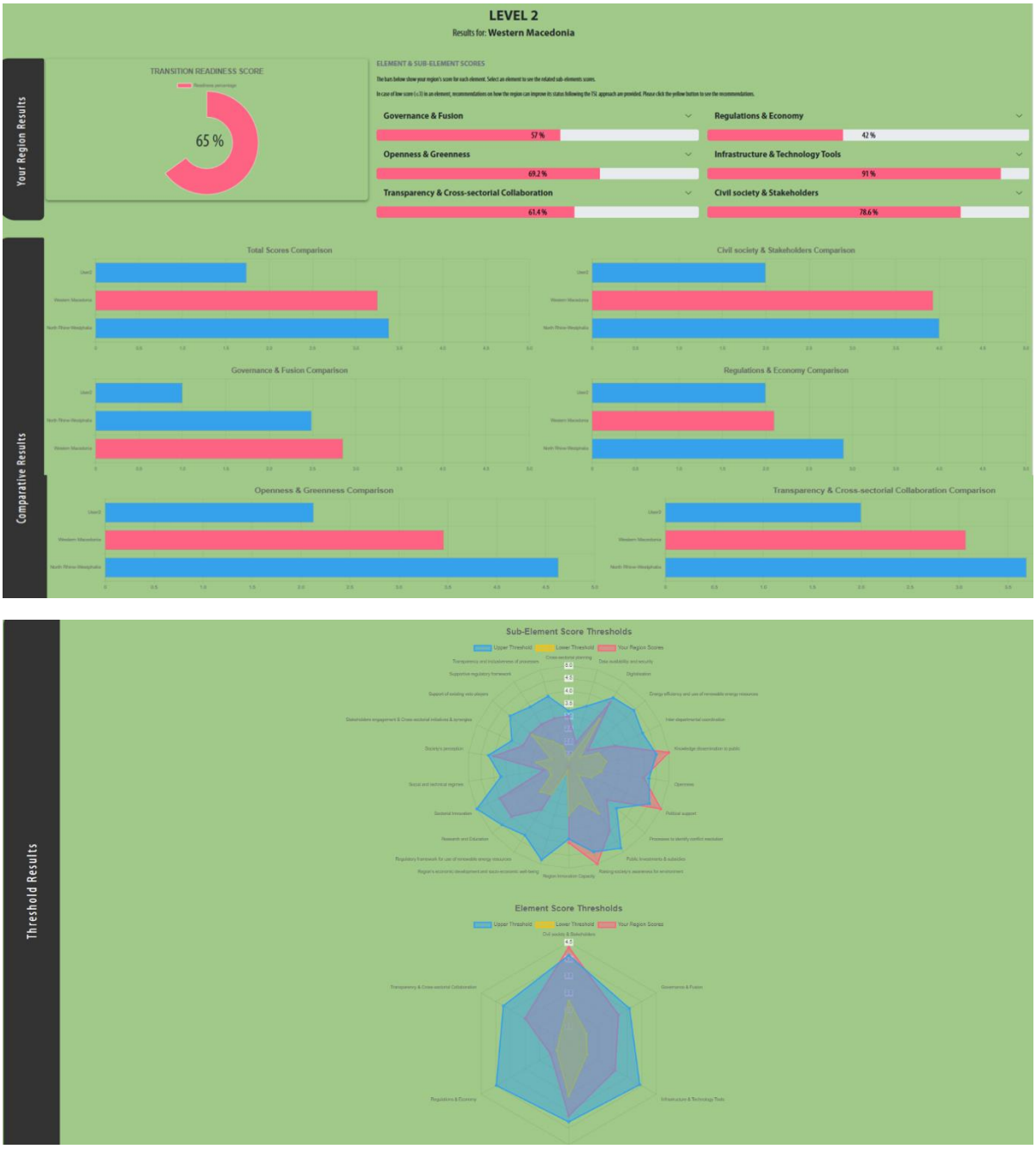

Figure 7: Screenshots of the results tab in the Transition Readiness Tool

The Transition Readiness Self-Assessment Tool is recommended to be used during the first phase of the transition process as it is a useful step for the creation of possible pathways/scenarios to achieve the TSL's vision. However, it is an iterative process allowing for adjustment of the transition pathways and the Pilot use cases.

Funded by the European Union

This continuous learning during the next phases of the transition process (e.g., Activity 11.3 of Transition Super-Lab Roadmap) is also crucial for adapting the strategies that were designed to accelerate a successful transition towards climate neutrality, ensuring that the region remains on course to achieve its desired outcomes and maximize the impact of its transition efforts through the Pilot use cases. By systematically analysing different dimensions of readiness, Transition Readiness Assessment fosters informed decision-making, targeted interventions, and the alignment of TSL efforts with regional needs.

The Transition Readiness Self-Assessment Tool was presented to the follower regions of the User Forum in a session organised in April 2024 and positive feedback related to its usefulness and the level of achievement of its objective was collected. Additional discussion about whether there are any elements or sub-elements that a transition-ready region needs but are not included in the current version of the tool, took place with the User Forum participants. This feedback will be used for future improvement of the tool beyond the project. Finally, the tool was also presented during the TRANSFORMER final conference at Bochum in June 2024 and some more suggestions related to what additional results a user would like to receive from the tool were collected for future integration.

Although the Transition Readiness Assessment could help the TSLs in identifying their weak points for effectively co-designing with the stakeholders the possible transition pathways in Phase 1 of the Transition Super-Lab Roadmap, the relevant tool was developed after the TSLs had developed their pathways. Therefore, it was used later in July 2024, and the results presented in the next section can be used by the TSLs after the end of the project for adjustment of the transition pathways and the Pilot use cases if needed. Also, it is suggested to be used in the future by the TSLs as an iterative reassessment process to ensure that the region remains on course to achieve its desired outcomes through effectively designed strategies to speed the transition towards climate neutrality.

3.8 Results from the Transition Readiness Assessment of TRANSFORMER TSLs

3.8.1 Comparative analysis of the qualitative answers

Below is a comparative analysis of the answers provided by the four TSLs during the use of the Transition Readiness Self-Assessment Tool. At this point, we have to emphasise that due to time constraints, the questions of the Transition Readiness Tool were ‘only’ completed by a single respondent from each TSL as a test for the framework. This fact combined with the high complexity of some questions that need specific expertise may reduce the adequacy of the results.

In response to the question about the level of the **inter-departmental coordination** for implementing actions to combat climate change Emilia-Romagna and Lower Silesia indicated clear interdepartmental strategy towards the implementation of innovative policy, but its practical implementation is limited. In the Ruhr Area, the cooperation of related organisations has started emphasising in local innovation capacity. However, no practical result exists yet for innovative solutions in the region. In Western

Funded by the European Union

Macedonia, multiple departments are involved in the implementation of climate actions but there are significant coordination gaps and inefficiencies that hinder the cooperation among them.

Regarding the level of **cross-sectorial planning**, Emilia-Romagna has a dedicated local unit for the coordination of the planning activities among the various sectors. However, this unit has neither the power nor the legal mandate to influence the formulation of national strategies on mitigation and adaptation to climate change. This situation is similar in the Ruhr Area while in Lower Silesia there are different working groups involved in each sector's planning activities. Due to the lack of effective communication between sectors and the inadequate framework for cross-sectorial planning, fragmented cross-sectorial initiatives are developed in the region. In Western Macedonia, the level of cross-sectorial planning is even lower as there are no horizontal processes applied in planning and thus sector-based initiatives with no collaboration among sectors are developed and implemented to achieve climate neutrality.

Interdepartmental coordination and cross sectorial planning may raise conflicts between the different stakeholders and thus efficient and fair conflict resolution mechanisms should be further established. For applying such mechanisms, it is necessary to have a clear view of the stakeholders that should be involved in the transition process and what role each of them should have. The identification of the transition-related stakeholders and their power and interest have been already mapped in Emilia-Romagna, Lower Silesia and the Ruhr Area. Therefore, these three regions can start developing **processes to recognise potential conflicts** among the stakeholders and implement the most suitable conflict resolution mechanisms. In Western Macedonia, although all stakeholders have been identified and their interests, strengths, weaknesses and needs have been recorded, the level of stakeholders' analysis is still at low level.

In terms of **public investments & subsidies**, Emilia-Romagna and the Ruhr Area are active in raising EU and national funds (participating in EU projects, smart cities mission) to test innovative solutions. In Lower Silesia the regional funding is used for implementing small scale innovative initiatives while the region welcomes private investment in emerging mobility solutions. In Western Macedonia, the region has secured funding for wide development of integrated Information and Communication Technologies (ICT) and Information Technology Systems (ITS) enabled solutions and a wide infrastructure for smart solutions is under development.

In terms of **political support** for climate transition, Emilia-Romagna and Lower Silesia stated that strategic plans are implemented slowly due to legal restrictions and insufficient funding, while in Western Macedonia a delayed alignment with EU requirements and poor implementation of plans have been noted. Ruhr Area, on the other hand, has a political system that totally supports the region’s effort towards climate neutrality through various aspects including legislation, funding and institutional change.

Funded by the European Union

In the **openness** part and more specifically for the level of (inter)national synergies with neutral partners (research institutions, universities) and other regions and organisations for knowledge transfer, in Emilia-Romagna and the Ruhr Area there are national and international synergies with neutral partners characterised by heterogeneity in skills and high expertise. However, there is no freedom to participate and collaborate in region's processes. In Lower Silesia, there are national and limited international synergies with neutral partners but no heterogeneity in skills and high expertise exists. In Western Macedonia, the synergies with neutral parties are limited to the national level.

Additionally, Emilia-Romagna, Lower Silesia and the Ruhr Area have modern infrastructure and services. There is still a lack of framework for their integration and a lack of capacity for transitioning to advanced innovation. Thus, although the availability of infrastructure and services offered in the region are at a good level contributing to the region's **digitalisation**, the digital infrastructure still needs further improvement. Western Macedonia is at a lower level in terms of digitalisation as the existing infrastructure needs modernisation. Emerging new services are operating in the region but physical and digital infrastructure for their operation is not sufficient.

In the **research and education** field, both Emilia-Romagna and Lower Silesia have universities and research institutions with high national reputation that provide independent scientific advice on climate policy. The Ruhr Area has dedicated institutes with high reputation on scientific advice on climate policy and is also centre for start-up companies, research centres and technology parks that collaborate towards the achievement of climate neutrality. On the other hand, in Western Macedonia there are small research institutions, but no research on climate neutrality is performed. Additionally, in Emilia-Romagna and Lower Silesia the population is in full transition towards digital competencies and good level of digital competence is already achieved. In the Ruhr Area, citizens are sufficiently competent in digital services. In Western Macedonia, the high level of education and digital capabilities are limited to young people. However important part of the population has no digital services accessibility.

In terms of share of **renewable energies** in gross final energy consumption and generation, Emilia-Romagna's share is equal or slightly above EU average (22 -31%). Lower Silesia and the Ruhr Area have a lower share than the EU average (12-21%) while Western Macedonia's share is over the EU average (more than 42.5%).

Regarding the aspect of **transparency and inclusiveness of the region's government processes**, the four TSLs were asked to define the level of smartness, inclusiveness and transparency of the region's government processes in terms of using e-tools, e-governance practices, data transparency, and mechanisms for citizen participation. Emilia-Romagna has fully committed to a data-centric approach to improving government, and the preferred approach to innovation is based on open data principles. Additionally, mechanisms for citizen participation are applied by case. Lower Silesia and the Ruhr Area have data centric governance (citizen can proactively explore the new possibilities inherent in strategically collecting and leveraging data). However, in Western Macedonia digitalisation and transparent

Funded by the European Union

government processes are still under development (e.g. e-documents). Mechanisms for citizen participation are limited to open informative meetings. Therefore, in Emilia-Romagna, Lower Silesia and the Ruhr Area the data related to government processes is in comparison to Western Macedonia open and easily accessible. Contrarily, in Western Macedonia the data is not yet open or accessible to public.

Additionally, in order to identify the level of **stakeholders' engagement in participatory approaches,** the regions were asked about the practices that they use for co-creation and co-design of innovative solutions and the level of cross-sectorial synergies. In Emilia-Romagna and the Ruhr Area, the stakeholders are mobilised upon specific issues. In Lower Silesia, a multi stakeholder platform is available but there is no regular operation nor emphasis in innovative emerging solutions support. In Western Macedonia, no stakeholders' engagement practices are applied. For the **cross-sectorial synergies**, in Emilia-Romagna there are clusters of companies related to urban mobility that demonstrate collaborative business models and smart solutions. In Lower Silesia and the Ruhr Area, while occasional synergies between companies exist, no formal cooperation schemes have been established. Finally, in Western Macedonia, collaborative business models are implemented locally at a very small scale and the synergies between different sectors are rare.

In **regulations** and economy field, Emilia-Romagna has a comprehensive regional climate policy learning cycle including target setting, strategic planning, policy formulation and progress monitoring. Lower Silesia and the Ruhr Area have a long-term regional climate strategy not older than five years with adequate level of detail, alignment with national goals and cohesion between short-term actions and long-term climate goals. In Western Macedonia although there are regional plans there is no alignment between national goals as defined in the national strategic documents (e.g the National Energy and Climate Plan) and regional goals.

Regarding the level of **socio-technical transition**, in Emilia-Romagna there is economic competition between new and existing regimes and windows of opportunity for niche innovations do not (sufficiently) materialise. In Lower Silesia niche innovations begin to be stabilised and flow of resources for ongoing innovation activities are established. In the Ruhr Area and Western Macedonia, niche innovations are being developed. The regions are experimenting on techno-economic performance, socio-cultural acceptance and political feasibility of radical innovations and are working on creating transformative coalitions of actors who are willing to develop and implement innovative solutions.

In Emilia-Romagna and Lower Silesia, despite having a **regulatory framework for the use of renewable energy resources** embedded in supportive regulatory framework, there are no monitoring system for environmental and social impact of RES initiatives. In the Ruhr Area, there are supportive mechanisms for renewables (e.g., carbon tax, tax incentives, Net Metering, feed-in-tariffs like the Renewable Energy Act-EEG etc) while in Western Macedonia although there is a regulatory framework for the use of renewable energy resources, there are legal obstacles and fragmented RES initiatives.

Funded by the European Union

For the **region's economic development and socio-economic well-being**, Emilia-Romagna answered that the region is above national average economic performance and socio-economic well-being is near to average. Lower Silesia has higher performance than the national average in both economic development and socio-economic well-being. In the Ruhr Area the economic performance and socio-economic well-being are under the national average while in Western Macedonia the economic performance is below national average, but the socio-economic well-being is near to average.

In the infrastructure, technology and tools element, aspects related to the **data availability and security**, regional innovation capacity and sectorial innovation were qualitatively assessed. Emilia-Romagna stated that there are observatories that collect data for understanding the current situation of different sectors. In Lower Silesia, the Ruhr Area and Western Macedonia, there is no smart data collection infrastructure. In these three regions traditional methods such as surveys are used for data collection.

For the **region's innovation capacity**, the data-driven and evidence-based character of the current regional policy-making was assessed along with the existence of skilled workforce on innovative solutions. All four regions stated that data-driven and evidence-based character of the regional policy-making is based on the stakeholders' cooperation (Public-Private Partnerships for data and knowledge exchange). Additionally, Emilia-Romagna has access to specialised organisations and tools for guiding decision making on solutions to be adopted, assessing the solutions impact and developing dedicated policies to strengthening innovation. Lower Silesia and Western Macedonia have teams of experts that can be mobilised to guide the adoption of innovation. The regions apply innovative policies "based on analogy results" from other regions and knowledge gained through networks. Finally, Ruhr Area's workforce capacity and competence are assessed as sufficient for adopting innovative policy and solutions.

Regarding the number of big innovators in terms of strong commitment and ability to invest in innovation and high-tech start-up companies that promote the **sectorial innovation** in the region, Emilia-Romagna and the Ruhr Area have a significant number of high-tech companies and start-ups (e.g., 400 tech companies and 200 start-ups). Lower Silesia is a hub for technology and innovation with big innovators and start-ups (e.g., 2,200 tech companies and 1,600 start-ups) while in Western Macedonia no high-tech companies and start-ups were identified.

Regarding **societal perception** and the level of adoption of green solutions by the citizens, Emilia-Romagna and the Ruhr Area have already identified community-led initiatives for achieving climate neutrality. In Lower Silesia, the society starts adopting new services and green solutions thanks to incentives provided by the region. In Western Macedonia people are aware of green solutions. However, many of them don't adopt them or cannot afford their adoption due to financial constraints.

Additionally, Emilia-Romagna, Western Macedonia and Lower Silesia organise often campaigns for **raising environmental awareness** supported by scientific research and evidence. In the Ruhr Area except of the organised campaigns, the region uses mechanisms (such as Citizen Assemblies) for continuing educating

Funded by the European Union

and training citizens on climate policy. The region also implements capacity-building and training programmes.

