transformer

Definition of Transition Super-Lab use cases

Deliverable No.:	D3.2
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.:	WP3
Work package/Measure Title: Super-Lab Development and Pilots	
Responsible Author(s): Dmitri Domanski	
Responsible Co-Author(s): Georgia Ayfantopoulou, Alice Benini, Lorenzo Cello, Mariem Chakroun, Marek Giergiczny, Maria Konstantinidou, Lukasz Lemanik, Panagiotis Ptochoulis, Robert Pudelko, Spela Zalokar	
Date:	31.05.2023
Status:	Submitted
Dissemination level:	Public

Abstract

This deliverable includes status report regarding the definition of pilot use cases for the TRANSFORMER Labs.

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
12.05.23	Dmitri Domanski (BMR)	Submission of the document to reviewers	Draft	WPL
19.05.23	Morgane Juliat (RC)	Review	Draft	WPL
19.05.23	Thomas Meister (RUB)	Review	Draft	WPL
19.05.23	Maria Konstantinidou (CERTH)	Review	Draft	WPL
26.05.23	Dmitri Domanski (BMR)	Second submission of the revised document to reviewers	Draft	WPL
29.05.23	Thomas Meister (RUB)	Review	Draft	WPL
30.05.23	Morgane Juliat (RC)	Review	Draft	WPL
30.05.23	Maria Konstantinidou (CERTH)	Review	Draft	WPL
31.05.23	Dmitri Domanski (BMR)	Final Review	Final	WPL
31.05.23	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

Legal disclaimer

Funded by
the European Union

transformer

Table of Contents

Table of Figures

Funded by the European Union

List of Acronyms

B2B	Business to Business
B2H	Business to Human
CAWI	Computer Estimated Web Interview
CCUS	Carbon Capture, Use, and Storage
CLuBE	Cluster of Bioeconomy and Environment of Western Macedonia
CO2	Carbon dioxide
DAC	Direct Air Capture
DCE	Discrete Choice Experiment
ELPE	Ellinika Petrelaia (Hellenic Petroleum)
EV	Electric Vehicles
GHG	Greenhouse Gas
GW	Gigawatt
GWI	Gas and Heat Institute Essen e.V.
H2B	Human to Business
H2H	Human to Human
HDVs	Heavy-duty vehicles
IPCEI	Important Projects of Common European Interest
KPIs	Key Performance Indicators
KTEL	Interurban/Urban bus company
LGOM	Copper Valley (Legnicko-Głogowski Okręg Miedziowy)
LL	Living Lab
M	Million
MoU	Memorandum of Understanding
MW	Megawatt
NGO	Non-Governmental Organization
NIMBY	Not In My Backyard
PPC	Public Power Corporation
PT	Public Transport
PV	Photovoltaic
QH	Quadruple Helix
RER	Regione Emilia-Romagna
RES	Renewable Energy Source
SMR	Small Modular Rectors
SWOT analysis	Strengths Weaknesses Opportunities Threats analysis
TJTP	Territorial Just Transition Plan
TSL	Transition Super Lab
WM	Western Macedonia

Funded by the European Union

Executive Summary

This report is dedicated to the documentation of the process of co-creation of use cases in the four regions of the TRANSFORMER project that are developing pilots for Transition Super Labs. The use cases are defined, designed and selected in the framework of Work Package 3 “Super-Lab development and pilots”. The aim is to create concrete project ideas for Transition Super Labs that would help test the approach: how a Transition Super Lab (TSL) can accelerate the region's transition process towards climate neutrality? The direction for the development of the pilot use cases is provided by the visions that the four regions have developed for their TSLs at the beginning of the project together with their regional stakeholder coalitions (Task 3.1). By completing the task of setting up Super Lab use cases (T3.2), the four regions are laying the foundations for the further development of their TSLs as pilots with the content development to be provided through the next step within the WP3 when Action Plans for long-term implementation and establishment of the TSLs will be developed.

The report starts with an introduction to the topic of pilot use cases and sets up the framework for their application in the TRANSFORMER project. It does so by presenting a catalogue of the fundamental criteria considered indispensable for TSL development against the background of the goals and the claim of the project to accelerate the shift towards climate neutrality. Furthermore, the section contextualises the deliverable within the project and outlines how it is related to other activities.

The next part of the report focuses on the methodologies and approaches that have been applied to facilitate the processes of pilot use-cases development. Here, the report provides an overview of the most important activities, such as workshops and mapping exercises that have been crucial for aligning the different approaches to the definition of pilot use cases as well as for data collection. The section demonstrates how other key sub-tasks, especially vision and coalition-building, are intertwined with the task of uses cases development, and how this defines the methodological course of action.

The chapter on the Transition Super Labs is the core of this report. It provides detailed explanations of the background and the process of defining and selecting the pilot use cases. The partners from the four TSL regions describe how the pilot use cases have been defined and selected and give a general overview of each use case by explaining its main idea. They list potential stakeholders from the quadruple helix who are supposed to be involved in the use case development and describe which co-creation processes are expected to take place. The relevance of the use cases selected for the TSLs is verified by applying some fundamental criteria that ensure the TSL concept will be tested.

The report ends with conclusions and outlook. By doing so, it builds a bridge to the task of producing Action Plans, which will be the next key step towards the development of Transition Super Labs.

Funded by
the European Union

1 Introduction

The TRANSFORMER project aims to design long-term systemic transformation frameworks for European regions to accelerate the shift towards climate neutrality. This will be done through the development of Transition Super Labs (TSL) which are piloted in four regions: the Ruhr Area in Germany, Emilia-Romagna in Italy, Lower Silesia in Poland, and Western Macedonia in Greece, as seen in Figure 1. Each region is faced with a unique set of challenges and socio-technical systems that will impact the TSL development and goals.

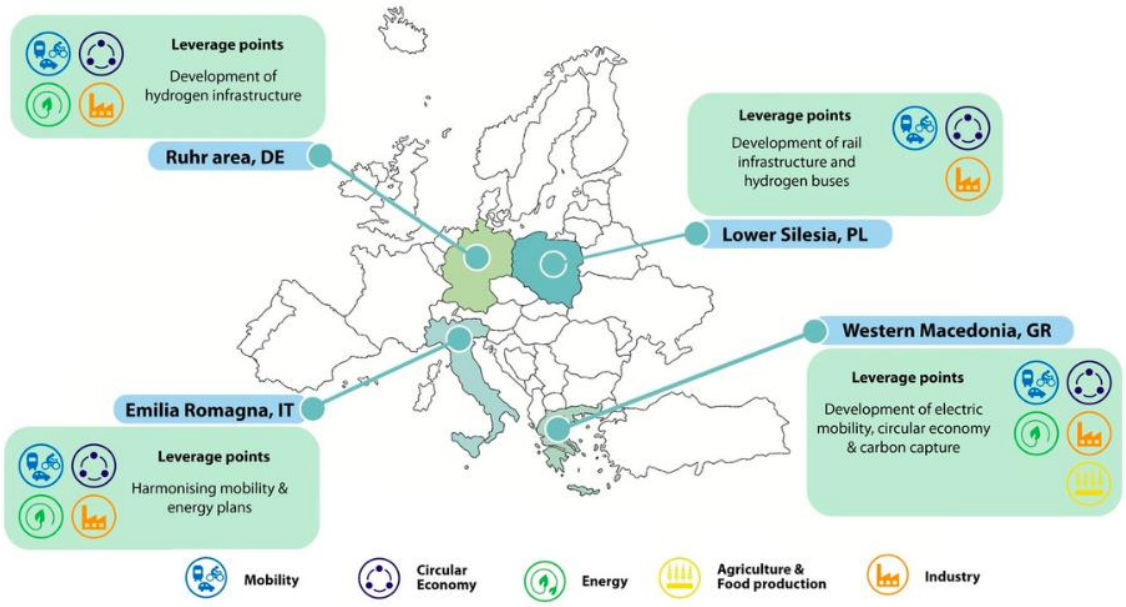

Figure 1: TSL regions[1]