In terms of the **knowledge dissemination**, processes of public consultation exist in Emilia-Romagna, Western Macedonia and Lower Silesia but there is not active participation in decision making. In the Ruhr Area the vision and sustainable goals towards the achievement of climate neutrality are diffused to the public in the beginning of decision-making processes by using appropriate language and common understanding. So, a common understanding is achieved at a very early stage of the decision-making processes enhancing the active participation of the public throughout the whole process.

Finally, regarding the **support from existing veto players**, the Ruhr Area and Western Macedonia avoid the creation of conflict with veto players during the decision-making processes while in Emilia-Romagna and Lower Silesia the interests of veto players are set as high priority in the decision-making process.

3.8.2 Transition readiness scores by element and sub-element

The total transition readiness score for Western Macedonia is around 2.5, for Lower Silesia and the Ruhr Area about 3.0 and for Emilia-Romagna above 3.5, indicating the highest score among the regions. These results may not adequately represent the real transition readiness level of the regions as due to time constraints the questions of the Transition Readiness Tool were 'only' completed by a single respondent from each TSL as a test for the framework. However, due to high complexity some questions can only be assessed by people with specific expertise.

Delving deeper into the scores of each element for the regions, in Governance & Fusion Western Macedonia has quite low score (around 1.5), Lower Silesia scores 3.0, the Ruhr Area slightly above 3.0 and Emilia-Romagna around 3.5, indicating the highest score. In Openness & Greenness, Western Macedonia scores slightly below 3.0, Lower Silesia slightly above 3.0, Ruhr Area above 3.5 and Emilia-Romagna 3.8. In Transparency & Cross-Sectorial Collaboration, Western Macedonia scores 1.5, Lower Silesia slightly below 3.0, Ruhr Area 3.0 and Emilia-Romagna 3.8, indicating the highest score. In Regulations & Economy, Western Macedonia scores 2.0, Ruhr Area slightly above 2.0, Lower Silesia around 3.5 and Emilia-Romagna 4.0, while in Infrastructure & Technology Tools, Western Macedonia scores around 1.7, Lower Silesia slightly above 3.0, Ruhr Area around 3.0 and Emilia-Romagna reaches almost 4.0. Finally, in Civil Society and Stakeholders, Western Macedonia scores slightly above 2.5, Lower Silesia slightly above 3.0, Emilia-Romagna around 3.5 while Ruhr Area reaches almost 4.0 indicating the highest score.

Emilia-Romagna consistently scores the highest across all elements reaching closer to 4.0 in most categories except of Civil society & Stakeholders that has the second highest score after the Ruhr Area. Western Macedonia generally scores the lowest, with most of elements' scores around 2.5 or below. Table 5 presents the Transition readiness scores (%) per element and sub-element per TSL.

Funded by the European Union

Table 5: Transition readiness scores (%) per element and sub-element

Transition Readiness Sub-elements	Emilia-Romagna	Lower Silesia	Ruhr Area	Western Macedonia
Governance and Fusion	**67.80%**	**60.20%**	**64%**	**35.20%**
Cross sectorial planning	60%	40%	60%	20%
Inter-departmental coordination	80%	80%	60%	40%
Public Investments & subsidies	80%	60%	80%	100%
Processes to identify conflict resolution	60%	60%	60%	20%
Political support	60%	60%	100%	40%
Openness and Greenness	**76.40%**	**67%**	**72.80%**	**58.60%**
Openness	80%	60%	80%	40%
Digitalisation	80%	80%	80%	60%
Research & Education	80%	80%	80%	40%
Energy efficiency and use of renewable energy resources	60%	40%	40%	100%
Transparency and cross-sectorial collaboration	**76.20%**	**56.20%**	**60%**	**30%**
Transparency and inclusiveness of processes	80%	60%	60%	30%
Stakeholders engagement & Cross-sectorial initiatives & synergies	70%	50%	60%	30%
Regulations and economy	**80%**	**73.40%**	**42.40%**	**40%**
Supportive regulatory framework	80%	60%	60%	40%
Social and technical regimes	80%	60%	40%	40%
Regulatory framework for use of renewable energy resources	80%	80%	60%	40%
Region's economic development and socio-economic well-being	80%	100%	20%	40%
Infrastructure, Technology and Tools	**78.40%**	**66.40%**	**61.80%**	**35.60%**
Data availability and security	80%	40%	40%	40%
Region Innovation Capacity	70%	60%	80%	60%
Sectorial Innovation	80%	100%	80%	20%
Civil society and Stakeholders	**68.80%**	**64.20%**	**87.20%**	**55.40%**
Society's perception	80%	60%	80%	40%
Raising society's awareness for environment	60%	60%	100%	60%
Knowledge dissemination to public	60%	60%	100%	60%
Support from existing veto players	80%	80%	60%	60%

Funded by the European Union

In general, the results of the tool show that Western Macedonia is 42% transition ready, Lower Silesia 64%, Ruhr Area 65% and Emilia-Romagna 74% (Figure 8).

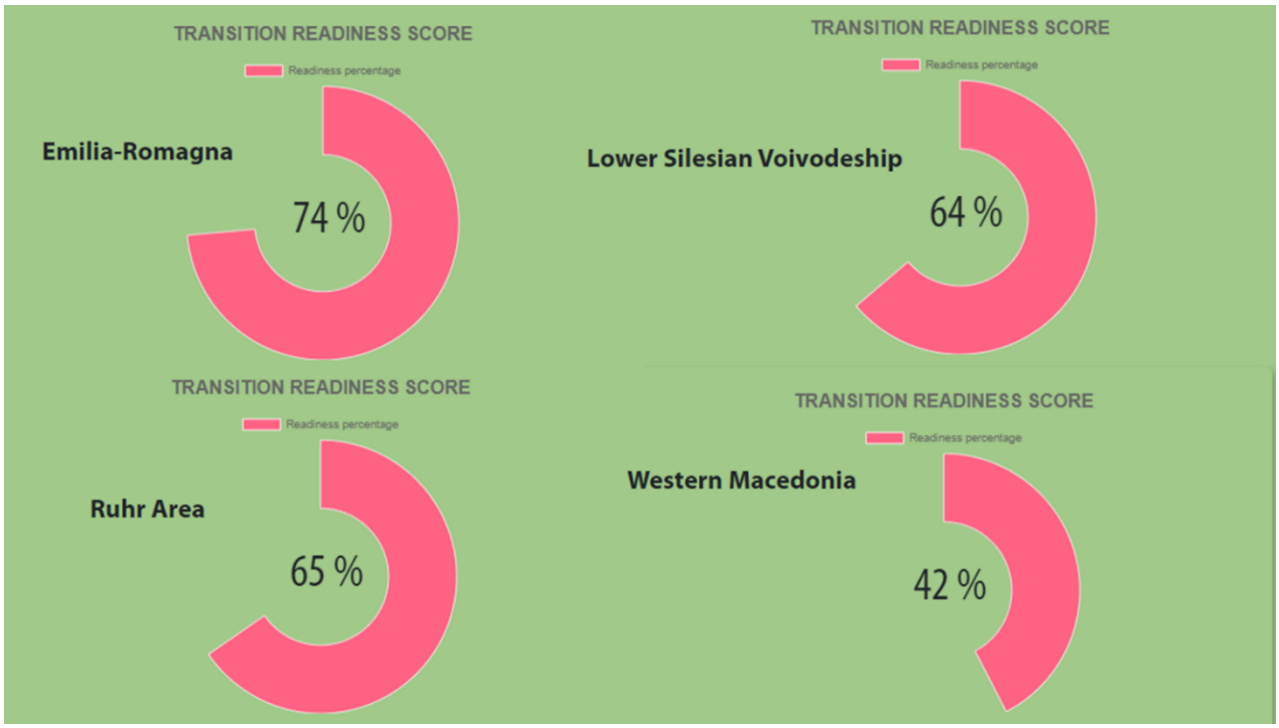

Figure 8: Total transition readiness score per region

3.8.3 Weak points identification

Elements and sub-elements with low scores are identified as weak points for each region. The following heatmap (Figure 9) presents the responses of each region to each question. The scores are indicated in a range from low (darker colours) to high (light colours).

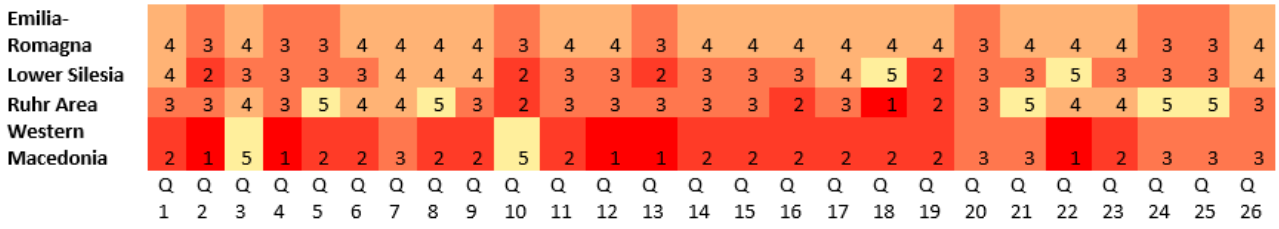

Figure 9: Responses of the regions to the Transition Readiness Self-Assessment Tool

The question-based analysis proved that in all regions the **lowest scores were detected in questions regarding the Governance and Fusion and more specifically the cross-sectorial planning (Q2) and the processes to identify conflict resolution (Q4).** Additionally, the stakeholder's engagement practices for co-creation and co-design of innovative solutions (**Q13) is also a problem in the regions. The regions**

Funded by the European Union

(except Emilia-Romagna) have also low scores in data availability (Q19), a problem which affects the progress toward data-driven and evidence-based policy making (Q20). On the other hand, regions have **high levels of Public Investments and subsidies (Q4) and physical and digital infrastructure and services offered in the region** although sometimes they need modernisation **(Q7)**.

Figure 9 above gives a first overview of the strong and weak points of the regions that need high attention. At a further step, the lower and upper thresholds of each element and sub-element are calculated and presented in Table 6 (they are also presented in graph format in the results of each region in the Transition Readiness Self-Assessment Tool).

Table 6: Lower and Upper Thresholds of the Transition Readiness Sub-elements

Transition Readiness Sub-elements	Lower Threshold	Upper Threshold
Governance and Fusion	**2.1**	**3.58**
Cross sectorial planning	1.29	3.21
Inter-departmental coordination	2.29	4.21
Political support	1.99	4.51
Public Investments & subsidies	3.18	4.82
Processes to identify conflict resolution	1.5	3.5
Openness and Greenness	**3.05**	**3.82**
Openness	2.29	4.21
Digitalisation	3.25	4.25
Research & Education	2.5	4.5
Energy efficiency and use of renewable energy resources	1.59	4.41
Transparency and cross-sectorial collaboration	**1.82**	**3.74**
Transparency and inclusiveness of processes	1.84	3.91
Stakeholders engagement & Cross-sectorial initiatives & synergies	1.77	3.48
Regulations and economy	**1.91**	**3.98**
Supportive regulatory framework	2.18	3.82
Social and technical regimes	1.79	3.71
Regulatory framework for use of renewable energy resources	2.29	4.21
Region's economic development and socio-economic well-being	1.17	4.83

Funded by the European Union

Infrastructure, Technology and Tools	**2.13**	**3.93**
Data availability and security	1.5	3.5
Region Innovation Capacity	2.9	3.85
Sectorial Innovation	1.77	5
Civil society and Stakeholders	**2.77**	**4.12**
Society's perception	2.29	4.21
Raising society's awareness for environment	2.5	4.5
Knowledge dissemination to public	2.5	4.5
Support from existing veto players	2.92	4.08

Elements and sub-elements with scores below the lower threshold are identified as weak areas requiring attention and improvement. Table 7 and Table 8 reveal the elements and sub-elements respectively which seem to be problematic for each region.

All transition readiness elements except of regulations and economy are identified as weak points for Western Macedonia. For Emilia-Romagna, Lower Silesia and the Ruhr Area, no transition readiness elements have been identified as weak points as their scores were higher than the upper thresholds. However, in terms of transition readiness sub-elements, the weak points of Lower Silesia are related to Public Investments & subsidies and Region innovation capacity while the weak points of the Ruhr Area are related to region's economic development and socio-economic well-being and support from existing veto players. For Emilia-Romagna no weak points were identified.

Table 7: Weak points of the TRANSFORMER regions in terms of Transition Readiness elements

Element	Emilia-Romagna	Lower Silesia	Ruhr Area	Western Macedonia
Governance and Fusion				x
Openness and Greenness				x
Transparency and cross-sectorial collaboration				x
Regulations and economy				
Infrastructure, Technology and Tools				x
Civil society and Stakeholders				x

Funded by the European Union

Table 8: Weak points of the TRANSFORMER regions in terms of Transition Readiness sub-elements

Transition Readiness elements	Transition Readiness Sub-elements	Emilia-Romagna	Lower Silesia	Ruhr Area	Western Macedonia
Governance and Fusion	Cross sectorial planning				x
	Inter-departmental coordination				x
	Political support				
	Public Investments & subsidies		x		
	Processes to identify conflict resolution				x
Openness and Greenness	Openness				x
	Digitalisation				x
	Research & Education				x
	Energy efficiency and use of renewable energy resources				
Transparency and cross-sectorial collaboration	Transparency and inclusiveness of processes				x
	Stakeholders engagement & Cross-sectorial initiatives & synergies				x
Regulations and economy	Supportive regulatory framework				x
	Social and technical regimes				
	Regulatory framework for use of renewable energy resources				x
	Region's economic development and socio-economic well-being			x	
Infrastructure, Technology and Tools	Data availability and security				
	Region Innovation Capacity		x		
	Sectorial Innovation				x
Civil Society	Society's perception				x
	Raising society's awareness for environment				
	Knowledge dissemination to public				
	Support from existing veto players			x	

Funded by the European Union

Recommendations for each specific sub-element where the regions score low are provided through the tool. These recommendations are related to how the region can improve the situation of that particular sub-element in order to increase its transition readiness[36].

4 Assessing the efficiency and success of Transition Process towards climate neutrality

There are different approaches for assessing the successful implementation of innovation and the socio-technical transitions (Figure 10) such as the system dynamics, the open innovation community and the NESTA innovation model (spiral).

As an innovation system is a complex and dynamic system that continuously evolves, a need for shift from static and descriptive methods to more dynamic and forward-thinking ones has emerged. Towards this direction, the last years system dynamics technique has been used to model innovation systems besides the modelling of intricate socio-economic systems that has been extensively employed for.

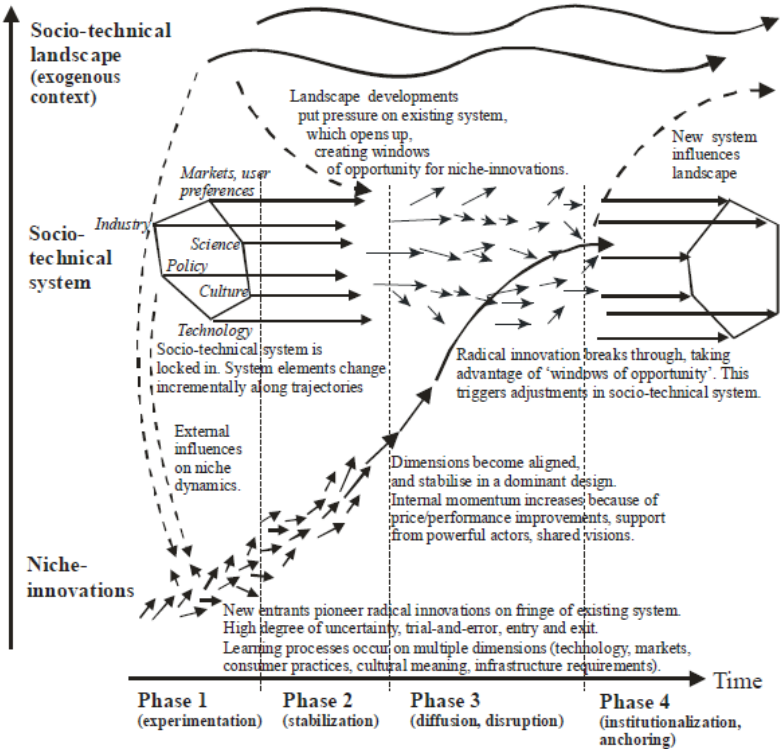

Figure 10: Multi-level perspective on socio-technical transitions

[36] For details on the recommendations provided thrugh the Transition Readiness Self-Assesment Tool see deliverable D5.3 Best practices and recommendations for Super-Labs operation towards the region transition, (URL not available yet)

Funded by the European Union

System Dynamics (SD) modelling has been established as a method and tool for three main purposes: i) to identify feedback loops to uncover the primary mechanisms of growth, balance, and erosion (or stagnation) that drive the dynamic behaviour of socio-economic systems, ii) to replicate - that is, simulate - the system's dynamic behaviour using differential equations, and iii) to test and develop more effective policies that lead to enhanced system performance. In this context, the modelling process in system dynamics is a cyclical one, involving five main stages: problem definition, dynamic hypothesis creation, model formulation, model testing (or validation), and policy formulation/evaluation[37].