Through the TSL implementation, TRANSFORMER aims to aid the regions in reaching the targets set by the Paris Agreement[2] and the European Green Deal[3] to radically transform the economy of the European Union and transition to a carbon-neutral economy. Policies put in place in the regions to tackle these challenges will be co-designed with the quadruple helix representatives. Through the TSL approach, the four regions aim to achieve the following objectives:

- Objective 1: Develop and implement an effective methodology for initiating and accelerating TSLs as flagship demonstrators for achieving carbon neutrality. This will be achieved through the Living Lab methodology.
- Objective 2: Develop and manage dynamic portfolios of innovative solutions to target and prioritise the transition needs of the project regions with the aim to achieve climate neutrality within 10 to 15 years.
- Objective 3: Secure speedy and agile action in the TSLs by close interaction among different Stakeholders.

[1] TRANSFORMER Project Proposal

[2] United Nations (2015)

[3] European Commission (2019)

Funded by the European Union

- Objective 4: Build the foundation for self-sustaining communities of practice for TSLs in Europe and beyond.
- Objective 5: Systematically explore and assess the TSL approach on a regional scale with regard to its potential to become a foundation in the Green European transition.

According to the description of work, "[t]his Deliverable will document the monitoring of TSLs partners on co-creation and co-design pilot use cases for their labs, which will be implemented ensuring the application of the integrative open innovation process for the use case solutions' demonstration"[4]. It is developed within the Work Package 3 "Super-Lab development and pilots" and is directly related to Task 3.2 "Setting-up Super-Lab uses cases". The involved project partners are expected to prepare a report where they present pilot use cases and describe how these were developed.

The direction for the development of the pilot use cases is provided by the visions that the four regions have developed for their TSLs at the beginning of the project together with their regional stakeholder coalitions (Task 3.1). 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. In TRANSFORMER's structure, the vision-building process during the first months of the project (and partially initiated even before the start of the project) has been one of the first essential steps towards TSLs development. Without such a common idea about the respective region's future characterised by sustainability and climate neutrality, there would be no clear framework for developing Transition Super Labs and, more concretely, pilot use cases. The coalition-building process in the TRANSFORMER regions has been another fundamental step to ensure that TSLs and pilot use cases would be developed in a co-creative, cross-sectorial and inclusive way. This can only be achieved in collaboration with stakeholders from all parts of the quadruple helix. In all the TSLs, active involvement of regional stakeholders was crucial to contribute to the definition of the pilot use cases.

Pilot use cases are the core of the Transition Super Labs in the four TRANSFORMER regions. They allow for an application of the TSL concept in practice. Designing and developing them together with regional stakeholders is the most practical part of the project. It is the first space where the TSL concept is tested, where project partners can learn to what extent the concept is accepted and what needs to be improved in the post-pilot phase. At the same time, this deliverable is a key step before the development of the TSL Action Plans, which, among other things, "will document mission- and scenario(s)-oriented measure planning, incl. defining roles and responsibilities of coalition members, internal and external communication planning, measures for access to and availability of TSL equipment and infrastructure, identifying co-created values/potential impacts for all measures, and for developing business models and financing/funding schemes (based on consultation on green innovation procurement, available financing and funding programmes, etc.)"[5].

What is a pilot use case in the TRANSFORMER project? In the project proposal, it is generally referred to as use cases and not pilot use cases. However, in numerous discussions among project partners, the term "pilot use cases" have become common, and we have decided to apply it in the framework

[4] TRANSFORMER Grant Agreement
[5] TRANSFORMER Grant Agreement

Funded by the European Union

of this report as well[6] because it explicitly emphasises the meaning and the purpose of the use cases in TRANSFORMER. At the same time, it is important to mention that this term is not defined in the project proposal, but from the concept of the project it can be deducted that pilot use cases are co-created concrete project ideas to achieve climate neutrality, promote systemic transformation through innovation and be developed and implemented with a focus on a regional transformation. Furthermore, pilot use cases have the following characteristics:

- They define a goal-oriented set of interactions between different actors;
- They help identify all relevant issues and resources for the development of Transition Super Labs;
- They evaluate the feasibility of these project ideas;
- They are real-life experiments, which serve for the concept development and its implementation in practice.

To ensure that pilot use cases contribute to reaching project goals it is necessary to define certain criteria for them to fulfil. Such criteria need to correspond to the idea and the concept of Transition Super Labs as in the framework of the TRANSFORMER project the labs consist of the pilot use cases. At the same time, these criteria must be sufficiently open for very different types of projects. They cannot make TSLs too exclusive as this would contradict the idea of a TSL as a space, a setting, a collaboration open for everyone and for experimentation.

The partners working on Task 3.2 have developed a catalogue of the basic and necessary criteria for a TSL pilot use case. The criteria were discussed on several occasions, especially at the digital workshop on pilot use cases organised by BMR on 22 March and at the Consortium Meeting in Bologna (28 to 30 March).

The criteria for TSL pilot use cases are the following:

- 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

The definition, selection and development of pilot use cases need to be checked against these criteria.

[6] Therefore, the terms "use case(s)" and "pilot use case(s)" are used synonymously in this report.

Funded by the European Union

1.1 Contribution of partners

The detailed concept and the structure of the report for this deliverable were developed by Business Metropole Ruhr (BMR), the deliverable's lead partner, in coordination with ENoLL, the T3.2 lead partner. BMR was responsible for outlining the deliverable contents and coordinating the preparation of the deliverable. Partners working on the development of the Transition Super Labs have provided content for the main part of this deliverable (chapter on Transition Super Labs). Altogether, the following partners have been involved in the preparation of this report:

- BMR has prepared the introduction as well as the conclusions and outlook chapter, it has also prepared the chapter on the Ruhr Area TSL,
- ENoLL has provided support in deliverable preparation and has prepared the chapter about the methodology applied in the framework of Task 3.2,
- ITL and RER have prepared the chapter on the Emilia-Romagna TSL,
- Dumni z Lubina and UNI WARSAW have prepared the chapter on Lower Silesia TSL,
- ANKO and CERTH have prepared the chapter on Western Macedonia TSL.

1.2 Relation to other activities

Task 3.2 under which the deliverable is released is closely related to Task 3.1 "Enabling coalitions, empowering affected marginalised communities, and developing vision for Super-Labs" and D3.1 "Recommendations for Transition Super-Lab coalitions building, empowering of vulnerable and marginalised groups, and vision process". While D3.2 documents the monitoring of TSLs partners on co-creation and co-design of pilot use cases for their labs, D3.1 has provided recommendations on the building of coalitions and presents the vision-finding process of the TSLs. Both vision and coalition-building are essential tasks for the preparation of pilot use cases. In addition, deliverable 3.2 is closely connected to the activities of WP2 which maps, defines and categorises Transition Super Labs, WP4 activities on roadmap development, WP5 tasks on evaluation and impact assessment and WP6 actions on stakeholder relationship building and capacity building program development. The training provided through the capacity building program feeds into all activities of the TSL development process and has guided the TSLs on the key topics presented in this deliverable.

Task 3.2 is directly related to the following activities through the following actions:

- Development of qualitative and quantitative transition KPIs by Task 5.1 Assessment framework for TSLs,
- Monitoring and assessment of the TSLs pilots and regions of Task 5.2 Impact Evaluation of TSLs pilots in regions and Task 5.3 Tools and structures assessment
- Task 2.2 Feasibility studies for the four TRANSFORMER Super Labs, which will systematically assess and define marginalised communities addressed in WP3,
- Analysis of the process and development of Super-Lab pilots of Task 4.1 Development of Transition Super-Lab roadmap blueprint process.
- Sharing the tools and methods used during this phase of TSL implementation by Task 4.2 Development of Transition Super-Lab Toolkit and by Task 4.3 Development of a Transition Super-Lab knowledge hub.

Funded by the European Union

1.3 Target groups

The project has defined three different target groups (TG) that are either directly or indirectly influenced by the project activities and will be engaged. These are:

- Target Group A: Project partners in the four TSL regions,
- Target Group B: Stakeholders in the TSL regions, with a particular focus on marginalised communities,
- Target Group C: Follower regions across Europe. This group is further defined as public authorities, enterprises that invest in renewable energy sources, enterprises active in the energy storage market, technology providers enabling climate transition, researchers in the field of sustainable development, policy analysts, and ecologists.

This deliverable targets all these target groups.

2 Methodology and Approach

This deliverable provides an overview of the process used to define pilot use cases for the four pilot TSLs. Each TSL has identified between two and four pilot use cases that align with regional priorities. These use cases have been developed collaboratively and interactively with the identified key stakeholders.

The approach employed for this process incorporates the following essential elements:

- Development of the vision
- Coalition-building, including mapping of stakeholders
- Use cases development process

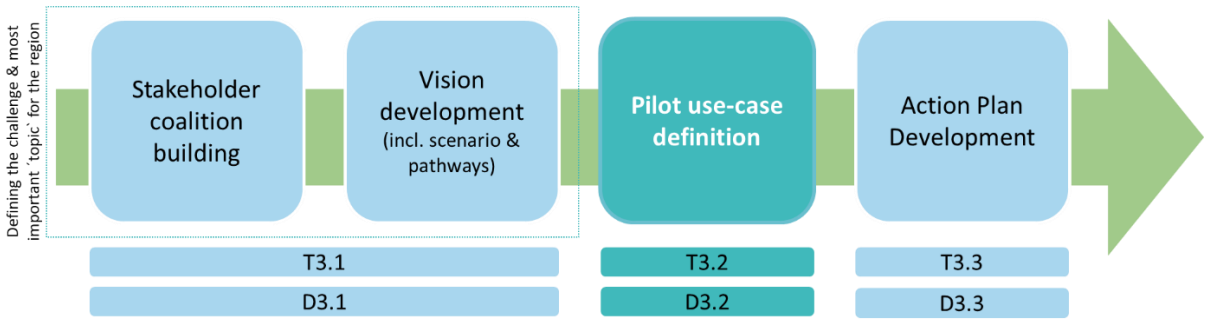

Figure 2: TSL process for defining pilot use cases

2.1 Vision development process

The initiation of the vision development process took place prior to the commencement of the project and was initially outlined during the proposal development phase. In order to enhance the visions, the TSLs participated in a digital workshop in October 2022, which was organised by RUB and BMR. Within this workshop, each TSL conducted a preliminary assessment of the region concerning the transition towards climate neutrality. They also revised the vision based on the information provided in the

Funded by the European Union

Grant Agreement and elaborated on how the vision contributes to achieving the goal of climate neutrality. Furthermore, the TSLs determined if any aspects of the vision required adjustments and proceeded to identify the stakeholders involved in its implementation. The vision development process continued in February 2023 through discussions and the collection of data. The full process and outcomes of the vision development process are described in D3.1.

As part of the consortium meeting in Bologna in March 2023, BMR and RUB organised an open discussion facilitated by ENoLL to delve deeper into the vision-building process. The purpose of this discussion was to encourage TSLs to engage in brainstorming activities centred around the following questions:

- *How does your TSL fit – so far – to the TSL concept?*
  - *Regarding the co-creation of the vision, the scenarios and the pilot use cases.*
  - *Regarding the systemic and regional focus.*
  - *To what extent is it fitting and to what extent not? Why?*
- *How can we achieve that the theoretical TSL concept on the one hand and the practical TSL implementation on the other hand better fit each other?*
- *Where do you want to see your TSL in two years?*
- *What will happen with your TSL after two years?*

This open discussion has a valuable contribution to this deliverable by providing a clear understanding of the pilot use cases and their relevance within their respective contexts. Additionally, there has been fruitful brainstorming regarding the merits and drawbacks of these choices, along with a focus on the long-term sustainability of the outcomes of the TSL use cases.

2.2 Coalition-building

Each TSL has been internally developing coalitions based on project recommendations and training. Two digital training sessions focused on stakeholder engagement activities were held by ENoLL. Through these trainings, the TSLs gained further insights into various techniques and methods for effective engagement.

Considering that the stakeholder mapping is an essential initial step in the coalition-building process for the four Transition Super Labs (TSLs), workshops were conducted under the framework of the Transformer project implementation to identify and record representatives from academia, industry, government, and civil society, collectively known as quadruple helix. An initial workshop held in October 2022 aimed to capture these stakeholders, while a refined mapping exercise in February 2023 further enhanced the comprehensiveness of the mapping process across the four TSLs. During the quadruple helix stakeholder mapping, a simple exercise was employed to record the names of organizations and subsequently include contact persons. This process played a crucial role in identifying and involving relevant stakeholders from academia, industry, government, and civil society in the coalition-building efforts of the Transformer project.

The coalition-building processes for the Emilia-Romagna, Lower Silesia, Ruhr Area, and Western Macedonia regions shared common elements in establishing collaborative and inclusive approaches to address their respective challenges. In all regions, the involvement of diverse stakeholders was

Funded by the European Union

crucial for generating a comprehensive understanding of the issues at hand and ensuring a holistic approach to problem-solving.

The Emilia-Romagna TSL initiated the coalition-building process through internal coordination within the Regional Emilia-Romagna (RER) authority, aligning different specialized departments on the cross-sectoral themes addressed by the TRANSFORMER project. External stakeholders from quadruple helix (QH) groups were then engaged in a participatory and co-creative process to define pilot use cases collaboratively.

Similarly, the coalition-building process for the Lower Silesia TSL aimed to bring together local authorities, industry experts, community representatives, and other relevant parties to collectively address transportation and energy challenges. Through engaging with local authorities, conducting interviews, and fostering regular meetings and discussions, the coalition adopted a bottom-up approach that considered the perspectives and input of those directly affected by the issues.

The Ruhr Area's TSL adopted a dynamic and flexible coalition-building process. It began with vision building and involved the active participation of regional stakeholders, adjusting to emerging demands and needs. The coalition sought to involve key stakeholders initially and gradually expand to include specific regional actors crucial for successful use case design and implementation. The process emphasized inclusivity and active participation to avoid exclusivity.

Similarly, the coalition-building process for the Western Macedonia TSL identified relevant stakeholders from government agencies, non-profit organizations, community groups, businesses, and academic institutions. Stakeholders were encouraged to actively participate through various engagement and outreach efforts. Building strong relationships, establishing open communication channels, and developing a shared vision were common goals across all regions.