In the literature, open innovation is characterized as a strategy that allows organizations to tap into external expertise and technological capabilities that are not internally accessible. This approach aims to decrease innovation expenses and simultaneously distribute the associated risks[38]. The three main open innovation processes consist of: the outside-in process, also known as technology exploration or inbound innovation[39] [40]; the inside-out process, also defined as technology exploitation or outbound innovation; and the combination of both.

Open Innovation Community (OIC) follows a a crowdsourced participatory innovation approach that: (1) facilitate a debate generation and consensus building; and (2) validate the results of the examined innovation. The added value of OIC (in relation to other stakeholder platforms) stems from: (i) its explicit focus on urban policy issues and the policy requirements of emerging mobility solutions; (ii) the incorporation of international members, bringing together relevant experiences and insight. The OIC gathers stakeholders such as expert communities, local practitioners and policy-makers as well as innovators from the private side. Also, networks and associations of these groups can be involved, given their inherent expertise and multiplicator capacity. The Open Innovation Community adopts a Communities of Practice structured approach aimed at enhancement, transfer and take-up of innovation findings contributing. It also serves as a dissemination audience to maximise the innovation impacts. The OIC approach was successfully implemented in SPROUT project[41] with an explicit focus on urban transport policy issues (Figure 11) involving urban mobility policy makers, economic operators, and researchers in the form of an Open Innovation Community on Urban Mobility Policy.

[37] Uriona Maldonado, M. & Grobbelaar, S. (2017). System Dynamics modelling in the Innovation Systems literature. Conference: 15th Globelics International. Available at: https://www.researchgate.net/publication/319545608_System_Dynamics_modelling_in_the_Innovation_Systems_literature

[38] Enkel, E., Gassmann, O. and Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon, R&D Management, Vol. 39 No. 4, pp. 311-316. Available at: https://doi.org/10.1111/j.1467-9310.2009.00570.x

[39] Dahlander, L. and Gann, D.M. (2010). How open is innovation?, Research Policy, Vol. 39 No. 6, pp. 699-709. Available at: https://www.sciencedirect.com/science/article/pii/S0048733310000272?via%3Dihub

[40] Van de Vrande, V., de Jong, J.P.J., Vanhaverbeke, W. and de Rochemont, M. (2009), Open innovation in SMEs: trends, motives and management challenges, Technovation, Vol. 29 Nos 6-7, pp. 423-437. Available at: https://www.sciencedirect.com/science/article/pii/S0166497208001314

[41] SPROUT project. Available at: (https://sprout-civitas.eu/)

Funded by the European Union

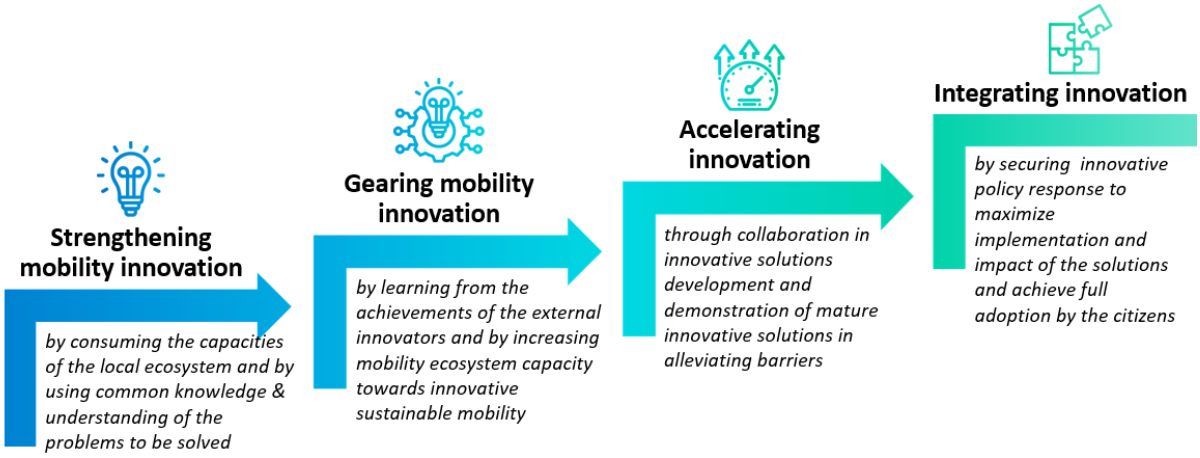

Figure 11: The Open innovation community approach in mobility context

While each innovation is a complex narrative of feedback loops, Nesta innovation spiral presents the structured phases that most innovations undergo. Nesta approach is dedicated to discovering, examining, and validating new approaches, instruments, and procedures (collectively referred to as innovation methods) to foster innovation from diverse sectors and global sources[42]. The steps and the innovation methods to be engaged in each step are depicted in Figure 12. Although NESTA model doesn't correspond to the complex and non-linear phases of the innovation creation, it was studied as state-of-the-art, as its phases provide valuable input for the development of the steps of the TRANSFORMER transition model as described below.

Figure 12: NESTA spiral[42]

[42] NESTA, A compendium of innovation methods, Available at: https://media.nesta.org.uk/documents/Compendium-of-Innovation-Methods-March-2019.pdf

Funded by the European Union

As the cross-sectorial transition towards climate neutrality is an emerging topic that isn't widely studied, there is no literature related to the assessment of transition through innovation. As the System Dynamics of cross-sectorial innovation would be a method with high complexity, the TRANSFORMER transition model considers a combination of the open innovation community steps with NESTA innovation spiral. However, aspects related to systems dynamics have been integrated in TRANSFORMER model (e.g., identification of key stakeholders, relationships mapping) along with elements that exist in traditional planning methodologies (e.g., SUMPs).

The 4 steps of the TRANSFORMER transition model that a TSL should follow to achieve a transition towards climate neutrality are based on a combination of the Open Innovation Process and the NESTA innovation spiral. The first version of the Transition model (see deliverable D5.1[43]) was the basis upon which the first version of the roadmap was developed. However, the roadmap was evolving during the project integrating valuable lessons learned and experiences from the different activities performed in the project and the final version of the Transition Super-Lab Roadmap was delivered at the end of the project. As the transition model and the roadmap are two inseparable elements for the application of the TSL approach to achieve the transition to climate neutrality, the first version of the transition model was also adapted to be aligned with the Transition Super-Lab Roadmap. The adapted Transition model is presented in Figure 13.

Both the **TRANSFORMER transition model** and the **TRANSFORMER Transition Super-Lab Roadmap** are equally important elements in the context of the transition procedure. They refer to different levels of the process and are directly linked to each other.

- **The TRANSFORMER transition model** refers to a set of principles that supports the conceptual framework of the TSL approach and guides the process of the region's transition towards climate neutrality. It helps define the desired future state of the region, outlines the steps needed to achieve that state, and provides a structured approach for managing the transition. The transition model encompasses various elements such as the vision and goals of the change, the roles and responsibilities of stakeholders involved, the necessary resources, and the strategies for overcoming challenges. It provides a high-level understanding of the transition process and acts as a reference point for decision-making throughout the transition.
- **The TRANSFORMER Transition Super-Lab Roadmap** is a detailed plan that outlines the specific activities, milestones, and dependencies involved in implementing a transition. It provides a step-by-step guide for executing the transition model and serves as a communication tool to align stakeholders and keep them informed about the progress of the change. Integrating key tasks, timelines, responsible parties, resource allocation, and any critical dependencies or constraints that need to be considered, provides a more granular view of the transition process, allowing for better coordination and monitoring of the efforts.

[43] TRANSFORMER Project (2024). Deliverable 5.1 ''Framework for Super-Labs Assessment'', Available at https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D5.1_Framework-for-Super-Labs-Assessment_public.pdf

Funded by the European Union

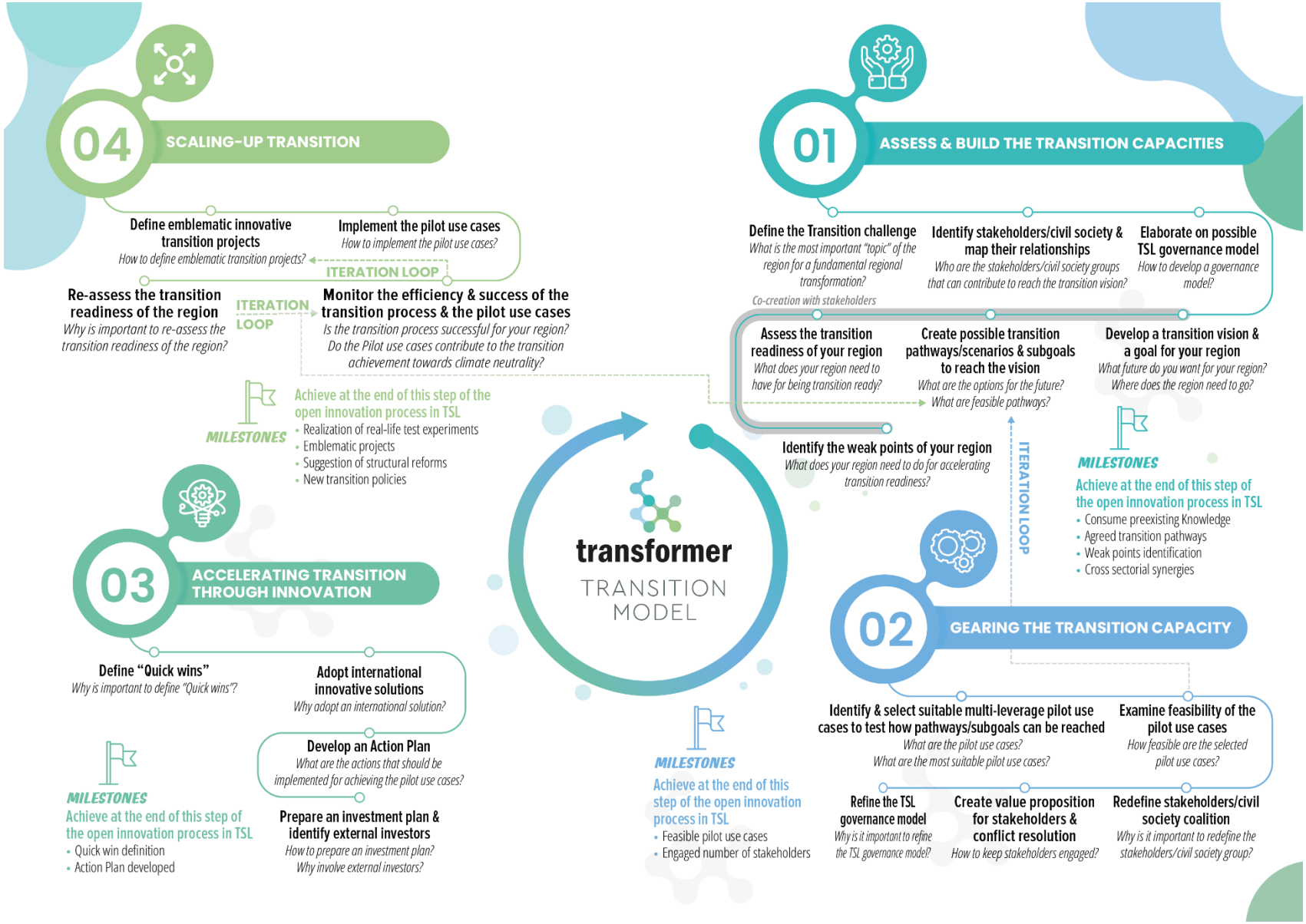

Figure 13: TRANSFORMER transition model

Funded by the European Union

The efficiency and success of the transition process is assessed through the achievement of the defined milestones to be reached at the end of each step in the suggested timeline (milestone achievement monitoring). The milestones and timelines suggested are based in TRANSFORMER TSLs experience within the two years project.

It is important to ensure that data generated from each step of the process will be collected by the TSLs for the quantification of the milestones at a later stage (e.g., number of stakeholders engaged, identified weak points, defined ''Quick wins'', number of suggested structural reforms, etc.). By quantifying the milestones, the monitoring of the transition process and the identification of good practices throughout the process will be feasible.

4.1 The transition process towards climate neutrality

The updated version of the transition model towards a climate neutral transition (TRANSFORMER transition model) is described below:

4.1.1 Assess and build the transition capacities

This first phase is a preparatory stage that helps each TSL to create a fertile ground for the transition by consuming the capacities of the local ecosystem and by using common knowledge and understanding of the problems to be solved. This stage contains a sequence of paces that a TSL should follow and the milestones that should be achieved at the end of this phase are considered critical for the continuation and the success of the transition process:

1. Define the transition challenge in the region
2. Identify stakeholders based on the challenge (coalition building)
3. Elaborate on possible TSL governance model
4. Collaborate with stakeholders to develop a transition vision
5. Engage stakeholders in discussions to explore potential pathways and scenarios for realizing the vision
6. Assess the transition readiness of the region (based on the methodology described in Chapter 3)
7. Identify the weak points of the region (based on the methodology described in Chapter 3)

Define the transition challenge

Transition challenge of TSLs refer to the main difficulty and obstacle faced by the region during its transition period from fossil-fuel-based to zero-carbon local economies. Sometimes this challenge resulted from the need of the region for economic and social transformation and is already predefined in European, national and/or regional strategic plans. However, often transition strategies don´t exist or although they exist, there are different, more urgent transition needs and challenges that are not addressed in the strategic plans due to political reasons and lobbying. Thus, the TSLs need to define their transition challenge based not only to the existing strategic plans but also considering the real needs and potentials of the region. The Quantitative Regional Assessment Framework for Transition Super-Labs (QRAFT) could be conducted in this phase as the initial assessment of the transition needs and potentials

Funded by the European Union

of a region, aiming to identify the most important "topics" for the region (such as agriculture, energy, manufacturing, mobility, etc.) to achieve climate neutrality.[44]

Build a coalition of stakeholders

A coalition is a temporary alliance or partnering of groups in order to achieve a common purpose or to engage in joint activity. Coalition building is seen as the process by which parties (individuals, organizations, or nations) come together to form a coalition. Forming coalitions with other groups of similar values, interests, and goals allows members to combine their resources and become more powerful than when they each acted alone[45]. In the TRANSFORMER project, coalition building starts in this first step of the transition process and continues throughout the whole process including the identification and engagement of the transition-related stakeholders from the quadruple helix stakeholders in the TSLs activities among others. Based on the vision and the Pilot use cases, each TSL creates a unique roster of key stakeholders from the public sector, private sector, academia and civil society. For defining the list of stakeholders, it is important to define the geographical area of implementation of the Pilot use cases or the geographical area for which impact can be created from Pilot use cases implementation or impact can be assessed.

Stakeholders' relationships should be also mapped in this stage. Usually, their current relationships are considered but in TRANSFORMER it is critical to explore also their potential relationships in the context of achieving the transition ("Don't think about what you are doing but also about what you will be able to do for achieving TSL's vision).

The veto players need to be identified at this stage. As veto player we may define the stakeholder whose decision has more impact in the achievement or the non-achievement of the goal of a Pilot use case. As a game theory term "a veto player is a stakeholder whose utility maximization objective has the most prominent impact on the outcome of a conflict"[46].

Elaborate on possible TSL governance model

After identifying stakeholders' and mapping their relationships and responsibilities during the coalition building activities, the TSLs need to develop a governance model that all the involved stakeholders need to follow in order to work together in a lasting and self-sustaining way. A **TSL governance blueprint** that consists of **four governance bodies (TSL coordination**, **Reflexive monitoring board**, **Stakeholder**

[44] For more information about QRAFT see deliverable D2.2 ''Quantitative mapping research report'', Available at: https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D2.2_Quantitative-mapping-research-report.pdf

[45] Spangler, B. (2003). Coalition Building. Conflict Information Consortium.

[46] Darbandsari P, Kerachian R, Malakpour-Estalaki S, Khorasani H. (2020). An agent-based conflict resolution model for urban water resources management. Sustain Cities Soc, Vol 57. Available at: https://doi.org/10.1016/j.scs.2020.102112

Funded by the European Union

coalitions and Pilot management) within a governance arrangement was developed in TRANSFORMER project.[47]

Develop a transition vision

A common definition of a vision has been prepared by TRANSFORMER partners as following: a *vision for Transition Super-Labs is an ideal representation for the future of the region that captures a common understanding of the desirable and transformative direction towards a sustainable society.* Vision development is an essential element of the TSL process. It is crucial for achieving long-term transformation because it provides a clear set of goals, direction and alignment and collaboration among the key stakeholders.