While the coalition-building processes in these four regions shared common elements such as stakeholder engagement, collaboration, and goal alignment, there were also specific differences based on the regional context and requirements. These differences allowed each region to tailor their approach to suit their unique circumstances, ensuring that the coalition-building processes were effective and relevant to their respective challenges.

2.3 Use cases development process

Definition of scenarios and use cases

An internal consortium workshop was organised and led by WP3 on March 22nd, focusing on the development process of vision and sub-visions. The discussion centred around the importance of having a clear vision involving the relevant stakeholders in exploring different scenarios and use cases, while ensuring that they are aligned with the vision and goals of the TSLs. Stakeholder engagement, collaboration, and a regional-scale approach were key elements in defining these aspects.

Funded by the European Union

During the workshop, participants engaged in fruitful discussions regarding scenarios and pilot use cases. This was followed by other internal meetings to identify pilot use cases as co-created concrete project ideas to achieve climate neutrality, promote systemic transformation through innovation and be developed and implemented with a focus on a regional transformation. The process of defining and selecting pilot use cases was highlighted to be transparent, participatory, interactive, co-creative, and (at least partially) bottom-up. Each TSL shared insights on how they defined and selected their respective pilot use cases.

The use cases development process

The use case development process for the four regions shared common elements while also exhibiting distinct approaches tailored to their specific contexts.

In Emilia-Romagna, the focus was on harmonizing existing mobility and energy initiatives through stakeholder collaboration, technology utilization, and integrated planning. Lower Silesia prioritized immediate impact by addressing transportation habits, incorporating stakeholder input, and considering unforeseen circumstances like energy policy changes. The Ruhr Area employed an inclusive approach, engaging key stakeholders in workshops and feedback sessions to develop innovative use cases aligned with climate neutrality goals and regional relevance. Western Macedonia identified specific needs through stakeholder input and expert consultations, leading to collaborative design, implementation, and scaling of use cases in alignment with shared vision and goals.

While stakeholder engagement, alignment with regional needs, and technology utilization were common themes, each region's use case development process reflected its unique priorities and challenges.

3 Transition Super Labs

3.1 Introduction

In this chapter of the report, the four TRANSFORMER regions present the pilot use cases for their Transition Super Labs. The project partners provide the documentation of the process of co-creation of use cases in the four regions and explain the use cases in detail. They do so against the background of the main topics already chosen for their respective regions during the project proposal preparation phase (for an overview, see Figure 1 in the introduction chapter) and, more concretely, according to the regions' visions developed in the framework of Task 3.1 and documented in the corresponding deliverable (D3.1).

For the TSLs, the challenge is to focus on project ideas with a value creation evident in practice without giving up the ambitions for contributing to systemic transformation. This can only be achieved in collaboration with stakeholders, and this was precisely what all four TSLs demonstrated, even though they did it in different ways according to the specific circumstances in the respective regions (documented in D3.1). Therefore, it was essential to develop a catalogue of some fundamental criteria for pilot use cases to ensure that the concept of Transition Super Labs is sufficiently considered and implemented (the digital workshop on pilot use cases on 22 March and the discussion during the

Funded by the European Union

Consortium Meeting in Bologna from 28 to 30 March were crucial for this task). The definition, selection and development of pilot use cases need to be checked against these criteria.

The criteria for TSL pilot use cases are the following:

- 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

There are twelve pilot use cases in total. The numbers per region vary according to the specific necessities and circumstances in the regions which are related, among other things, to the vision and coalition-building processes as well as scenario development. The pilot use cases are presented in the following by the four TSL regions (in alphabetical order of the regions).

3.2 Use Cases for TRANSFORMER TSLs

Emilia-Romagna

Introduction

Emilia-Romagna TSL began the process of defining and selecting the pilot use cases from an institutional internal level by involving the Region Emilia-Romagna (RER), a regional public authority with a range of different departments. RER is a complex institution composed of different departments, each one specialised on a specific topic (e.g., public transport and sustainable mobility; energy and green economy; environment; agriculture, etc.). TRANSFORMER project addresses cross-sectoral themes that involve more than one regional department with complex and different dynamics. Therefore, before involving and contacting external stakeholders the RER needed to establish internal coordination among all departments on the addressed cross-sectoral topic. Once the region had a clear overview of all funded and implemented projects at the institutional level, it was feasible to involve also other quadruple helix (QH) stakeholders' groups. This means that the pilot use cases have been initially defined in a top-down process but immediately after they have been shared with other QH stakeholders in a participatory and co-creative process (see below for details).

In line with RER's vision for the region's transition to carbon neutrality,[7] the vision developed for the Emilia-Romagna TSL in the context of the project TRANSFORMER is to harmonise existing mobility and energy initiatives. The aim is to achieve integrated and multilevel planning regarding sustainable mobility and energy initiatives at the regional level. The transport and mobility sectors are responsible for very high levels of greenhouse gas emissions. Transport causes about a quarter of the EU's total

[7] RER (2020)

Funded by the European Union

greenhouse gas emissions and generates air pollution, noise pollution and habitat fragmentation[8]. The region's transition to climate neutrality cannot be successful without putting in place strong initiatives towards sustainable mobility. Moreover, acting on the mobility sector could enhance significant transformations in other sectors. For instance, the improvement of sustainable mobility can boost tourism, city attractiveness and citizens' wellbeing, but also the industrial and education sector by promoting home-work and home-school sustainable commuting solutions.
The use-cases have been selected starting from the definition of three different scenarios to reach the vision:

a. Promote and increase cycle mobility to improve sustainable mobility;
b. Improve and spread the mobility management activity in order to reduce traffic congestion;
c. Improve the use of electric vehicles and optimize the infrastructure and the use of the electric vehicles charging infrastructures in the urban city centres of the Emilia-Romagna region.

The use cases are the following:

1) Definition of simple and clear indications on cycle mobility in collaboration with Emilia-Romagna region cartography department, to be included in the tenders/funding opportunities calls that will be issued from 2023 onwards, in order to collect information on the routes that will be created and to start creating a cartography of Emilia-Romagna Region cycle paths;
2) Promotion of mobility management coordination activities to be carried out together with the area mobility managers and company mobility managers, to favour actions and projects concerning sustainable home-work and home-school mobility, also paying attention to problems related to passengers with restricted mobility transport;
3) Creation of a centralized database at the regional level including all data on electric vehicle charging stations in order to optimize the existing infrastructure and improve the use of EVs, as an important sustainable mobility solution.

Pilot use case 1: Definition of simple and clear indications on cycle mobility in collaboration with RER's cartography department, to be included in future tenders/funding opportunities/calls

Pilot use case 1 aims at defining standardized, simple and clear indications on cycle mobility to create a practical map for cyclists in collaboration with RER's cartography department. The indications will contain accessibility and safety features and represent the different types of cycle tracks and lanes (e.g. separate cycleway, cycle street) including also sidewalks, in the whole region to help cyclists to plan their cycle route. These indications will be included in the tenders/funding opportunities/calls that will be issued by the RER from 2023 onwards to collect information on the routes that will be created and start building a cartography of Emilia-Romagna's cycle paths.

The extension of implementation and expected impact at the beginning is at a local/urban scale in order to define accessibility and safety features for cyclists that could be replicated on the whole regional and national territory. Thus, the aim is to define a cycle mobility standard to be included in a call for tender that can be replicated in all regional municipalities and, possibly, at the national level.

[8] European Environment Agency (2023)

Funded by the European Union

The development of the regional network for cycle mobility, together with the promotion of cycling culture, are key elements in the sustainable mobility policies of the RER, since the use of the bicycle is directly related to environmental pollution, transport safety, improvement of the quality of life and preservation of natural spaces. The involvement of stakeholders from the QH is central in this context, given that for enhancing cycle-pedestrian mobility it is fundamental to create a system of accessibility and itineraries that goes beyond the single "track", and which has characteristics of quality, recognition and safety.

The RER, in addition to financing cycle-pedestrian infrastructures, also promotes and co-finances initiatives and activities that promote the "cycling culture", in order to increasingly guide citizens towards the use of bicycles for individual or group travel and therefore, ensure effective use of the regional network.

The first workshop on cycle mobility was held on 24th January 2023 and it involved RER's departments dealing with cycling projects. This workshop was useful for understanding and mapping the current projects and initiatives implemented by the different departments. As a result of this first workshop, municipalities with more than 50,000 inhabitants and third-sector associations were contacted and invited to collaborate with the TSL activities and provide their inputs, including through a questionnaire on mobility management and sustainable mobility. The TSL received the answers from 8 stakeholders (2 not-for-profit associations, 6 municipalities and one in-house company, which also represents a municipality). Their answers were valuable to understand their perception of the existing initiatives at the regional level and of their potential contribution to the transformation process towards climate neutrality.

The majority of the QH stakeholders involved, agreed on the importance of an open and inclusive process where each of them can contribute to enhancing cycle mobility and improve sustainable mobility. It was evident that there is a need for technical coordination among all public and private initiatives, policies and projects in place adopting a result-oriented approach based on a unified mobility/energy/smart city coordination at the regional level. To assure the long-term commitment of QH stakeholders in Emilia-Romagna, the TSL should include local municipalities through a strong and effective awareness campaign. This could ultimately lead to increase investments and the allocation of public funds for sustainable mobility initiatives and projects.

Two further workshops were organized, respectively on the 20th and 27th of April, which involved also municipalities with more than 30,000 inhabitants. The discussion was focused on how to best structure the tenders/funding calls on cycle-pedestrian mobility. Moreover, RER informed municipalities that it is working on a GPS movement tracking app that could be used by municipalities from 2024 onwards. At the end of the two workshops, the RER asked the municipalities to send an e-mail by 4th May including general indications on the projects they would like to implement, including a draft financial plan. This planning activity is very important as it will allow the RER to prepare a document that can also be shared with the Italian Ministry of Environment and Energy.

Funded by
the European Union

22 municipalities joined the workshops:

1. Valsamoggia
2. Lugo
3. San Lazzaro di Savena
4. Castelfranco Emilia
5. Formigine
6. Riccione
7. Cento
8. Casalecchio di Reno
9. Sassuolo
10. Faenza
11. Imola
12. Carpi
13. Cesena
14. Piacenza
15. Forlì
16. Ferrara
17. Rimini
18. Ravenna
19. Reggio nell'Emilia
20. Modena
21. Parma
22. Bologna

For the second part of 2023, the TSL is planning the following activities:

- organizing a workshop with all Po Valley municipalities that subscribed to the PAIR9 (Air Regional Integrated Plan). The goal of this workshop is to collect their opinion about the existing initiatives in order to structure tenders for the next period;
- writing the call for tender and launching it by the end of summer 2023;
- selecting the proposals and allocating the funds.

The base of potential QH stakeholders to be involved is indeed quite broad, as several municipalities in Emilia-Romagna implement participatory practices for budgeting, a form of citizen participation in which citizens and third-sector associations are involved in the presentation of proposals funded by public money. Moreover, the RER adopts inclusive policies for marginalised groups that facilitate the cycle-pedestrian connections from urban centres to industrial zones and favour the accessibility to the train stations. The promotion of cycle-pedestrian mobility protects all those that use them, but especially the most vulnerable road users, like pedestrians, cyclists, children, elderly and people with disabilities.

[9] Piano Aria Integrato Regionale (PAIR): Regional integrated plan that sets the goals to improve air quality in Emilia-Romagna Region. The main goals of PAIR2030, that started in April 2023, are: 1. reduce pollutant emissions; 2. simultaneously intervene on transport, biomass combustion, agriculture, but also on industry, and do it both on a large and local scale (Po Valley and national level); 3. prevent acute pollution episodes by reducing local peaks (Regione Emilia-Romagna 2020).

Funded by the European Union

Finally, the development of the regional network for cycle-pedestrian mobility, together with the promotion of cycling culture, are key elements in the sustainable mobility policies of the Emilia-Romagna Region, since the use of the bicycle is directly correlated with the reduction of environmental pollution to reach the goal of climate neutrality. The promotion of safe walking and cycling can reduce car dependency and harmful vehicle emissions that contribute to climate change.

The innovative and experimental character of this use case is the ambition to systemically transform the planning criteria for the whole road infrastructure that can lead to safe and low-speed streets that encourage the use of bicycles. The main aim is to create a new infrastructural system with liveable streets that promotes the modal shift of the daily commute from car to bicycle.

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 Management is an approach that "aims to enhance mobility and improve accessibility while tackling urban transport-related problems such as congestion, poor air quality, loss of public space and energy consumption".[10]

It focuses on changing the travel behaviour of people towards more sustainable modes of transport through the promotion and implementation of a diverse set of measures, such as the organisation of services, information and communication.

The pilot use case 2 is about the promotion of mobility management coordination activities to be carried out together with the area mobility managers and company mobility managers to favour actions and projects concerning sustainable home-work and home-school mobility, also paying attention to problems related to passengers with reduced mobility and people living in rural areas. As regards marginalised communities, the RER has also been adopting inclusive policies for most vulnerable people like children, immigrants, elderly and people with disabilities. For instance, students from 6 to 18/19 years old with a family-annual income of less than €30,000 can have free bus travel cards.

On 27th March 2023 the Emilia-Romagna TSL organised an online workshop called "Public and private initiatives for sustainable mobility". Four mobility managers participated in the workshop: from a University (University of Bologna), a company (Aeroporto Marconi) and two municipalities (Municipality of Bologna and Municipality of Reggio Emilia). They shared their experience and best practices with the participants, an audience composed of QH stakeholders who were encouraged to ask questions and express their opinions.

[10] Infunti (2019, p. 4)

Funded by the European Union

Four key take aways emerged from the workshop:

1) Emilia-Romagna municipalities have been activating collaborative projects to involve citizens in the co-design of the initiatives.
2) When it comes to the promotion of sustainable mobility it is important to nudge people toward more sustainable transit options without banning private vehicles and considering the existing road infrastructure
3) It is fundamental to involve more stakeholders in mobility management activities.
4) Emilia-Romagna Region is working on the implementation of a regional IT platform for mobility managers of companies.

As a result of the workshop, the RER decided to include Mobility Managers indications in the calls for tenders for municipalities with more than 30,000 inhabitants. These indications will be the result of a new approach that will be standardized through coordinated actions defined and agreed upon within stakeholders' tables. The type of measures envisaged are:

- incentives for home-work and home-school commuting by bicycle
- incentives for the purchase of e-bikes
- Pedibus: a service aimed at promoting outward journeys from home to school on foot. It is a human bus made up of a caravan of children accompanied by two adults, with a terminus, stops, timetables and its own pre-established route. Children go to school in groups following a set route and picking up passengers at bus stops along the way.

The extension of implementation and expected impact of such initiatives will initially be at the local/urban level, but the definition of mobility management indications could be replicated and scaled up at the regional and even national level. Therefore, the aim is to define a mobility management standard to be included in a call for tender that can be replicated in all regional municipalities and, potentially, at the national level.