Create transition pathways and scenarios

A scenario can be defined as a structured framework comprising various feasible pathways aimed at achieving an envisioned vision. It involves considering different possibilities and assessing the potential pathways to determine the most suitable approach. Pathways are specific routes of actions taken to reach the vision with a structured approach. These are co-defined with the stakeholders before the Pilot use cases. In the TRANSFORMER project, our primary focus has been on the development of pathways.

Assess the transition readiness of the region

This activity includes the qualitative assessment of various elements that characterised the transition-ready ecosystems such as governance & fusion, openness & greenness, transparency and cross-sectorial collaboration, regulations and economy, infrastructure, technology & tools and civil society and stakeholders. The TSLs are able to conduct the Transition Readiness Assessment using the Transition Readiness Self-Assessment Tool as described in Chapter 3 for calculating their transition readiness level. This is an iterative process that can be conducted at any point of the transition process to ensure that the region remains on course to achieve its desired outcomes through effectively designed strategies to speed the transition towards climate neutrality. Transition Readiness Assessment and QRAFT could be combined in this first phase of the transition process providing to TSLs an initial overview of the region from both qualitative and quantitative perspective.

Identify the weak points of the region

By using the Transition Readiness Self-Assessment Tool as described in Chapter 3, the TSLs can also identify their weak points that will help them in effectively co-designing with the stakeholders the possible transition pathways.

[47] For more details on conceptual framing of TSL governance as well as the roles and responsibilities of each governance body see deliverable 2.3 Regional SWOT analyses as feasibility studies to be used as evidence base in decision-making for Action plan development (URL not available yet) and D4.2 Transition Super-Lab Roadmap (URL not available yet)

Funded by the European Union

The milestones of Phase 1 include:

- Consume pre-existing Knowledge through stakeholders' identification (M1-M6)
- Agreed transition pathways (M6)
- Weak points identification (M6)
- Cross-sectorial synergies (M6)

4.1.2 Gearing the transition capacity

In this phase the TSLs continue the coalition building activities trying to increase cross-sectorial ecosystem capacity towards innovative sustainable sectors:

Identify and select suitable multi leverage Pilot use cases to test the achievement of the pathways, vision and objectives

Pilot use cases are identified as co-created concrete project ideas to achieve climate neutrality and promote systemic transformation. Pilot use cases are developed and implemented with a focus on a regional transformation.

TSLs should select the most suitable Pilot use cases among the identified ones. The selection is based on the following criteria as defined and described in deliverable D3.2- Definition of Transition Super-Lab Pilot use cases[48]:

- Contribution to the goal of climate neutrality (according to agreed visions and scenarios)
- Potential for systemic transformation
- Regional character beyond merely local solutions and expected value for the region
- Experimental and innovative approach (may refer to the Pilot use cases' content or the development process)
- Potential for co-creation during the development phase (beyond the initial phase of definition and selection)
- Cross-sectorial approach

Examine feasibility of the Pilot use cases

As soon as the Pilot use cases are selected, their feasibility aspects should be examined. The TSLs should collect the necessary data in order to be able to assess if the Pilot use case is worth exploring further. The feasibility study should consider technical aspects including the availability of necessary technology, infrastructure requirements, data availability, compatibility with existing systems, and potential technical challenges or limitations. Along with the technical aspects, the operational feasibility of the Pilot use case should be examined, meaning the availability of skilled personnel and the organizational readiness for change. The economic viability of the Pilot use case should be also tested at this stage. Through cost-benefit analysis, the TSL would be able to assess both the short- and long-term costs and benefits. By examining potential sources of finances, the financial sustainability of the examined Pilot use case can be

[48] TRANSFORMER Project (2024). Deliverable 3.3 ''Transition Super-Lab Action Plan'' (URL not available yet)

Funded by the European Union

ensured. At this point, the TSLs should also identify legal/regulatory and socio-economic factors (e.g., citizens acceptance and political support) that may impact the Pilot use case implementation as well as define the timeframe horizon.

Redefine stakeholders/civil society coalition

Although the stakeholders to be involved have been identified in the first step of the process, it is considered essential to redefine the group of stakeholders that are relevant with the multi leverage Pilot use cases. Relevance of stakeholders could be defined as following: Important to secure feasibility, involved at Pilot use case implementation, veto stakeholder, impacted by the implementation, transition facilitator. A stakeholder can participate to more than one Pilot use case group.

Create value proposition for stakeholders and conflict resolution

As the participation of stakeholders in the TSL activities is voluntary, TSL should ensure the creation of a value proposition for each of them specifying in parallel the role of each stakeholder in the transformation process. Some examples of roles are the following: tools and data for building common understanding creation, capacity for conflict solving, implementer, conditions creator, one stakeholder mobilizing many other stakeholders in a field.

Additionally, in this cross-sectorial transition, TSLs cannot follow the same procedure for stakeholders' engagement and management. The role of the "leader" stakeholder able to "govern" other stakeholders needs to be also defined as a category and it is important to define their role in the transition process success.

Refine the TSL governance model

After the definition of the Pilot use cases and the identification of each Pilot use case objectives, indicators, and targets, the TSLs should re-assess the governance model that they elaborated in the first phase of the transition process. At this stage, the responsibilities of the stakeholders involved in the Pilot use cases become clearer and thus the Pilot use case managers and operational teams can be refined to ensure the successful implementation of the Pilot use cases. The TSL's changing nature necessitates an iterative approach to governance improvement, ensuring that the model remains aligned with the Pilot use cases' emerging objectives and demands. This activity functions as a vital feedback loop, allowing TSLs to tailor the governance model to the specific needs of the pilot initiatives, improve collaboration, and optimise decision-making processes.

The milestones of Phase 2 include:

- Feasible Pilot use cases (M12)
- Engaged number of stakeholders (people from the same organisation/company are considered as one stakeholder) (M12)

Funded by the European Union

4.1.3 Accelerating transition through innovation

In this phase TSLs stakeholders should collaborate in innovative solutions development and demonstration of mature innovative solutions in alleviating barriers. This could be achieved through the definition of "Quick wins'', the adoption of international innovative solution and the identification of external investors.

Define ''Quick wins''

The definition of ''Quick wins'' is a critical stage in this step of the transition process as they build momentum with stakeholders providing an immediate, visible improvement or positive outcome that can be achieved relatively easily and quickly (e.g., a feasibility study). The achievement of positive results quickly builds confidence among the parties involved, and it is more likely for them to actively participate and contribute towards the successful implementation of the Pilot use case. In cases of long-term Pilot use cases, ''Quick wins'' serve as milestones that require minimal effort and resources and can be implemented without extensive planning. However, they highlight progress ensuring long-term commitment and keeping stakeholders engaged through the whole process towards the achievement of the larger goal. Achieving ''Quick wins'' enhances the credibility of the project, encouraging further investment in necessary resources, such as funding, personnel and infrastructure. or technology, or effort towards the transition achievement. Finally, ''Quick wins'' create feedback loops through useful input, and areas for improvement can be identified. Through this iterative strategy, the Pilot use cases can be continuously refined increasing the likelihood of long-term success[49].

Adopt international innovative solutions

The adoption of international innovative solutions can accelerate the transition towards climate neutrality as the TSL benefit from global best practices, proven methods, technologies and innovative ideas that may not be readily available within the local context. Moreover, by adopting and adjusting solutions that have been successfully implemented in other countries/regions mitigate the implementation risks. The successful implementation of global solutions to local environments simulates collaboration and knowledge sharing among countries, organizations, and research institutes. This cooperation promotes collaborative problem solving, the transfer of expertise and joint research and development activities. New ideas and solutions could be raised as a result of these joint activities.

[49] Bakker, Stefan; Haq, Gary; Peet, Karl; Gota, Sudhir; Medimorec, Nikola; Yiu, Alice; Jennings, Gail; Rogers, John (2019). Low-Carbon Quick Wins: Integrating Short-Term Sustainable Transport Options in Climate Policy in Low-Income Countries. Sustainability. 11. 4369. 10.3390/su11164369

Funded by the European Union

Develop an Action Plan

An Action plan is a document that lists various measures necessary to realize the vision set by the TSLs and is directly linked with the Pilot use cases. A complete Action Plan should include among others:

- Concrete actions and measures that need to be accomplished during the implementation of the Pilot use cases
- Financial options
- Stakeholders' responsibilities
- Defined timeline
- Risks and mitigation measures

Prepare an investment plan and identify external investors

The preparation of a detailed investment plan for the Pilot use cases including the financial measurements for the monitoring of the financial plan is an essential step that should be aligned with the Action Plan. During this step the identification of external investors that can support the implementation of the Pilot use cases when the traditional local resources are insufficient is considered critical. Bridging the funding gaps during the implementation enhances the credibility and legitimacy of the process and builds confidence among other stakeholders. Moreover, the external investors bringing valuable expertise and knowledge from similar climate-related projects have the power to drive market transformation. They open new opportunities for partnerships and collaborations ensuring the success and viability of the Pilot use cases and enhancing scalability and replicability aspects.

The milestones of Phase 3 include:

- Quick win definition (M12)
- Action Plan developed (M20)

4.1.4 Scaling-up transition

For a transition process to be effective and successful, it is important to ensure an innovative policy response to maximise the implementation and impact of the solutions and achieve full adoption by citizens. The successful implementation of the previous steps of the transition process ensures the scalability of the Pilot use case implementation and the maximisation of their impact. By monitoring the efficiency and the success of the transition process and the Pilot use cases, the TSLs can develop alleviation policies for the weak points, identify legal incentives and suggest new legal transition policies and structural changes.

Define emblematic innovative transition projects

As emblematic innovative transition projects are defined:

- Large scale projects, or
- Projects that have high transformative impact, or
- Projects characterized by their potentiality for scalability and replication

Funded by the European Union

Defining emblematic projects in a transition process is crucial as they stand out as a pioneering example of innovation in the process of transition inspiring and motivating stakeholders and civil society. They serve as concrete illustrations of the transition's vision and goals, aims and targets. Additionally, by implementing emblematic projects, the TSLs can gain valuable knowledge to be used for the refinement and improvement of future actions.

Implement the Pilot use cases

In this step the TSLs implement the concrete actions that are identified in the Action Plans for the Pilot use case deployment. The timelines as defined in the Action Plans as well as the roles and responsibilities of each involved stakeholder as identified in the previous steps should be respected. The continuous communication with the stakeholders and the alignment with the investment plan are essential in order to ensure a successful implementation of the Pilot use cases.

Monitor the efficiency and success of the transition process and the Pilot use cases

This step includes:

- Perform Evidence-based use case Impact Assessment to ensure the sustainability of transition (as described in Chapter 5)
- Collect data for each step of the transition process (Methodology for assessing the efficiency and success of the Transition Process towards climate neutrality) in order to quantify various elements that will help TSLs assess at what level the milestones have been achieved (to what extent the structural changes were achieved?)
- Assess the usefulness of the tools used in each transition step in alignment with the roadmap and the toolkit

Re-assess the transition readiness of the region

By reusing the Transition Readiness Self-Assessment Tool, the TSLs will be able to evaluate the progress and evolution of their region's preparedness for transformation. Additionally, the TSLs can evaluate if the recommendations suggested through the Transition Readiness Self-Assessment Tool in Phase 1 for increasing their transition readiness level contributed towards this direction. At this stage the results of the Transition Readiness Assessment can be combined with the results of the Assessment of the Efficiency and Success of the Transition Process and the Evidence-based use case Impact assessment to provide an overview of whether the different activities of the transition process improve the regional conditions contributing to the achievement of the goal for climate neutrality.

The milestones of Phase 4 include:

- Realisation of Pilot use cases as real-life test experiments (as soon as the Action Plan is defined)
- Emblematic projects (M22)
- Suggestion of structural reforms (M22)
- New transition policies (M22)

Funded by the European Union

4.2 Application of the Methodology for Assessing the Efficiency and Success of the Transition Process in TRANSFORMER TSLs

The TSL should get familiarised with the Methodology for Assessing the Efficiency and Success of the Transition Process towards climate neutrality at the very beginning of their transition process (Phase 1 of the Transition Super-Lab Roadmap) and set their targets for each milestone. Having in mind this milestone achievement monitoring approach the TSLs will have a clear overview of what should be monitored and assessed during the transition process paving the ground for the monitoring activities in the fourth phase of Transition Super-Lab Roadmap (Activity 10.2 of the Transition Super-Lab Roadmap).

A first quantification of these milestones to assess the results of the transition process as suggested in the TRANSFORMER transition model is presented in Table 9. The input for the quantification of the milestones was collected during the different activities performed in the project. However, the TSLs should continue collecting data in order to be able to monitor their transition-enabling activities and develop best practices beyond the project.

Table 9: Milestones quantification per TSL

	Milestone	Emilia-Romagna	Lower Silesia	Ruhr Area	Western Macedonia
1	Consume pre-existing Knowledge-stakeholders identified (M1-M6)	70	11	48	30
2	Agreed transition pathways (M6)	3	2	3	3
3	Weak points identification (M6)	0	2	2	12
4	Cross-sectorial synergies (M6)	0	0		2
5	Feasible Pilot use cases (M12)	3	2	3	4
6	Engaged number of stakeholders (M12)	Approx. 30	Approx. 8	Approx. 25	Approx. 15

Funded by the European Union

	Milestone	Emilia-Romagna	Lower Silesia	Ruhr Area	Western Macedonia
7	Quick win definition (M12)	Not achieved during the project	Not achieved during the project	Not achieved during the project	Not achieved during the project
8	Action Plan developed (M20)	One per Pilot use case (in total 3)	One per Pilot use case (in total 2)	One per Pilot use case (in total 3)	One per Pilot use case (in total 4)
9	Realisation of real-life test experiments (as soon as the Action Plan is defined)	Not achieved during the project	Not achieved during the project	Not achieved during the project	Not achieved during the project
10	Emblematic projects (M22)	Not achieved during the project	Not achieved during the project	Not achieved during the project	Not achieved during the project
11	Suggestion of structural reforms (M22)	Not achieved during the project	Not achieved during the project	Not achieved during the project	Not achieved during the project
12	New transition policies (M22	Not achieved during the project	Not achieved during the project	Not achieved during the project	Not achieved during the project

Funded by the European Union

5 Evidence-based use case Impact Assessment Methodology

5.1 Quantitative analysis through KPIs for sectorial improvement

A six-step approach (Figure 14) that TSLs should follow to achieve a structured and comprehensive impact assessment of the Pilot use cases was developed. The focus of this analysis is (1) the improvement of the operational readiness of the pilot actions and (2) the level of fulfilment of the regional needs and priorities through pilot outcomes.

The methodology unravels through the following steps: (1) identification of the expected impact categories, (2) KPIs identification, (3) baseline scenario definition, (4) TO-BE scenario definition, (5) analysis for impact determination, and (6) conclusions and overall impact determination.

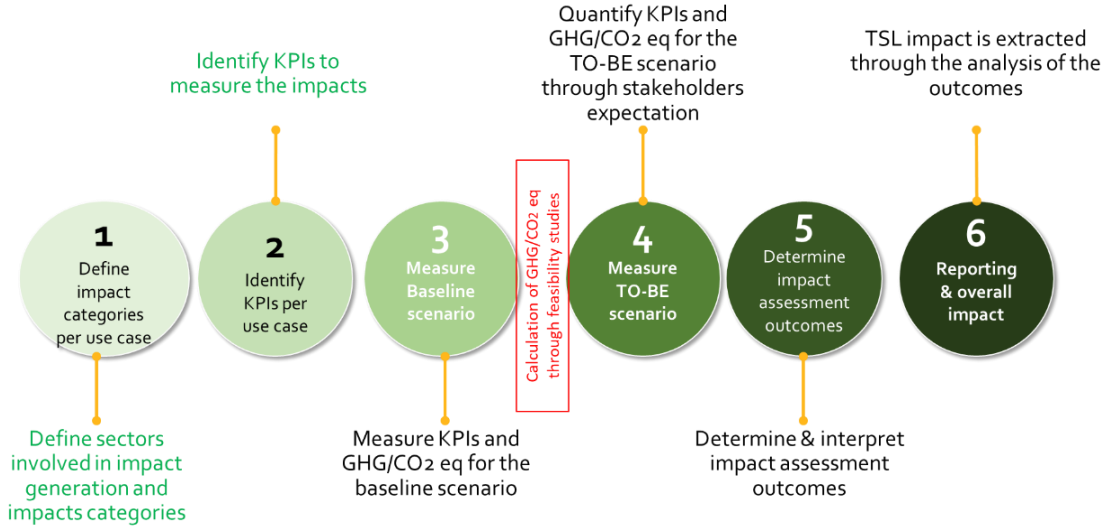

Figure 14: The six-step approach of the evidence-based use case Impact Assessment

The Evidence-based use case Impact Assessment Framework defines "what" needs to be evaluated, "how" it will be evaluated, ''when" the evaluation activities will take place and "who" will perform the evaluation.

5.2 Step 1- 2. Set the areas, the expected Impact and KPIs

Considering the key sectors of TRANSFORMER TSLs (Mobility, Circular Economy, Energy, Agriculture & Food Production, and Industry) and the regions vision for climate neutrality, 5 areas of climate neutrality interventions/achievements are defined:

- Sustainable Zero Carbon Energy
- Sustainable Agriculture & Agri-food system
- Net Zero Industrial Transformation
- Moving without emissions
- Circular Economy

Funded by the European Union

Based on the 4 TSLs visions and their Pilot use cases a set of impact categories was created for each of the areas of climate neutrality interventions/achievements (Pilot use case sectors). Each region's Pilot use case is directly related with one or more sector and each TSL should identify this relation at the beginning of the assessment process and proceed with the analysis through KPIs of the main impact categories.

For each Pilot use case, each TSL should define sectors involved in impact generation and impact categories (step 1&2):

- Single sector Pilot use case: Expected Impact categories definition for the unique sector involved in Pilot use case
- Cross-sectorial Pilot use Case: Impact categories definition for all sectors involved in the Pilot use case.
- Compile list of impacts and select the KPIs for impact assessment from the indicative list of KPIs associated to impact categories.

We included both rather common indicators as well as ones that go beyond the standard set to produce new insights or to shine a light on currently underrepresented aspects. For "new" or less common indicators, data availability may be limited or not exist at all. The indicators can be either quantitative or qualitative and can be derived from one or more measures. The indicators can be expressed as a ratio, index, percentage or other value. Data availability is crucial but did not restrict the indicator selection as new data gathering processes may occur during the TSLs implementation. The following list includes specific indicative KPIs that were selected from the extended list of KPIs in the report ''Measuring progress towards climate neutrality, Part I: Assessing structural change through net zero indicators''[50] and will be further validated, modified, enriched or decreased at the end of the project based on TSLs feedback.

Table 10: Indicative Impact Categories and KPIs to measure impact[50]

Pilot use cases Sectors	Impact categories	KPIs for measurements
1. SUSTAINABLE ZERO CARBON **ENERGY**	E1: SUPPORTING REGULATORY FRAMEWORKS	– **CO2 eq reduction per invested EUR [t CO2 eq/EUR]** – **Share of EU financial support for zero carbon energy (EU budget and other programmes, e.g., TRANSFORMER) [%]** – **Public money going to fossil-fuels (fossil fuel subsidies) [EUR]**
	E2: INFRASTRUCTURE TO ENABLE A SECURE TRANSITION	– **Infrastructure additions (incl. cross-border capacities) for electricity and gas networks [km; MW]** – **Storage capacities for energy (for electricity, heat, gas) [TJ or m3]**

[50] Ecologic Institute, IDDRI. (2021). MEASURING PROGRESS TOWARDS CLIMATE NEUTRALITY, PART I: ASSESSING STRUCTURAL CHANGE THROUGH NET ZERO INDICATORS. Available at: https://www.ecologic.eu/sites/default/files/publication/2021/Net_Zero_Indicators_Part_1-Technical_Proposal.pdf

Funded by the European Union

Pilot use cases Sectors	Impact categories	KPIs for measurements
	E3: REDUCING TOTAL ENERGY CONSUMPTION & EMISSIONS	– Share of renewable energies in gross final energy consumption [%] – Share of "green" H2 in gross final energy consumption [%] – Carbon intensity of electricity generation [g CO2 eq/kWh] – CO2 emissions from energy generation captured and used or stored (with share from produced electricity/heat [t CO2] – Share of households' expenditure on electricity and gas and other housing fuels for average and poor households [%]
2. SUSTAINABLE **AGRICULTURE & AGRI-FOOD SYSTEMS**	E1: FOSTER NEW ECO-AGRICULTURAL PRACTICES AND INNOVATION	– GHG emissions of agriculture [tCO_2eq per year] and per agricultural output [tCO_2 **eq**/kg of produced output]
	E2: REDUCING EMISSIONS AND AGRICULTURE/FOOD WASTE	– CO_2 emissions from agriculture activities captured and used or stored [t CO_2] – Amount of agriculture waste [% of total agriculture production or tons/year]
3. NET ZERO **INDUSTRIAL** TRANSFORMATION	E1: ENSURE LOW-CARBON INDUSTRY COMPETITIVENESS BY INTEGRATING CLIMATE POLICY	– Annual investments in zero carbon industrial processes [EUR] – GHG emissions per industrial output (including specific basic material production, like cement aluminium etc…) [tCO_2eq/tonne] – CO_2 intensity of gross final energy consumption in industry (sub-indicator for energy intensive industry) [tCO_2/kwh]
	E2: INFRASTRUCTURE TO ENABLE THE INDUSTRIAL TRANSITION	– Share of industrial sites having access to CO_2 storage [%] – Share of industrial sites having access to electricity produced by "green" hydrogen [%] – Length or transport capacity of hydrogen and CCS infrastructure network (with sub-indicators per infrastructure) [km or volumes per year]
4. MOVING WITHOUT EMISSIONS	E1: ZERO CARBON FUELS	– Share of low-emission fuels (with sub-indicators for biofuels, synthetic fuels, RES and H2) – Energy consumption of transport (incl. sub-indicators for fuel types) [PJ – Electric charging points (incl. sub-indicators for different charging types) [number] – GHG emissions from transport (incl. sub-indicators for road, rail, water, air if available in regional level) [Mt CO_2eq]
	E2: INCENTIVISING THE MODAL SHIFT	– Modal split of passenger transport (according to type) [%] – Expenditure per capita on public transport [EUR]
	E3: TRANSPORT PLANNING AND DIGITALISATION	– Passenger transport volume (incl. sub-indicators for mode and purpose) [passenger-km]

Funded by the European Union

Pilot use cases Sectors	Impact categories	KPIs for measurements
		– Infrastructure updates and additions (incl. roads, rail, bike-lines etc.) [km and invested EUR per capita – Average distance travelled per year [km] – Commuting travel time [average time of commute in minutes per day] – Congestion and delays [hours spend in road congestion annually]
5. CYCLING ECONOMY	E1: ENHANCING INVESTMENT INTO RESEARCH, DEVELOPMENT AND DEMONSTRATION	– Legal framework for cycling economy activities – Funding for cycling economy activities (EU budget, other programmes) [Total EUR]

5.3 Steps 3-4. Baseline and TO-BE scenarios

The assessment of the baseline vs TO-BE scenario defines the impact of TRANSFORMER TSLs interventions to the transition process towards the climate neutrality. During the assessment, two processes are implemented for measuring the transition impact KPIs:

- baseline scenario: Data measurement **involved in KPIs calculation BEFORE** the implementation of TRANSFORMER TSLs interventions
- TO-BE scenario: Values of KPIs measuring impact through **stakeholders' estimation (EXPECTATION)**

5.3.1 Baseline measurements and TO-BE scenario quantification

The KPIs the TSLs selected in the previous step must be quantified for the baseline scenario. TSL describe their baseline scenario per impact (KPI), focusing on the measurements of the current situation while in TO-BE scenario the focus is on "what is expected through the implementation of the transition intervention''.

The TSL records the baseline values to set the base for comparison with the TO-BE situation – i.e. the after the TRANSFORMER implementation reality. Therefore, it is imperative to ensure that the measurements used to quantify the KPIs for the AS-IS and TO-BE scenarios are the same for each KPI and the quantifications accrue from the same process.

Each TSL provides measurements that quantify the selected KPIs in each Pilot use case before the TRANSFORMER project, covering a specified time period. The baseline scenario aims at recording the current operational reality before the implementation of the transition intervention, while the TO-BE scenario does so for the expected reality after the implementation of the TSL Pilot use cases. The

Funded by the European Union

quantification of the KPIs in the TO-BE scenario (target values) will be performed by the stakeholders based on their expectations.

The overall goal is to measure two, directly comparable situations so as to improve the operational readiness of the Pilot use cases and examine the level of fulfilment of the regional needs and priorities through the pilot outcomes.

5.3.2 CO2 calculation methodology

Based on the KPIs selected and quantified, each TSL will calculate the CO_2 emissions in the baseline and TO-BE scenario (expected estimation), and thus it will have an overview of the expected CO_2 reduction per Pilot use case. Then, each TSL will examine if the expected CO_2 reduction will be achieved when the Pilot use case is implemented. This step, meaning the calculation of the CO_2 saving from the implementation of the Pilot use case, can be performed as a part of the Pilot use case feasibility study. However, TSL could engage different methods such as modelling or simulation techniques. By applying the CO_2 calculation methodology, the TSLs will have an evidence-based assessment of the Pilot use case impact that will provide valuable insights to decide if a Pilot use case is worth implementing (in terms of both CO_2 reduction and levelized cost of carbon abatement)[51].

5.4 Steps 5-6. Determine impact assessment outcomes & Reporting overall impact

The outcomes of the impact assessment are recorded and analysed in step 6. The determination of the impact assessment outcomes is based on a) the KPIs selected for each Pilot use case of the TSL (steps 1-2) and their expectations/measurements (steps 3-4) and b) on the CO^2 calculation of the Pilot use case. Therefore, at the end of impact assessment, each TSL will be able to answer the following questions in order to assess if a Pilot use case is worth to be implemented:

- Are the expected values of the KPIs and the expected CO2 reduction achieved?
- How much does 1kg CO^2eq reduction cost (levelized cost of carbon abatement in € per year)?

In case of common KPIs' among the TSLs Pilot use cases, cross pilot assessment results could be further examined and discussed (through KPIs weights and Multicriteria analysis).

The assessment of each Pilot use case can be monitored for each TSL through a unique Traceability Matrix that facilitates mapping and tracing of the TSL requirements for each Pilot use case and recording the assessment results. Thus, the TSLs will ensure that all the requirements initially set are covered in a Pilot

[51] Friedmann, Y S. J., Fan, Z., Byrum, Z., Ochu, E., Bhardwaj, A., and Sheerazi, H. (2020). Levelized Cost of Carbon Abatement: An Improved Cost-assessment Methodology for a Net-zero Emissions World. Available at: https://www.eesi.org/files/Levelized_Cost_of_Carbon_Abatement.pdf

Funded by the European Union

use case, so that the Pilot use case could be a best practice for other regions that would like to accelerate their transition towards climate neutrality.

5.5 Application of the Evidence-Based use case Impact Assessment Methodology in TRANSFORMER TSLs

Through an interactive session that took place at the consortium meeting in Lower Silesia in September 2023, the TSLs discussed the expected impacts of each Pilot use case and which of the ***impact indicators*** that were suggested in the TRANSFORMER Evidence-based use case Impact Assessment Methodology could be used to measure this impact (Activity 6.1 of the Transition Super-Lab Roadmap). However, it is noted once again by all TSLs that the lack of regional datasets in different sectors related to climate neutrality might pose difficulties in the evaluation of some of the suggested indicators. Table 11 below present the impact categories and impact KPIs that were selected by each TSL during the interactive session.

Table 11: Selection of impact categories and KPIs from the suggested Evidence-based use case Impact Assessment Methodology per TSL

	Pilot use cases Sectors	**Impact categories**	**KPIs for measurements**
Emilia-Romagna	1. SUSTAINABLE ZERO CARBON **ENERGY**	E1: SUPPORTING REGULATORY FRAMEWORKS	– **CO2 eq reduction per invested EUR [t CO2 eq/EUR]**
	4. **MOVING** WITHOUT EMISSIONS	E1: ZERO CARBON FUELS	– **Energy consumption of transport (incl. sub-indicators for fuel types) [PJ** – **Electric charging points (incl. sub-indicators for different charging types) [number]** – **GHG emissions from transport (incl. sub-indicators for road, rail, water, air if available on a regional level) [Mt CO2eq]**
		E2: INCENTIVISING THE MODAL SHIFT	– **Modal split of passenger transport (according to type) [%]** – **Expenditure per capita on public transport [EUR]**
		E3: TRANSPORT PLANNING AND DIGITALISATION	– **Passenger transport volume (incl. sub-indicators for mode and purpose) [passenger-km]** – **Infrastructure updates and additions (incl. roads, rail, bike-lines etc.) [km and invested EUR per capita** – **Average distance travelled per year [km]** – **Commuting travel time [average time of commute in minutes per day]** – **Congestion and delays [hours spend in road congestion annually]**

Funded by the European Union

	Pilot use cases Sectors	Impact categories	KPIs for measurements
Lower Silesia	1. SUSTAINABLE ZERO CARBON **ENERGY**	E3: REDUCING TOTAL ENERGY CONSUMPTION & EMISSIONS	– **Share of renewable energies in gross final energy consumption [%]** – **Share of ''green'' H2 in gross final energy consumption [%]** – **Share of H2 in gross final energy consumption [%]** – **Carbon intensity of electricity generation [g CO2 eq/kWh]** – **CO2 emissions from energy generation captured and used or stored (with share from produced electricity/heat [t CO2]** – **Share of households' expenditure on electricity and gas and other housing fuels for average and poor households [%]**
	3. NET ZERO **INDUSTRIAL** TRANSFORMATION	E2: INFRASTRUCTURE TO ENABLE THE INDUSTRIAL TRANSITION	– **Share of industrial sites having access to CO_2 storage [%]** – **Share of industrial sites having access to electricity produced by ''green'' hydrogen [%]** – **Length or transport capacity of hydrogen and CCS infrastructure network (with sub-indicators per infrastructure) [km or volumes per year]**
	4. **MOVING** WITHOUT EMISSIONS	E1: ZERO CARBON FUELS	– **Energy consumption of transport (incl. sub-indicators for fuel types) [PJ** – **GHG emissions from transport (incl. sub-indicators for road, rail, water, air if available in regional level) [Mt CO_2eq]**
		E2: INCENTIVISING THE MODAL SHIFT	– **Modal split of passenger transport (according to type) [%]**
		E3: TRANSPORT PLANNING AND DIGITALISATION	– **Passenger transport volume (incl. sub-indicators for mode and purpose) [passenger-km]** – **Commuting travel time [average time of commute in minutes per day]** – **Congestion and delays [hours spend in road congestion annually]**

Funded by the European Union

	Pilot use cases Sectors	Impact categories	KPIs for measurements
Ruhr Area	1. SUSTAINABLE ZERO CARBON **ENERGY**	E1: SUPPORTING REGULATORY FRAMEWORKS	– **CO2 eq reduction per invested EUR [t CO2 eq/EUR]** – **Share of EU financial support for zero carbon energy (EU budget and other programmes, e.g., TRANSFORMER) [%]**
		E2: INFRASTRUCTURE TO ENABLE A SECURE TRANSITION	– **Infrastructure additions (incl. cross-border capacities) for electricity and gas networks [km; MW]** – **Storage capacities for energy (for electricity, heat, gas) [TJ or m_3]**
		E3: REDUCING TOTAL ENERGY CONSUMPTION & EMISSIONS	– **Share of renewable energies in gross final energy consumption [%]**
	3. NET ZERO **INDUSTRIAL** TRANSFORMATION	E1: ENSURE LOW-CARBON INDUSTRY COMPETITIVENESS BY INTEGRATING CLIMATE POLICY	– **GHG emissions per industrial output (including specific basic material production, like cement aluminium etc…) [tCO_2eq/tonne]**
		E2: INFRASTRUCTURE TO ENABLE THE INDUSTRIAL TRANSITION	– **Share of industrial sites having access to CO_2 storage [%]**

	Pilot use cases Sectors	Impact categories	KPIs for measurements
Western Macedonia	1. SUSTAINABLE ZERO CARBON **ENERGY**	E1: SUPPORTING REGULATORY FRAMEWORKS	– **CO2 eq reduction per invested EUR [t CO2 eq/EUR]** – **Share of EU financial support for zero carbon energy (EU budget and other programmes, e.g., TRANSFORMER) [%]**
		E2: INFRASTRUCTURE TO ENABLE A SECURE TRANSITION	– **Infrastructure additions (incl. cross-border capacities) for electricity and gas networks [km; MW]** – **Storage capacities for energy (for electricity, heat, gas) [TJ or m_3]**
		E3: REDUCING TOTAL ENERGY CONSUMPTION & EMISSIONS	– **Share of renewable energies in gross final energy consumption [%]** – **Share of H2 in gross final energy consumption [%]**

Funded by the European Union

	2. SUSTAINABLE **AGRICULTURE & AGRI-FOOD SYSTEMS**	E1: FOSTER NEW ECO-AGRICULTURAL PRACTICES AND INNOVATION	– **GHG emissions of agriculture [tCO_2eq per year] and per agricultural output [tCO_2 eq/kg of produced output]**
		E2: REDUCING EMISSIONS AND AGRICULTURE/FOOD WASTE	– **CO_2 emissions from agriculture activities captured and used or stored [t CO_2]** – **Amount of agriculture waste [% of total agriculture production or tons/year]**
	4. **MOVING** WITHOUT EMISSIONS	E1: ZERO CARBON FUELS	– **Energy consumption of transport (incl. sub-indicators for fuel types) [PJ** – **Electric charging points (incl. sub-indicators for different charging types) [number]** – **GHG emissions from transport (incl. sub-indicators for road, rail, water, air if available in regional level) [Mt CO_2eq]**
		E2: INCENTIVISING THE MODAL SHIFT	– **Modal split of passenger transport (according to type) [%]** – **Expenditure per capita on public transport [EUR]**
		E3: TRANSPORT PLANNING AND DIGITALISATION	– **Passenger transport volume (incl. sub-indicators for mode and purpose) [passenger-km]** – **Infrastructure updates and additions (incl. roads, rail, bike-lines etc.) [km and invested EUR per capita** – **Average distance travelled per year [km]** – **Commuting travel time [average time of commute in minutes per day]** – **Congestion and delays [hours spend in road congestion annually]**

Along with these indicators, the TSLs defined more Pilot use case-specific indicators during the elaboration of their Action Plans in deliverable D3.3 (Activity 8.2 of the Transition Super-Lab Roadmap) which were completed in May 2024.