The potential stakeholders from the quadruple-helix that are supposed to be involved are the following: municipalities with more than 30,000 inhabitants, private companies, universities (involving their employees), citizens residents in Po Valley municipalities that subscribed to the Air Quality Plan in Emilia-Romagna region.

The mobility management activity can reduce traffic congestion resulting in a reduction of air pollution, more efficient use of the existing transport infrastructure and reduction of energy consumption and noise. All these aspects are a great contribution to reaching the goal of climate neutrality. The innovative and experimental character of this use case is to give annual continuous incentives to citizens to encourage them to change their travel behaviour towards more sustainable modes of transport.

Finally, the potential of this use case regarding systemic transformation lies in the possibility of producing structural changes in the mobility habits of workers and citizens that can contribute to the decarbonization of the mobility sector.

Funded by the European Union

Pilot use case 3: Creation of a centralized database at the regional level including all data on electric vehicle (EV) charging stations

Pilot use case 3 is about the creation of a centralized database at the regional level including all data on electric vehicle charging stations (e.g. GPS coordinates of the charging stations, number of recharges, quantity of KW delivered every hour) in order to optimize the existing infrastructure and improve the use of Electric Vehicles (EVs), as an important sustainable mobility solution.

Emilia-Romagna TSL has been conducting bilateral meetings with EV charging station companies in order to collect EV charging station usage data at the regional level and discuss with them their plans to optimize the existing infrastructure and improve the use of EVs.

To this date, meetings and interviews were held with the following companies:

- Iren Mercato SpA
- Enermia srl
- Hera Comm SpA
- BE Charge srl
- Enel X Mobility srl

During the interviews, all participants emphasized the significance of municipalities in creating MoUs with EV charging infrastructure companies to effectively manage infrastructure in accordance with current requirements. Additionally, it was disclosed that providing incentives to companies and individuals is crucial for promoting electric mobility. Such incentives should not only encourage the purchase of electric cars but also provide training and informative sessions to enhance awareness and understanding of electric mobility.

However, the RER has still not managed to collect all data needed to create the regional database. This is because most data are sensitive, so the EV charging infrastructure companies do not want to provide specific data, such as the number of recharges and quantity of KW delivered every hour from each charging point.

Moreover, as the Italian State already decided how to allocate the funds from the Italian Recovery and Resilience Plan (Next Generation EU) for the development of EV charging infrastructure, the RER can only implement policies within this broader framework.

This use case will be a particularly useful contribution to the goal of climate neutrality as electric mobility will play a central role in transforming the mobility and energy systems towards decarbonization. The innovative and experimental character of this use case is the creation of an informal stakeholders' coordination group composed of the main EV charging infrastructure companies and users.

Finally, the potential of this use case regarding systemic transformation is the definition of an electric mobility framework in order to understand the market trends and the EV charging station operators' and electric power distributors' intentions.

Funded by the European Union

Lower Silesia

Introduction

Based on the mission facing the Copper Valley region of Lower Silesia which is the pursuit of zero-emission and listening to the voice of the inhabitants, the direction in which this transformation is most needed and thus can produce the quickest effects was selected at the outset of the Project. This direction stems from the urgent need to change the daily transport of tens of thousands of people using private cars to get to the plants of KGHM, the European copper giant, and the economic zones in nearby cities. The choice of the area of action, was initially dictated by the experience of the local NGO project partner, informal interviews and suggestions from local authorities. Once the project was launched, in December, meetings were held with residents of the municipalities affected by transport exclusion in connection with the public consultation on the new rail link. These confirmed the rationale for focusing on the pressing need for new forms of transport and outlined the scale of the problem, which, unfortunately, cannot be solved by the new rail link alone. The idea was quickly endorsed by stakeholders in the emerging TSL, such as local authorities and the local carrier, who helped to outline the problem, but also to bring the solution closer. At a TSL meeting in 15th of March 2023, a joint effort created the first pilot use case. In this case, the TSL has served to clarify a bottom-up problem and start taking action.

The second pilot use case of Polish TSL was heavily influenced by a situation that was not foreseeable when the project proposal was started. The Russian aggression in Ukraine and attacks on strategic infrastructure such as power and heating plants forced many of the European countries to revise their previous energy policy. This issue has become very widely reported in the Polish and European media and, consequently, also among participants in Lower Silesian TSL. Furthermore, the interviews we conducted with local authorities in January and February showed us the big differences between the views of decision-makers and our vision. This inspired us to raise the issue of energy sources during the TSL discussion. As stakeholders from the local government pointed out at the first Lower Silesian TSL stakeholder meeting in March, zero-emission in transport is not just about the absence of combustion engines. The energy that powers the vehicles also has to be sustainable However, to tackle such a complex issue as energy in a bottom-up manner and simultaneously give our actions a driving force, we decided to find out what people in the Copper Valley have to say on the subject. This came about as a result of an exchange of views between participants at the TSL meeting in March, where business, science, local government and NGO representatives made their case, but no one could determine what would best meet the expectations of the residents of the municipalities where the TSL activities would take place. What we find out will then define our next steps in this field.

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

As mentioned, the first use case that arose after the TSL meeting was the issue of developing the lines of the new public transport links in such a way that the inhabitants of the Copper Belt municipalities would prefer them over transport by private cars. This direction was inspired by the new rail link being developed in the LGOM area. It will run through Lubin, Polkowice and Głogów - towns closely linked to mining but also rich in economic zones where large companies have located their factories. Despite the undoubted benefits that the new link will provide, it was noted that this will still not be enough to

Funded by the European Union

fulfil the need for public transport for all of the more than thirty thousand people employed by the mining industry in the region alone.

At the TSL meeting, the local municipalities, represented by the head of the Lubin Poviat (district), addressed issues of transport exclusion. For many in the region's municipalities, relying on cars or occasional private buses is the only way to get to larger towns and cities where they work, study or access essential services. Another stakeholder, Koleje Dolnośląskie (Lower Silesian Railways), introduced the solution it is currently testing. The idea is to create bus services that would run between towns and villages, where there is no railway, and the nearest train station. Their timetable would be adapted to the train timetable to ensure that travellers would have the optimum time to reach their destination. Such connections, created in places where demand is greatest, would provide an alternative that would reduce car use.

TSL's work will involve carefully analysing this solution and preparing the best possible bus-rail connections for the people of the Copper Belt region. The optimum routes will need to be found, and it will be necessary to calculate how many passengers will use them and, therefore, how CO_2 emissions will potentially be reduced. This will be based on working with experts and stakeholders such as the Institute for Territorial Development, but we also want to involve civil society, especially those affected by transport exclusion. The final shape of our proposed solutions will be based on opinions collected from people living in the municipalities between Lubin, Polkowice and Głogów. Only in this way the TSL can count on results that will be accepted by society. Obtaining a co-creation solution in this way, using the knowledge of all the groups involved, is an innovative way of planning that has not been used to date in planning this type of connection. Instead of, at most, asking the public for accepting one of the ready-made options, as has been the case up to now, its opinions will be incorporated into the planning from the earliest stage.

In the course of the project, TSL aims to produce relevant studies, collate them with the analyses of the opinions of the region's residents, and then, on the basis of these, create optimal connections, which will be presented to the region's decision-makers to influence their implementation.

The trains that run in Lower Silesia are mostly fully electrified, while buses would also be designed to operate in the least carbon-intensive manner. Electric buses are already in operation in the region's cities, and their number is steadily increasing. In the future, once the proper infrastructure is in place, we consider introducing hydrogen-powered buses.