Emilia-Romagna defined various KPIs that are designed to measure different aspects of the impact each Pilot use case has on the region, from improvements in modal share to satisfaction levels of involved stakeholders. The KPIs defined for each Pilot use case are the following:

Pilot use case 1: Development of a regional cycling mobility cartography and network, new cyclability guidelines and modal shift survey

- Modal share improvement linked to bicycles from 5% (current data) to 20% at regional level (through surveys and flows monitoring) in 10 years
- Number of municipalities involved (all the 22 municipalities with over 30,000 inhabitants)

Funded by the European Union

- Number of citizens and companies involved by municipalities in the co-creation activities (at least 50 citizens and 5 municipalities)
- Level of satisfaction and perception of contribution to the decision-making process of the involved actors (4 out of 5 on a 5-Point Likert scale)

Pilot use case 2: Promotion of mobility management coordination activities to be carried out together with the area mobility managers and company mobility managers

- Mobility manager nomination for all companies with more than 100 employees
- Reduce commuting travel time (to less than 40 minutes)
- Increase remote working to reduce congestion and delays of 20% in 10 years
- 20% reduction of the use of the car in favour of the bicycle through the adoption of mobility management plans within 10 years

Lower Silesia also defined the following indicators for its Pilot use cases:

Pilot use case 1: Convenient transport connections for the benefit of the environment and the

- Level of participation and satisfaction of local communities in decision-making processes related to transportation
- Number of community ideas and initiatives discussed/tested
- Diversity of participation (demographics/community groups)
- Quantification of CO2 emission reductions resulting from decreased reliance on private cars
- Percentage increase in the use of public transport, particularly bus-rail connections compared to private car usage
- Number of new public transport links established
- Cost savings for commuters due to reduced reliance on private cars
- Improvement in air quality and reduction in pollution levels resulting from decreased carbon emissions
- Maintenance of the green alternative transportation system over time

Pilot use case 2: Develop a framework for integrating public participation methods in energy-related decision-making

- Level of participation and satisfaction of local communities in decision-making processes related to energy transition
- Number of community ideas and initiatives discussed/tested
- Diversity of participation (demographics/community groups)
- Quantification of CO2 emission reductions resulting from transition to cleaner energy sources
- implementation of renewable energy projects or infrastructure improvements
- Adoption of policies informed by citizen preferences regarding energy sources and policies), as evidenced by changes in regulations or incentives

Funded by the European Union

- Improvement in air quality and reduction in pollution levels resulting from the adoption of cleaner energy sources
- Sustained transition to renewable energy sources in the LGOM region (100% RE)

The Ruhr Area identified impacts related to the decarbonisation of key industrial sectors, preservation and enhancement of ecological integrity, local value creation, social impact, public awareness and engagement and scalability for all three Pilot use cases (extension of the Rhine-Herne Canal into a "Hydrogen River", hydrogen in neighbourhoods and residential districts and H2 system cockpit: recording and connecting existing hydrogen initiatives to achieve optimal systemic synergy effects).

Finally, Western Macedonia defined the following KPIs for the Pilot use cases.

Pilot use cases 1**:** Production, transfer and storage of PV energy and consumption in Ptolemaida Public Transport buses and Pilot use case 2: Production, transfer and storage of H2 energy and consumption in Kozani Public Transport buses

- Share of RES and H2 in public transportation (for Pilot use Case 1: 20% by 2030, 60% by 2035 and 100% by 2040, for Pilot use case 2: 11% by 2030, 60% by 2035 and 100% by 2040).
- Decrease in energy consumption of public transportation (incl. sub-indicators for fuel types) [MJ]: (for Pilot use case 1: decrease of 20% by 2030, decrease of 60% by 2035 and 100% by 2045 both diesel & biodiesel fuel replaced totally by RES-PV / H2 fuel, for Pilot use case 2: decrease of 11% by 2030, decrease of 60% by 2035 and 100% by 100%2045 both diesel & biodiesel fuel replaced totally by RES-PV / H2 fuel)
- Increase of energy efficiency per passenger-kilometre travelled. (MJ/p-km) (for Pilot use case 1: increase of 16% by 2030, of 43% by 2035 and of 66% by 2045. For Pilot use case 2: increase of 11% by 2030, of 46% by 2035 and of 70% by 2045)
- Decrease of Greenhouse Gas (GHG) emissions [% of CO2eq] (for Pilot use case 1: decrease of 20% by 2030, of 60% by 2035 and of 100% by 2045. For Pilot use case 2: decrease of 11% by 2030, of 60% by 2035 and of 100% by 2045)
- Reduction of 20% in noise levels by 2045
- Decrease of operating cost (running and maintenance cost (€) (for Pilot use case 1: decrease of 12% (BEB) and 6% (FCEB) by 2030, of 40% (BEB) and 20% (FCEB) by 2035 and of 77% (BEB) and 42% (FCEB) by 2045. For Pilot use case 2: decrease of 7% (BEB) and 4% (FCEB) by 2030, of 41% (BEB) and 22% (FCEB) by 2035 and of 79% (BEB) and 45% (FCEB) by 2045)
- User satisfaction: increase of 20% of the users that are satisfied by the service (measured on a scale from 1 to 5)

Funded by the European Union

Pilot use case 3: Application of CO2 capture/emission reduction technologies in farms & transfer, storage & reconsumption of CO2 in farms (link to the circular economy park) impact is related to climate change mitigation, improved soil health, biodiversity conservation, economic benefits and improved air and water quality and can be measured by the following KPIs as they are defined by Western Macedonia:

- CO2 captured and used or stored from agriculture activities compared to emissions [30% by 2030]
- GHG emissions reduction of the farm's activity [Mt CO2eq and %]. The reduction depends on the applied measure by 2030. For machinery measures the expected reduction is 75% (0.029 MtCO2eq). For livestock farming measures the expected reduction ranges from 3-5% (0.002-0.004 MtCO2eq). For agricultural practices the expected reduction ranges from 10-20% (0.017-0.034 MtCO2eq).
- Cost Savings. The cost savings depend on the applied measure by 2030. For machinery measures the expected cost savings are more than €6 million, for Livestock Farming measures the expected cost savings range from €5,000 to more than €400,000 and for Agricultural Practices the expected cost savings range from €300,000 to more than €1 million.
- Innovative practices used (20% of the available cases in the Region of Western Macedonia to apply innovative practices by 2030)

For Pilot use case 4 (Development of Kozani's Transition Super-Lab and Data Space), the Transition Super-Lab will offer several benefits, including innovation, stakeholder engagement, capacity building for sustainable innovation and policy impact. Transition Super-Labs can have a significant impact on policy by generating evidence and insights for policy development and implementation. By involving policymakers in transition living labs, cross sectorial solutions can be co-created, tested, and refined, leading to more effective and sustainable policies towards climate neutrality.

Although the first steps (1 and 2) of the Evidence-based use case Impact Assessment Methodology took place within TRANSFORMER project the monitor and the analysis of the impact of the Pilot use cases (steps 3-6) will complete at a later stage after the implementation of the Pilot use cases beyond TRANSFORMER project (Activity 10.2: Monitor & assess results and impacts of the Transition Super-Lab Roadmap). Additionally, continuous monitoring and assessment of the TSLs' activities through the Pilot use cases are essential in tracking progress, measuring impact, and identifying areas for improvement. The use of specific indicators and metrics will enable the TSLs to evaluate their performance and make data-driven adjustments to their strategies. This evidence-based approach ensured that the TSLs remained aligned with their objectives and responsive to emerging transition trends and challenges.

Funded by the European Union

6 Conclusions

The aim of the current deliverable was to delve into the transition assessment of the TSLs through the framework developed. The TRANSFORMER project's framework for assessing Transition Super-Labs presents a comprehensive groundwork for evaluating and accelerating the shift towards climate neutrality in regions. The framework emphasises the importance of a methodological approach that cover the aspects of transition readiness, effectiveness and success of the transition process and evidence-based use case impact assessment leveraging lessons learned from its implementation in the four TRANSFORMER Transition Super-Labs. These methodologies are integral to understanding the current state of a region's transition readiness and the effectiveness of its transition process.

The Transition Readiness Assessment of a region is built upon a systemic approach to cross-sectorial transition ecosystem that defines the required elements and sub-elements that a region should have in order to be characterised as transition-ready. By using the Transition Readiness Self-Assessment Tool, the region can identify its weak points through benchmarking and qualitative assessment techniques, thereby determining the most suitable transition pathways for a swift achievement of climate neutrality.

The Assessment of the Efficiency and Success of the transition process is built on a combined approach of the OIC and NESTA innovation approaches integrating elements from the traditional planning methodologies as used in mobility. Through 4 phases including assessing and building the transition capacities, gearing the transition capacity, accelerating transition through innovation and scaling-up transition, the process underscores the importance of stakeholder dynamics, agreed transition pathways, and Pilot use cases in achieving climate neutrality. All these steps are vital in developing a structured approach towards the envisioned vision of the region and achieving systemic transformation through emblematic projects, Action Plans and maximisation of impact. The assessment is performed through milestones achievement monitoring that ensure that regions not only plan but also adapt and evolve their strategies based on real-time data and feedback.

Finally, the Evidence-based use case Impact Assessment Methodology is based on the quantification of KPIs in the current region’s situation (baseline scenario) and the stakeholders’ expectations (TO-BE scenario). The CO_2 calculation methodology will further contribute to the TSLs´ decision making process by providing an evidence-based report on the value of implementing a Pilot use case. This methodology provides a robust mechanism to evaluate the impact of Pilot use cases on regional decarbonisation efforts. This data-driven approach allows for precise measurement of outcomes, facilitating informed decision-making and continuous improvement.

The application of the assessment framework in the TRANSFORMER TSLs has yielded significant insights. Regions like Emilia-Romagna have shown higher transition readiness, whereas others like Western Macedonia have identified several areas needing improvement. These insights underscore the

Funded by the European Union

importance of tailored strategies and interventions that address specific regional challenges and leverage unique strengths.

Recommendations provided through the Transition Readiness Self-Assessment Tool are designed to enhance the transition readiness of regions. For instance, improving inter-departmental coordination, enhancing stakeholder engagement, and investing in digital infrastructure are critical steps for many regions. Additionally, fostering cross-sectorial synergies and ensuring robust data availability and security are pivotal for achieving climate neutrality.

TSL Assessment Reports are suggested to be developed by the TSLs. These reports can integrate information from all the stages of the methodological approach including the results of the Transition Readiness Assessment, the Assessment of the Efficiency and Success of the Transition Process and the Evidence-based use case Impact Assessment. The results of these three assessments can be combined to provide an overview of whether the different activities of the transition process improve the regional conditions, increased the regional capacity of adopting innovation and contributed to the achievement of the goal for climate neutrality. The availability of the data generated or/and collected by TSLs throughout the whole assessment process is a critical factor that will enhance the validity and reliability of the results, leading to evidence-based decision for more effective climate interventions.

In conclusion, the Framework for Super-Labs Assessment provides a comprehensive, multi-faceted approach to assessing and accelerating the transition towards climate neutrality. It integrates various elements, and highlights the importance of collaboration, strategic planning, and practical implementation in achieving a sustainable future. The assessment of the TSLs should be viewed as an iterative process that contribute to the reassessment of the different transition-related activities as well as of the strategic goals, objectives and targets of the Pilot use cases. By addressing the transition readiness, efficiency, and impact, it equips regions with the tools and insights needed to navigate the complexities of systemic transformation.

Funded by the European Union

References

Ahlers, D., Wienhofen, L.W.M., Petersen, S.A., Anvaari, M. (2019). A Smart City Ecosystem Enabling Open Innovation. In: Lüke, KH., Eichler, G., Erfurth, C., Fahrnberger, G. (eds) Innovations for Community Services. I4CS 2019. Communications in Computer and Information Science, vol 1041. Springer, Cham. Available at: https://doi.org/10.1007/978-3-030-22482-0_9 (last access: 23.05.2024)

Aslesen W.H. and Freel, M. (2012). Industrial knowledge bases as drivers of open innovation?. Industry & Innovation, 19 (2012), pp. 563-584. Available at: https://doi.org/10.1080/13662716.2012.726807 (last access: 23.05.2024)

Baccarani, C., & Golinelli, G. M. (2014). Le parole dell'innovazione (The words of innovation). Sinergie, 94 (May-Aug), 9–14. Available at: https://ojs.sijm.it/index.php/sinergie/article/view/170/170 (last access: 29.05.2024)

Bakker, Stefan; Haq, Gary; Peet, Karl; Gota, Sudhir; Medimorec, Nikola; Yiu, Alice; Jennings, Gail; Rogers, John (2019). Low-Carbon Quick Wins: Integrating Short-Term Sustainable Transport Options in Climate Policy in Low-Income Countries. Sustainability. 11. 4369. 10.3390/su11164369

Bank of England-Financial Policy Committee (2022). Financial Stability Report. Available at: https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-report/2022/financial-stability-report-july-2022.pdf (last access: 06.05.2024)

Ciasullo, M.V., Troisi, O., Grimaldi, M. et al. (2020). Multi-level governance for sustainable innovation in smart communities: an ecosystems approach. Int Entrep Manag J 16, 1167–1195. Available at: https://doi.org/10.1007/s11365-020-00641-6 (last access: 29.05.2024)

Dahlander, L. and Gann, D.M. (2010). How open is innovation?, Research Policy, Vol. 39 No. 6, pp. 699-709. Available at: https://www.sciencedirect.com/science/article/pii/S0048733310000272?via%3Dihub (last access: 06.05.2024)

Darbandsari P, Kerachian R, Malakpour-Estalaki S, Khorasani H. (2020). An agent-based conflict resolution model for urban water resources management. Sustain Cities Soc, Vol 57. Available at: https://doi.org/10.1016/j.scs.2020.102112 (last access: 06.05.2024)

Delacámara, G., G. O'Higgins, T., Lago M. & Langhans S., Ecosystem-Based Management: Moving from Concept to Practice, Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity pp 39–60. Available at: https://link.springer.com/chapter/10.1007/978-3-030-45843-0_3 (last access: 29.05.2024)

Funded by the European Union

Ecologic Institute, IDDRI. (2021). MEASURING PROGRESS TOWARDS CLIMATE NEUTRALITY, PART I: ASSESSING STRUCTURAL CHANGE THROUGH NET ZERO INDICATORS. Available at: https://www.ecologic.eu/sites/default/files/publication/2021/Net_Zero_Indicators_Part_1-Technical_Proposal.pdf (last access: 06.08.2024)

Enkel, E., Gassmann, O. and Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon, R&D Management, Vol. 39 No. 4, pp. 311-316. Available at: https://doi.org/10.1111/j.1467-9310.2009.00570.x (last access: 06.05.2024)

Equus Software. (2018). Applying an Ecosystem Approach to Global Mobility Management. https://www.equusoft.com/wp-content/uploads/2018/05/Ecosystem-Approach-to-Global-Mobility-WP-1.pdf (last access: 08.05.2024)

European Central Bank, (2022). Financial Stability Review. Available at: https://www.ecb.europa.eu/pub/financial-stability/fsr/html/ecb.fsr202211~6383d08c21.en.html#toc15 (last access: 07.06.2023)

European Commission (2021). Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. Available at: https://knowledge4policy.ec.europa.eu/publication/forging-climate-resilient-europe-new-eu-strategy-adaptation-climate-change_en (last access: 06.08.2024)

Eurostat (2021). Share of energy from renewable sources. Available at: https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_ren/default/table?lang=en (last access: 06.08.2024)

Flügge, B. (2017). The Mobility Ecosystem. In Smart Mobility - Connecting Everyone: Trends, Concepts and Best Practices (pp. 47–68). Available at: https://doi.org/10.1007/978-3-658-15622-0_3 (last access: 13.03.2024)

Friedmann, Y S. J., Fan, Z., Byrum, Z., Ochu, E., Bhardwaj, A., and Sheerazi, H. (2020). Levelized Cost of Carbon Abatement: An Improved Cost-assessment Methodology for a Net-zero Emissions World. Available at: https://www.eesi.org/files/Levelized_Cost_of_Carbon_Abatement.pdf (last access: 13.03.2024)

Geels, W.F. (2020). Transformative innovation and socio-technical transitions to address grand challenges, European Commission- Directorate-General for Research and Innovation (Working paper). Available at: https://op.europa.eu/en/publication-detail/-/publication/24c4a811-a9f9-11ea-bb7a-01aa75ed71a1/language-en (last access: 13.03.2024)

Funded by the European Union

Herzog, (2008). Open and closed innovation – Different cultures for different strategies. Gabler. Available at: https://link.springer.com/book/10.1007/978-3-8349-8090-8 (last access: 07.05.2024)

Idrissia et al., (2012). SMEs' degree of openness: The case of manufacturing industries. Journal of Technology Management & Innovation, 7 (2012), pp. 186-210. Available at: http://dx.doi.org/10.1016/j.jenvman.2019.109564 (last access: 07.05.2024)

Johnson, G., Scholes, K. and Whittington, R. (2008). Exploring Corporate Strategy (8th edn). London: Prentice Hall Europe.

Kourtit, K., Nijkamp, P., & Arribas-Bel, D. (2012). Smart cities perspective-a comparative European study by means of self-organizing maps. Innovation: The European Journal of Social Science Research, 25(2), 229–246. Available at: https://doi.org/10.1080/13511610.2012.660330 (last access: 07.05.2024)

Kunc, M, (2011). System Dynamics and Innovation: A complex problem with multiple levels of analysis, System Dynamics Society proceedings. Available at: https://proceedings.systemdynamics.org/2012/proceed/papers/P1019.pdf (last access: 13.03.2024)

Lazzarotti and Manzini, (2009). Different modes of open innovation: A theoretical framework and an empirical study. International Journal of Innovation Management, 13 (2009), pp. 615-636. Available at: https://www.worldscientific.com/doi/abs/10.1142/S1363919609002443 (last access: 18.06.2024)

Moura, H. & Teixeira, J. (2010). Managing Stakeholders Conflicts. In book: Construction Stakeholder Management (pp.286-316)

Muench, S., Stoermer, E., Jensen, K., Asikainen, T., Salvi, M. and Scapolo, F., Towards a green and digital future, (2022), Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-52452-6, doi:10.2760/54, JRC129319. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC129319 (last access: 18.06.2024)

NESTA (2019). A compendium of innovation methods, Available at: https://media.nesta.org.uk/documents/Compendium-of-Innovation-Methods-March-2019.pdf (last access: 07.08.2024)

Oomens, I. M. F., & Sadowski, B. M. (2019). The importance of internal alignment in smart city initiatives: An ecosystem approach. Telecommunications Policy, 43(6), 485–500. Available at: https://doi.org/https://doi.org/10.1016/j.telpol.2018.12.004 (last access: 18.06.2024)

Funded by the European Union

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science, 325(5939), 419–422. Available at: https://www.science.org/doi/10.1126/science.1172133 (last access: 18.06.2024)

Öberg, C. and Allen T. A., (2019). The openness of open innovation in ecosystems – Integrating innovation and management literature on knowledge linkages, Journal of Innovation & Knowledge, Vol. 4. Issue 4. pages 211-218. Available at: https://www.sciencedirect.com/science/article/pii/S2444569X18300131?via%3Dihub (last access: 07.06.2023)

Reggi, L., Dawes, S. (2016). Open Government Data Ecosystems: Linking Transparency for Innovation with Transparency for Participation and Accountability. In: ,et al. Electronic Government. EGOV 2016. Lecture Notes in Computer Science, vol 9820. Springer, Cham. Available at: https://doi.org/10.1007/978-3-319-44421-5_6 (last access: 07.06.2023)

Robertsone, G., Lapiņa, I. (2023). Digital transformation as a catalyst for sustainability and open innovation, Journal of Open Innovation: Technology, Market, and Complexity, Volume 9, Issue 1. Available at: https://www.sciencedirect.com/science/article/pii/S2199853123001191 (last access: 07.06.2023)

Rockström et al. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity, Ecology and Society 14(2): 32. Available at: https://pubs.giss.nasa.gov/docs/2009/2009_Rockstrom_ro06010m.pdf (last access: 07.06.2023)

Saaty, T. L. (2012). Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World. Third Revised Edition. Pittsburgh: RWS Publications

Scott Slocombe, D. (1993), Implementing Ecosystem-Based Management, BioScience, Vol. 43, No. 9, pp. 612-622, Oxford University Press. Available at: https://academic.oup.com/bioscience/article-abstract/43/9/612/257693?redirectedFrom=fulltext (last access: 07.06.2023)

Spangler, B. (2003). Coalition Building. Conflict Information Consortium.

SPROUT project. Available at: (https://sprout-civitas.eu/) (last access: 07.06.2023)

Thomas, K. (1992). Conflict and negotiation processes in organizations. In: Dunnette, M. and Hough, L. (eds) Handbook of Industrial and Organizational Psychology. Palo Alto, CA: DaviesBlack Publishing, pp. 651–717

Funded by the European Union

TRANSFORMER Project (2024). Deliverable 2.1 ''Summary of data collection on TSL predecessors'', Available at: https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D2.1_Summary-of-data-collection-on-TSL-predecessors.pdf (last access 29.07.2024)

TRANSFORMER Project (2024). Deliverable 2.2 ''Quantitative mapping research report'', Available at: https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D2.2_Quantitative-mapping-research-report.pdf (last access 29.07.2024)

TRANSFORMER Project (2024). Deliverable 2.3 ''Regional SWOT analyses as feasibility studies to be used as evidence base in decision-making for Action plan development'' (URL not available yet)

TRANSFORMER Project, (2024). Deliverable 4.2 ''Transition Super-Lab Roadmap'' (URL not available yet)

TRANSFORMER Project (2024). Deliverable 5.1 ''Framework for Super-Labs Assessment'', Available at https://transformerknowledgehub.imet.gr/wp-content/uploads/2024/06/D5.1_Framework-for-Super-Labs-Assessment_public.pdf (last access 29.07.2024)

TRANSFORMER Project (2024). Deliverable D5.3 ''Best practices and recommendations for Super-Labs operation towards the region transition'', (URL not available yet)

Uriona Maldonado, M. & Grobbelaar, S. (2017). System Dynamics modelling in the Innovation Systems literature. Conference: 15th Globelics International. Available at: https://www.researchgate.net/publication/319545608_System_Dynamics_modelling_in_the_Innovation_Systems_literature (last access: 07.06.2023)

Van de Vrande, V., de Jong, J.P.J., Vanhaverbeke, W. and de Rochemont, M. (2009). Open innovation in SMEs: trends, motives and management challenges, Technovation, Vol. 29 Nos 6-7, pp. 423-437. Available at: https://www.sciencedirect.com/science/article/pii/S0166497208001314 (last access: 07.06.2023)

Wang, R., Li, F., Hu, D., & Larry Li, B. (2011). Understanding eco-complexity: Social-Economic-Natural Complex Ecosystem approach. Ecological Complexity, 8(1), 15–29. Available at: https://doi.org/https://doi.org/10.1016/j.ecocom.2010.11.001 (last access: 07.06.2023)

Wu Y., F. Gu, Ji, Y., Guo, J. and Fan, Y. (2020). Technological capability, eco-innovation performance, and cooperative R&D strategy in new energy vehicle industry: evidence from listed companies in China, Clean. Prod., 261, pp. 121-157. Available at: https://www.sciencedirect.com/science/article/pii/S095965262031204X?via%3Dihub (last access: 07.06.2023)

Funded by the European Union

Annex A: Assigning weights to the Transition Readiness sub-elements

The individual results of each TRANSFORMER expert are presented below:

RUHR-UNIVERSITAET BOCHUM

The responses of RUB showed that the most important sub-elements are the Transparency and inclusiveness of processes, Public Investments & subsidies, Openness and Digitalisation. On the other hand, the less important sub-element are Political support and Supportive regulatory framework among others. The Consistency Ratio of the AHP procedure was about 5.49%.

Transition Readiness Sub-element	Weight
Cross sectorial planning	7.00%
Inter-departmental coordination	7.00%
Processes to identify conflict resolution	2.10%
Political support	0.70%
Public Investments & subsidies	11.70%
Openness	11.70%
Digitalisation	11.70%
Research & Education	1.20%
Energy efficiency and use of renewable energy resources	2.00%
Transparency and inclusiveness of processes	13.60%
Stakeholders engagement & Cross-sectorial initiatives & synergies	10.70%
Supportive regulatory framework	0.70%
Regulatory framework for use of renewable energy resources	0.70%
Social and technical regimes	2.00%
Region's economic development and socio-economic well-being	0.70%
Data availability and security	2.00%
Region Innovation Capacity	0.70%
Sectorial Innovation	2.70%
Society's perception	2.00%
Raising society's awareness for environment	3.90%
Knowledge dissemination to public	3.90%
Support from existing veto players	1.20%

Funded by the European Union

RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH

The responses of RC showed that the most important sub-element is the Processes to identify conflict resolution while the less important sub-element is the Region Innovation Capacity. The Consistency Ratio of the AHP procedure was about 24%.

Transition Readiness Sub-element	Weight
Cross sectorial planning	6.60%
Inter-departmental coordination	7.10%
Processes to identify conflict resolution	10.30%
Political support	2.30%
Public Investments & subsidies	3.50%
Openness	7.10%
Digitalisation	5.90%
Research & Education	1.90%
Energy efficiency and use of renewable energy resources	1.80%
Transparency and inclusiveness of processes	5.10%
Stakeholders engagement & Cross-sectorial initiatives & synergies	4.10%
Supportive regulatory framework	2.60%
Regulatory framework for use of renewable energy resources	2.10%
Social and technical regimes	4.80%
Region's economic development and socio-economic well-being	2.70%
Data availability and security	8.00%
Region Innovation Capacity	1.70%
Sectorial Innovation	3.00%
Society's perception	5.20%
Raising society's awareness for environment	2.90%
Knowledge dissemination to public	6.80%
Support from existing veto players (neutralisation of veto players)	4.60%

Funded by the European Union

BUSINESS METROPOLE RUHR GMBH

The responses of BMR showed that the most important sub-elements are the Processes to identify conflict resolution and the Inter-departmental coordination. On the other hand, the less important sub-elements are Political support, Public Investments & subsidies and Openess. The Consistency Ratio of the AHP procedure was about 24%.

Transition Readiness Sub-element	Weight
Cross sectorial planning	9.80%
Inter-departmental coordination	10.60%
Processes to identify conflict resolution	12.20%
Political support	0.50%
Public Investments & subsidies	0.60%
Openness	0.70%
Digitalisation	8.30%
Research & Education	1.30%
Energy efficiency and use of renewable energy resources	2.10%
Transparency and inclusiveness of processes	7.90%
Stakeholders engagement & Cross-sectorial initiatives & synergies	4.60%
Supportive regulatory framework	1.00%
Regulatory framework for use of renewable energy resources	1.90%
Social and technical regimes	5.10%
Region's economic development and socio-economic well-being	5.60%
Data availability and security	6.40%
Region Innovation Capacity	1.90%
Sectorial Innovation	7.20%
Society's perception	2.90%
Raising society's awareness for environment	3.30%
Knowledge dissemination to public	4.20%
Support from existing veto players (neutralisation of veto players)	2.00%

Funded by the European Union

FIT CONSULTING SRL

The responses of FIT showed that the most important sub-element is Transparency and inclusiveness of processes while the less important sub-elements are Political Support and Public Investments & subsidies. The Consistency Ratio of the AHP procedure was about 15%.

Transition Readiness Sub-element	Weight
Cross sectorial planning	4.40%
Inter-departmental coordination	4.00%
Processes to identify conflict resolution	5.10%
Political support	1.00%
Public Investments & subsidies	1.10%
Openness	9.70%
Digitalisation	5.40%
Research & Education	6.00%
Energy efficiency and use of renewable energy resources	5.80%
Transparency and inclusiveness of processes	11.00%
Stakeholders engagement & Cross-sectorial initiatives & synergies	2.30%
Supportive regulatory framework	5.30%
Regulatory framework for use of renewable energy resources	6.20%
Social and technical regimes	5.70%
Region's economic development and socio-economic well-being	1.90%
Data availability and security	5.90%
Region Innovation Capacity	1.70%
Sectorial Innovation	4.50%
Society's perception	3.70%
Raising society's awareness for environment	2.70%
Knowledge dissemination to public	2.40%
Support from existing veto players (neutralisation of veto players)	4.20%

Funded by the European Union

EUROPEAN NETWORK OF LIVING LABS IVZW

The responses of ENoLL showed that the most important sub-element is Processes to identify conflict resolution while the less important sub-elements are Society's perception, Research & Education and Political Support. The Consistency Ratio of the AHP procedure was about 22%.

Transition Readiness Sub-element	Weight
Cross sectorial planning	8.00%
Inter-departmental coordination	6.90%
Processes to identify conflict resolution	9.80%
Political support	3.00%
Public Investments & subsidies	4.40%
Openness	5.40%
Digitalisation	4.00%
Research & Education	2.90%
Energy efficiency and use of renewable energy resources	3.80%
Transparency and inclusiveness of processes	3.10%
Stakeholders engagement & Cross-sectorial initiatives & synergies	4.30%
Supportive regulatory framework	3.00%
Regulatory framework for use of renewable energy resources	3.80%
Social and technical regimes	7.10%
Region's economic development and socio-economic well-being	7.10%
Data availability and security	5.00%
Region Innovation Capacity	3.50%
Sectorial Innovation	3.50%
Society's perception	2.00%
Raising society's awareness for environment	3.10%
Knowledge dissemination to public	3.10%
Support from existing veto players (neutralisation of veto players)	3.20%

Funded by the European Union

Annex B: Questions of the Transition Readiness Assessment Framework

Table 12: Questions of the Transition Readiness Assessment Framework (level 1)

Sub-element	*Questions*	*Scale*				
		1	*2*	*3*	*4*	*5*
Cross-sectorial planning	*What is the level of cross-sectorial Planning?*	Sector based planning. Non-extended collaboration! There are no horizontal processes applied in planning	Working groups of each sector are involved in planning developing fragmented cross-sectorial initiatives. Inadequate framework of cross-sectorial planning and lack of effective communication between sectors.	A dedicated local unit for climate change is responsible for the coordination of the planning activities among the various sectors. The unit has neither the power nor the legal mandate to influence the formulation of federal national strategies on mitigation and adaptation to climate change	Participation of regional government (as well as representation from different sectors, civil society and academia) in the National commissions for climate change to enhance the cross-sectorial aspect of climate-change-related interventions.	Comprehensive and holistic cross-sectorial planning approach for addressing climate change challenges. Full Public involvement in cross-sectorial planning. Linked with available finance & Political support.
Public Investments & subsidies	*At what level the region has the competence for fund raising for innovation (PP schemes, …) What is the level of public investments for smart*	Initiatives are low. NO funding available for innovative policymaking. Region capacity is low in raise funding opportunities.	Region is participating in networks and initiatives for exploiting smart city including mobility dedicated funds with no results until now.	Regional funding is used for implementing small scale innovative initiatives. Region welcomes Private investment in emerging mobility solutions.	Region is active in Raising EU and national funds (participating in EU projects, smart cities mission) for test-bending innovative solutions	Region has secured funding for wide development of integrated ICT & ITS enabled solutions. A wide infrastructure for smart solutions is under development.

Funded by the European Union

Sub-element	Questions	Scale				
		1	2	3	4	5
	innovative policy making?					
Political support	*What is the level of political support in climate transition?*	Climate transition is no priority in the political agendas.	Delayed alignment with the EU requirements related to the achievement of climate neutrality. Development of the required plans (e.g., Just Transition Plan). However, these plans are poorly implemented.	Strategic plans are implemented slowly due to legal restrictions and insufficient funding.	Governmental Mechanisms for quickly alleviating legal and bureaucracy barriers.	A political system that totally supports the regions effort towards climate neutrality through various aspects including legislation, funding, institutional change etc.
Stakeholders' engagement & Cross-sectorial initiatives & synergies	*Does the region follow stakeholder's engagement practices for co-creation and co-design of innovative solutions?*	No engagement available	Multi stakeholder platform available but no regular operation nor emphasis in innovative emerging solutions support.	Upon specific issues the stakeholders were (are) mobilized and solution was found to problems.	6-month meetings among industry & public administration for solutions definitions and measures assessment	Stakeholders' engagement platforms and partnerships available and in operation in the region
	Is the region open to deploy and test new business models? Is the triple helix for innovation applied for	No existing synergies & no previous experience as pilot region in national or EU smart mobility program	Rare synergies between companies for innovations. Local very small implementation of collaborative business models	Participation in EU funds and/or contribution as pilot region. Occasional synergies between companies' innovations (no formal cooperation schemes)	Clusters between the companies in urban mobility of the city preparing & demonstrating collaborative business models and smart solutions	Synergies with big innovators. Participation in EU funds and/or contribution as pilot region. Research results are generalized & extended, and innovation acceleration activities are implemented.