In the long term, the solution offers not just a few connections that will reduce the most carbon-intensive modes of transport. TSL aims by presenting a better alternative to routine transport, such as the journey to work or school, to bring a systemic change in the daily lives of the region's residents. Having a green alternative will reduce the attractiveness of travelling by car, and for many people, it will cease to be a necessity.

Moreover, although the use case has been prepared for the LGOM region, it is not only applicable there. Nothing prevents the developed solutions from being copied by other regions of Lower Silesia, the whole of Poland (where transport exclusion often occurs on a much larger scale) or Europe. It would, of course, be easiest to transmit the solutions from the Copper Valley region to the

Funded by
the European Union

voivodeship, as it would be based on the proven activities of one operator. By providing people with an advantageous form of transport, we are at the same time making their daily lives easier and changing their routines to be more environmentally friendly. This is a key element in achieving our vision of reducing CO_2 emissions to zero.

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

The proposal for the second use case was an iterative and dynamic process. As described in Deliverable 3.1, the vision should be adapted to emerging requirements and needs, but also external shocks. Such a game-changer in Poland, as well as in Lower Silesia and the LGOM Region, turned out to be the outbreak of war in Ukraine and the related energy crisis. From the very beginning of the project, TSL planned to focus the second pilot use case on energy transition in the LGOM region.

As discussed in D2.1, one of the main challenges in implementing TSL is how to involve citizens in decision making processes. To do so in a comprehensive way, we plan to employ Discrete Choice Experiment (DCE), a method widely used in economics (but also other disciplines) which is used to elicit public preferences. The use of DCE in the context of a TSL is novel and goes beyond the approaches that has been applied so far (see for example Rybnik 360[11]). Therefore, this use case should be seen not only as an approach which will be used to understand the needs of the citizens with regard to the energy policy of LGOM region, but in a much wider context as testing a novel approach in increasing public participation in decision making process in the context of TSL. If successful, the approach based on the DCE method can be adapted and applied in other European regions/other TSLs. To better propagate the use of this approach in other context the survey development, and data analysis stage will be fully documented. There will also be an evaluation with regard to the impact of the survey results on political and economic decision making.

As described in Deliverable 3.1, KGHM is the largest copper producer in Europe and the second-largest consumer of electricity in Poland. However, the 5 conducted individual interviews with the stakeholders in the LGOM region revealed, on the one hand, how big impact the current energy crisis had on stakeholders' opinions regarding energy transition, and the other hand, it showed that the preferences of civil society are to a large extent not accounted for. These interviews were conducted with stakeholders such as Robert Raczyński - president of the town of Lubin, Tymoteusz Myrda - a member of the board of the Lower Silesian Marshal's Office, Damian Stawikowski - the president of the Lower Silesian Railways, Maciej Zathey - the director of Institute for Territorial Development (an institute responsible for preparing the Energy Strategy of Lower Silesia), and Piotr Podgórski – investment director of KGHM responsible for the deployment of small modular reactors (SMR) in KGHM.

Conducted pilot interviews with local citizens indicated that their opinions are in sharp contrast with the views and plans that the main stakeholders in LGOM have on energy transition in the region. The interviews with local citizens assured us that more meaningful civil society involvement in coalition-building is critical for the success of the Transition Super Lab.

[11] Sadura et al. (2021)

Funded by the European Union

The conducted interviews with the main stakeholders in the region revealed a wide range of possible paths for an energy transition that are considered in the region. The plans and opinions revealed by the stakeholders from the quadruple-helix will be used to prepare different scenarios for possible energy paths in the region, which will be assessed by local communities. Based on the stakeholders' opinions, the following options have been identified:

- Activating brown coal deposits: In Lower Silesia, between Legnica, Lubin, and Ścinawa, there are the largest lignite deposits in Europe, and perhaps even the largest in the world, estimated at around 35 billion tons in total. The war in Ukraine and high energy prices have brought these deposits back into the spotlight for those in power and the mining and energy industries.
- Nuclear energy development: To meet the increasing electricity demand, KGHM is developing its own nuclear plans. In February 2022, KGHM signed an agreement with US-based NuScale Power to begin work on the deployment of small modular reactors (SMRs) in Poland.
- Dynamic development of renewable energy sources and wider use of hydrogen, which would be in line with the current Energy Strategy of Lower Silesia – directions of support for the energy sector.

In the region, there are no NGOs whose activities include energy issues; therefore, 10 random interviews with citizens living in Lubin, which is situated in the centre of LGOM and is close to the planned investments, have been conducted. These interviews revealed that nuclear energy and activating lignite deposits and associated traditional energy development are highly controversial issues, as many people in the region perceive lignite mining as a huge threat to their health, safety, and the region's environment.

In order to assess the local citizens' preferences reliably in the second use case, we plan to use the discrete choice experiment method (DCE). DCE is a widely used stated preference method rooted in microeconomic theory. This approach allows us to assess the preferences and values that people have for different public programs. The planned study will be conducted on a sample of 400 respondents living in the LGOM region. Respondents will be recruited by a professional survey company. Despite the relatively small sample size of 400 respondents, we will strive to maintain sample representativeness according to key socio-demographic traits such as gender, age, municipality size, and education. The interviews will mainly be conducted using the CAWI mode (Computer Assisted Web Interview), and if necessary (due to an insufficient number of respondents in internet panels), face-to-face interviews will be conducted to reach the intended sample size. As the conducted pilot study revealed a potentially significant impact of the NIMBY effect (Not in My Backyard), considerable attention will be given to recruiting respondents living in close proximity to the planned investments.

Within the planned DCE study, we will assess the preferences of LGOM citizens for different ways of generating energy, namely:

- Nuclear energy,
- Brown coal,
- Wind power,
- Photovoltaic.

To determine the strength of the NIMBY effect and the extent to which it is influenced by the energy source, proximity to the plant will be one of the attributes. To express the trade-offs in monetary

Funded by the European Union

terms, we will use the change in electricity bills as a payment vehicle, either as the Willingness to Pay or Willingness to Accept.

To our knowledge, the use of DCE in assessing public preferences for energy sources, particularly in the context of meeting climate neutrality goals, has not been employed at the regional level where various options are viable and under discussion. Therefore, this experiment has the potential to become a valuable case study with significant practical implications not only at the local and regional scales but also at the national level. Existing legislation, such as the law on investments in wind power plants, and the 10H rule (one of the most restrictive distance rules in Europe) which mandates that new development must be located at least ten times the height of the wind power plant away from existing residential buildings and nature conservation areas, have resulted in halting investments in wind power farms. However, this decision was made without assessing public preferences. The planned DCE will enable us to assess public preferences for each option in relative and absolute terms. We believe that this knowledge will assist policymakers and stakeholders in choosing solutions that better meet societal needs and expectations. Some of these decision-makers are also participants in Lower Silesian TSL. The institutions mentioned earlier will be able to consult on the design of the survey so that it best answers their key questions. Once they have received the results of the study, they will be able to address its effects immediately so that they can have a real impact on changes in the region.

Doing this effectively will lead to a systemic change that will affect the way key decisions on energy issues are made in the region and then perhaps more widely. Unfortunately, it is not common for such ideas to be consulted in their original form. Typically, decisions are made beforehand and then the implementers have to deal with consequences, such as protests from local communities. By conducting research and, based on this, influencing decision-makers, or (depending on the outcome) educating the public, TSL wants to put such important processes on the right track.