Funded by the European Union

Sub-element	*Questions*	*Scale*				
		1	*2*	*3*	*4*	*5*
	smart solutions?					
Region's economic development and socio-economic well-being	*What is the level of region's economic development?* (Economic performance: GDP per capita, employment rate, income levels, business climate. Socio-economic well-being: poverty rate, quality of life)	Economic performance and socio-economic well-being under the national average.	Below national average economic performance and socio-economic well-being near to average.	Economic performance and socio-economic well-being near the national average.	Above national average economic performance and socio-economic well-being near to average.	Economic performance and socio-economic well-being above the national average.

Funded by the European Union

Table 13: Questions of the Transition Readiness Assessment Framework (level 2)

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
Governance & Fusion	***Inter-departmental coordination***	*1. What is the level of inter-departmental coordination for implementing actions to combat climate change?? (Region authority or functional region area may be considered) (Region authority or functional region area may be considered)*	Climate Change actions are implemented by the National authorities. Lack of connection with regional level.	Multiple departments are involved in actions implementation but there are important gaps and inefficiencies.	The cooperation of related organizations has started (i.e., intergovernmental partnerships, innovation hubs were organized emphasizing in local innovation capacity, etc). However, no practical result yet for innovative solutions in the region.	Clear interdepartmental strategy towards implementation of innovative policy exists but its implementation in practice (i.e., achieving generalisation of pilots of solutions emerging by companies) is limited.	A dedicated Department or authority is responsible for coordinating the actors in speedy adoption and assessment of innovative solutions. Innovation Scale up is already happening in the region.
	Cross-sectorial planning	*What is the level of cross-sectorial Planning?*	Sector based planning. Non-extended collaboration! There are no horizontal processes applied in planning	Working groups of each sector are involved in planning developing fragmented cross-sectorial initiatives. Inadequate framework of cross-sectorial planning and lack of effective communication between sectors.	A dedicated local unit for climate change is responsible for the coordination of the planning activities among the various sectors. The unit has neither the power nor the legal mandate to influence the	Participation of regional government (as well as representation from different sectors, civil society and academia) in the National commissions for climate change to enhance the	Comprehensive and holistic cross-sectorial planning approach for addressing climate change challenges. Full Public involvement in cross-sectorial planning. Linked with available

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
					formulation of federal national strategies on mitigation and adaptation to climate change	cross-sectorial aspect of climate-change-related interventions.	finance & Political support.
	Public Investments & subsidies	*At what level the region has the competence for fund raising for innovation (PP schemes, …) What is the level of public investments for smart innovative policy making?*	Initiatives are low. NO funding available for innovative policymaking. Region capacity is low in raise funding opportunities.	Region is participating in networks and initiatives for exploiting smart city including mobility dedicated funds with no results until now.	Regional funding is used for implementing small scale innovative initiatives. Region welcomes Private investment in emerging mobility solutions.	Region is active in Raising EU and national funds (participating in EU projects, smart cities mission) for test-bending innovative solutions	Region has secured funding for wide development of integrated ICT & ITS enabled solutions. A wide infrastructure for smart solutions is under development.
	Processes to identify conflict resolution	*At what level the stakeholder's analysis is mature?*	All stakeholders are identified (e.g., key stakeholders, veto players) and their interests, strengths, weaknesses and needs are recorded.	Mapping stakeholders' relationships to recognise potential conflicts	Mapping the power and the interest of stakeholders (Power/interest matrix: key stakeholders, Keep informed, keep satisfied, minimal effort stakeholders) [52]	Development of conflict resolution strategy for supporting effective stakeholders' management (avoiding, competing, collaborating,	Application of the chosen resolution strategy and measuring the success of conflict management; Minimization of possible conflicts.

[52] Johnson, G., Scholes, K. and Whittington, R. (2008). Exploring Corporate Strategy (8th edn). London: Prentice Hall Europe

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
						accommodating, compromise) [53]	
	Political support	*What is the level of political support in climate transition?*	Climate transition is no priority in the political agendas.	Delayed alignment with the EU requirements related to the achievement of climate neutrality. Development of the required plans (e.g., Just Transition Plan). However, these plans are poorly implemented.	Strategic plans are implemented slowly due to legal restrictions and insufficient funding.	Governmental Mechanisms for quickly alleviating legal and bureaucracy barriers.	A political system that totally supports the regions effort towards climate neutrality through various aspects including legislation, funding, institutional change etc.
Openness & Greenness	***Openness***	*What is the level of (inter)national synergies with neutral partners (research institutions, universities) and other regions and organisations for knowledge transfer (e.g.,*	There are no (inter)national synergies with neutral partners.	There are national synergies with neutral partners	There are national and limited international synergies with neutral partners but no heterogeneity in skills and high expertise exists.	There are national and international synergies with neutral partners characterised by heterogeneity in skills and high expertise. However, there is no freedom to participate and collaborate in	Region is part of international collaborations and synergies characterised by heterogeneity in skills and high expertise.

[53] Thomas, K. (1992) Conflict and negotiation processes in organizations. In: Dunnette, M. and Hough, L. (eds) Handbook of Industrial and Organizational Psychology. Palo Alto, CA: DaviesBlack® Publishing, pp. 651–717

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
		POLIS, Eurocities, EIT)?				region's processes.	
	Digitalisation	*What is the level of availability of physical/digital infrastructure & services offered in the region?*	Old infrastructures and lack of infra & services. Technology penetration is low.	Old infrastructures and lack of infra & services. Electronic services have been introduced allowing for integrated use of services.	Infrastructure need modernization. Emerging new services are operating in the region but physical & digital Infrastructure for their operation is not sufficient.	The region has modern infrastructure and services. There still lack of framework for their integration & lack of capacity for transition to advanced innovation taken up. Digital infrastructure needs further improvement.	In the region the infrastructure & services are advanced & well integrated. Digital management of different services will follow soon. Private and Public actors' capacity & collaboration is sufficient for transitioning towards innovation scale up.
	Research & Education	*Can the region be characterized as a region with Research & innovation activities on climate neutrality?*	There are no research institutions (unis, research centres) available.	Small research institutions in the region (e.g., universities/departments with low/medium reputation), but no research on climate neutrality is performed.	Unis and research institutions in the region (e.g., universities and institutions with high national reputation) that perform scientific work on climate policy. The results of the work aren't communicated to the region's policy makers for	Unis and research institutions in the region (e.g., universities and institutions with high national reputation) that provide independent scientific advice on climate policy. Centre for start-ups/spin-offs foundations.	Dedicated Institutes with high reputation on scientific advice on climate policy. Centre for start-up companies, research centres, technology parks that collaborate towards the achievement of climate neutrality.

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
					aligning the regional climate policy.		
		What is the region's population educational level and digital competence?	Low educational level of citizens (International standard classification of education (ISCED = 0-2)), aging population and low internet access capacity	Young people well educated and capable in electronic means. However important part of the population has no digital services accessibility	Medium Educational level of citizens (International standard classification of education (ISCED = 3-4). Citizens are sufficiently competent in digital services	Population in full transition towards digital competencies and good level of digital competence is already achieved	High Educational level of citizens (International standard classification of education (ISCED = 5-8)) and society fully adapted to shared and electronic economy model
	Energy efficiency and Use of renewable energy resources	*What is the share of renewable energies in gross final energy consumption and production?*	Lower than the low limit in 2021 ranking[54] (Less than 12%)	Higher than the low limit but lower than EU average (12-21%)	Equal or slightly over the EU average (22 -31%)	Quite over the EU average but lower than EU expectation by 2030 (32- 42.5%)	Over the EU expectation by 2030 (More than 42.5%)
		What is the level of smartness,	The government	Digitalization government processes	Data centric governance	Managed (Fully Digital) (The	Optimizing governance

[54] Eurostat (2021), Share of energy from renewable sources. Available at: https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_ren/default/table?lang=en

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
Transparency & Cross-sectorial Collaboration	***Transparency and inclusiveness of processes***	*inclusiveness and transparency of the region's Government processes (e-tools, e-Governance practices, data transparency, mechanisms for citizen participation, awareness of changes that are happening))?*	processes are not digitalized yet (no e-governance). No mechanisms for citizen participation exist.	and mechanisms for citizen participation are under development or limited available (e-Documents, open meetings).	(citizen or user can proactively explore the new possibilities inherent in strategically collecting and leveraging data)	organization has fully committed to a data-centric approach to improving government, and the preferred approach to innovation is based on open data principles). Mechanisms for citizen participation are applied by case.	(smart/innovative) (Digital innovation using open data and mechanisms for citizen participation are embedded deeply across the entire government, with buy in and leadership from the top policymakers)
		Is region's data open source, safe and easily accessible?	Data is not open and easily accessible	Data is open but not easily accessible	Data are open and easily accessible	Data is open, easily accessible and safe	Data is open, easily accessible and safe and there is legal framework for ensuring data privacy
	Stakeholders' engagement & Cross-sectorial initiatives & synergies	*Does the region follow stakeholder's engagement practices for co-creation and co-design of innovative solutions?*	No engagement available	Multi stakeholder platform available but no regular operation nor emphasis in innovative emerging solutions support.	Upon specific issues the stakeholders were (are) mobilized and solution was found to problems.	6-month meetings among industry & public administration for solutions definitions and measures assessment	Stakeholders' engagement platforms and partnerships available and in operation in the region

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
		Is the region open to deploy and test new business models? Is the triple helix for innovation applied for smart solutions?	No existing synergies & no previous experience as pilot region in national or EU smart mobility program	Rare synergies between companies for innovations. Local very small implementation of collaborative business models	Participation in EU funds and/or contribution as pilot region. Occasional synergies between companies' innovations (no formal cooperation schemes)	Clusters between the companies in urban mobility of the city preparing & demonstrating collaborative business models and smart solutions	Synergies with big innovators. Participation in EU funds and/or contribution as pilot region. Research results are generalized & extended, and innovation acceleration activities are implemented.
Regulations & Economy	***Supportive regulatory framework***	*Does the region follow a regulatory framework for achieving climate neutrality?*	Lack of supportive regulatory framework on climate neutrality.	Existence of NECPs and regional plans but no alignment between national and regional goals.	A long-term regional climate strategy not older than five years with adequate level of detail and alignment with national goals. Cohesion between short-term actions and long-term climate goals	Full formal regional climate policy learning cycle (target setting, strategic planning, policy formulation, progress monitoring).	Proliferation of framework climate laws with integrated policy cycle.

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
	Social and technical regimes	*At what degree socio technical transition happens in the region?*[55]	Strong commitment to existing regimes. Innovation is mostly incremental and dependent on Techno-economic, Social and cognitive and Institutional and political lock-in mechanisms.	Niche innovations are being developed. Experimentation on techno-economic performance, socio-cultural acceptance and political feasibility of radical Innovations. Creation of transformative coalitions of actors who are willing to develop and protect the innovation	Niche innovations begin to stabilise. Establishment of flow of resources for ongoing innovation activities	Economic competition between new and existing regimes; Windows of opportunity for niche innovations do not (sufficiently) materialise.	New socio-technical system replaces the old one and becomes institutionalised in regulatory programmes. Regular and sufficiently detailed progress monitoring of structural changes towards climate neutrality
	Regulatory framework for use of renewable energy resources	*Has the region a regulatory framework for use of renewable energy resources?*	No regulatory framework for RES	Although there is a regulatory framework, there are legal obstacles & fragmented RES initiatives	Support mechanisms for renewables (e.g., carbon tax, tax incentives, Net Metering etc)	Regulatory framework for use of renewable energy resources embedded in supportive regulatory framework. No	Existence of regulatory framework and monitoring system.

[55] Geels, W.F. (2020). Transformative innovation and socio-technical transitions to address grand challenges, European Commission- Directorate-General for Research and Innovation (Working paper). Available at: https://op.europa.eu/en/publication-detail/-/publication/24c4a811-a9f9-11ea-bb7a-01aa75ed71a1/language-en

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
						monitoring system for environmental and social impact of RES initiatives.	
	Region's economic development and socio-economic well-being	*What is the level of region's economic development?* (Economic performance: GDP per capita, employment rate, income levels, business climate. Socio-economic well-being: poverty rate, quality of life)	Economic performance and socio-economic well-being under the national average.	Below national average economic performance and socio-economic well-being near to average.	Economic performance and socio-economic well-being near the national average.	Above national average economic performance and socio-economic well-being near to average.	Economic performance and socio-economic well-being above the national average.

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
Infrastructure, Technology & Tools	***Data availability and security***	*How mature and smart is the data collection for understanding the current situation of different sectors? (Smart infrastructure, ITS, survey)?*	No data collection or rare surveys	Traditional methods of collecting data (e.g., survey)	Smart infrastructure for data collection	Observatories of data	Region as a living lab-Data space
	Region Innovation Capacity	*To what extend is the current regions's policy making data and evidence driven?*	No data available & open data framework do not exist	Open data framework accepted	Stakeholders' cooperation (PPP for data and knowledge exchange)	Observatories with cloud-based data storage Advanced data analysis techniques	Living Labs and/or digital twins available Advanced data analysis techniques Simulation techniques for testing new innovations

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
		Does the region have skilled workforce on innovative solutions?	Lack of knowledge & expertise	Specific People in public sector with know-how	Team of experts that can be mobilized for guiding innovation taken up. The region applies innovative policies "based on analogy results" from other regions and knowledge gained through networks.	Region has access to specialized organizations and tools for guiding decision making on solutions to be adopted, assessing the solutions impact and developing dedicated policies to strengthening innovation	Capacity is sufficient in the region ecosystem (i.e., operation of capacity building platform with the stakeholders) and competence is available (i.e. competence centre) for innovative policy & solutions taken up.
	Sectorial Innovation	*How wealthy is the region in terms of number of big innovators and high-tech start-up companies?*	No high-tech companies and start-ups	The region has few high-tech companies and no start-ups (e.g., 100 tech companies & <10 start-ups)	The region has high-tech companies and start-ups (e.g., 100 tech companies & 100 start-ups)	The region has high-tech companies and start-ups (e.g., 400 tech companies & 200 start-ups)	The region is hub for technology and innovation (Big innovators & Start-ups) (e.g., 2.2k tech companies & 1.6k start-ups)
Civil society & Stakeholders	***Society's perception***	*To what extent are citizens adopting new services and green solutions?*	People are not aware of what is climate neutrality is and how green solutions could speed up its achievement.	People are aware of green solutions. However, many of them cannot afford their adoption due to financial constraints.	Society starts adopting new services and green solutions thanks to incentives provided by the region.	Community-Led Initiatives for achieving climate neutrality.	Behavioural change is achieved.

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
	Raising society's awareness for environment	*What ways does the region use to raise environmental awareness?*	No educational initiatives for raising society's awareness for environment.	There are few educational initiatives but fragmented and without scientific evidence.	Some educational initiatives but sector based. Society can't perceive the overall impact of climate change.	Organised campaigns for raising environmental awareness supported by scientific research and evidence.	Existence of mechanism for continuing educating and training citizens on climate policy (such as Citizen Assemblies). Capacity-building and training programmes are implemented.
	Knowledge dissemination to public	*At what level the knowledge is disseminated to public?*	Policy makers participate in the decision-making process and knowledge isn't communicated to public.	The results of the decision-making process are communicated to public. No consultation or participation process is foreseen.	Public consultation process but not active participation in decision making.	Participation in decision-making. However, public interests are considered of low priority.	Diffusion to the public of a shared vision and sustainable goals towards the achievement of climate neutrality in the beginning of decision-making process. Use of Appropriate language and common understanding.
	Support from existing veto players	*To what extent the region is aware of the veto players in climate*	The region doesn't know who are the veto players.	Identification of veto players through stakeholders' analysis. However, they aren't considered during the	Veto players participate in the decision-making avoiding the creation of	Interests of veto players are set as high priority in the decision-making process	Creating value proposition for veto players. Equally participate in the decision-

Funded by the European Union

Element	***Sub-element***	*Questions*	*Scale*				
			1	*2*	*3*	*4*	*5*
		neutrality action?		decision-making processes.	conflict with them (avoiding approach)[53].	(competing or accommodating approach)[53].	making process. Wins-wins for all stakeholders (cooperative approach)[53].

Funded by the European Union