Ruhr Area

Introduction

From vision building to coalition-building and from coalition-building to pilot use cases: this is how this process could be summarised for the Ruhr Area in very basic terms. At the same time, as described in detail within Deliverable 3.1, coalition-building for a Transition Super Lab is a dynamic process that never ends as long as a TSL exists. Also, it is important to specify that while Ruhr Area's vision-building process had started prior to the project's lifetime (see D3.1,) it always included the participation of regional stakeholders with an explicit coalition-building process however beginning later, with the start of the project.

Therefore, the idea of a TSL, and how it is developed and implemented should not be too linear. It certainly incorporates systemic elements, and it is supposed to be open and flexible instead of exclusive and rigid, while at the same, maintaining the agreed structure and milestones and, thus providing a reliable framework for the TSL development. In addition, the development of pilot use cases for a TSL also requires effective project management with concrete and pragmatic goals and one

Funded by the European Union

of these goals is to have an active coalition of regional stakeholders who are willing and able to contribute to a TSL through the development of pilot use cases.

The first highlight in this process was the stakeholder workshop organised by BMR on 19 January 2023. Against the background of Ruhr Area's vision), the workshop was addressing members of the hydrogen forum and further stakeholders, all of them considered as so-called key stakeholders. Here, it is important to mention that according to the region's vision for the TSL (see also D3.1), Ruhr Area aims to be one the greenest industrial regions in Europe. The principles of sustainability and resource efficiency are strengths of the Ruhr Area and they will be the strategies against climate change. Hydrogen will be one of the key energies of the future in the economy and society. The goal is to transform the infrastructure and industry of the region in an inclusive, collaborative and innovative way so that the use of hydrogen, together with other renewable energies, significantly contributes to climate neutrality.

The workshop was attended by 25 regional stakeholders, and it explicitly aimed to collect and discuss ideas for TSL pilot use cases. It focused on the involvement of the key stakeholders whose relevance for the TSL has been assessed as particularly high according to the stakeholder analysis. Furthermore, due to their knowledge, experience, and networks in the field of hydrogen (or related to hydrogen), they are expected to be the "door-openers" for involving further stakeholders at a later stage of the TSL development. At the same time, an important goal of the workshop was to shape a group of regional actors that would be neither too small to avoid lock-ins nor too big to allow for active participation. The second phase of coalition-building will be directly related to the development of pilot use cases. It will address and involve more specific regional actors from all parts of the quadruple helix considered particularly relevant for the successful design and implementation of use cases.

In order to enable an open and productive discussion, participants of the workshop were divided into four groups moderated by TRANSFORMER colleagues and their colleagues from Hydrogen Metropole Ruhr, Ruhr Area's coordination unit for hydrogen run by BMR and the Regional Association Ruhr. For this discussion, there was neither something prepared as a hidden agenda nor there were prescriptions orientating or limiting the thematic focus (besides the general topic of hydrogen and fundamental criteria for a TSL, such as contribution to climate neutrality and systemic transformation as well as regional relevance). There were no agreements before this discussion which should be the pilot use cases, and there was no authority trying to guide the discussion in a certain direction and achieve corresponding results. To sum up, there was a real brainstorming exercise regarding possible pilot use cases. It was a very open discussion, absolutely transparent and interactive, with ideas developed from scratch.
The following ideas for pilot use cases were gathered at the workshop:

- Energy supply of the future at industrial and business sites
- Extension of the Rhine-Herne Canal to a "Hydrogen River"
- Hydrogen in neighbourhoods and residential districts: Hydrogen as an energy carrier in municipal heat planning
- Innovative digital solutions for the hydrogen market ramp-up (e.g., digital twin, sector coupling, sinks & clusters, consulting tool etc.)
- Smart process heat in industry
- Application-oriented innovative production of hydrogen

Funded by the European Union

After the workshop, it was decided to proceed in the following way:

- Approaching stakeholders who were not able to participate in the workshop or were not invited in order to ensure a more detailed, bilateral exchange, asking them about their ideas for possible pilot use cases and their feedback on the ideas from the workshop.
- Asking the participants of the workshop for their feedback and their preferences regarding the ideas for pilot use cases.

With the idea of considering and evaluating the opinions of all these stakeholders, BMR thus conducted a discussion and feedback process in order to select pilot use cases for the TSL. This process resulted very interesting and quite challenging at the same time. On the one hand, it was important to talk about TRANSFORMER to stakeholders not involved before and to learn about their views on the project. This particularly refers, to the Emschergenossenschaft (Emscher Cooperative), which is the oldest and biggest public German water board, located and active in the Ruhr Area, and the regional branch of the German Trade Union Confederation, an umbrella organisation for eight German trade unions. On the other hand, each stakeholder has certain preferences which differ according to his/her profile and the focus of his/her work. While for trade unions, for example, project ideas with an industrial focus, such as “Smart process heat in industry” take centre stage, from energy suppliers’ perspective, the topic of energy supply in neighbourhoods or the idea of a “Hydrogen River” appear more relevant. Basically, it is important to emphasise that during this feedback process, no idea for a pilot use case was assessed as not relevant. After receiving feedback from stakeholders, BMR made an assessment of the seven ideas for pilot use cases based on these central criteria:

- 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

All project ideas mentioned above would help accelerate the shift towards climate neutrality and contribute to systemic transformation, even though not to the same extent. “Application-oriented innovative production of hydrogen” would be basically an important project because of opening up new opportunities for less dependence on imports. Nevertheless, the maximum possible amount of produced hydrogen would be quite low and therefore it is difficult to assess the project’s transformative character.

All of these project ideas have a regional scope, and the region would benefit from them. They all definitely represent experimental and innovative approaches. On the contrary, they do not have the same potential for co-creation. The project idea for hydrogen production as well as “Smart process heat in the industry” are very much about technological innovations. Of course, technological innovations can also be based on processes of co-creation. However, it can be assumed that the spectrum of stakeholders involved would be relatively narrow and especially there would be no important role for civil society. In the case of the idea of energy supply through hydrogen for industrial

Funded by the European Union

and business sites, the potential for co-creation, especially with regard to the role of civil society is also quite difficult to estimate.

Therefore, according to the central criteria listed above, these three ideas for pilot use cases were best evaluated:

- Extension of the Rhine-Herne Canal to a “Hydrogen River”
- Hydrogen in neighbourhoods and residential districts: Hydrogen as an energy carrier in municipal heat planning
- Innovative digital solutions for the hydrogen market ramp-up (e.g., digital twin, sector coupling, sinks & clusters, consulting tool etc.)

In addition, a further idea for a pilot use case has been suggested by one of the stakeholders in the course of the feedback process:

- H2 system cockpit: recording and connecting existing hydrogen initiatives to achieve optimal systemic synergy effects

This project idea is relatively similar to “Innovative solutions for the hydrogen market ramp-up”. The advantage of “H2 system cockpit” is that there is already a concrete project idea at a research institute in the Ruhr Area, and there is an explicit goal of building a coalition across the different societal sectors to develop such a pilot use case.

Altogether, the following three project ideas have been selected as Ruhr Area’s pilot use cases:

- Extension of the Rhine-Herne Canal to a “Hydrogen River”
- Hydrogen in neighbourhoods and residential districts: Hydrogen as an energy carrier in municipal heat planning
- H2 system cockpit: recording and connecting existing hydrogen initiatives to achieve optimal systemic synergy effects

Selecting the pilot use cases is a key step before the development of the TSL Action Plan, which, among other things, will include measure planning, defining roles and responsibilities of coalition members and measures for access to and availability of TSL equipment and infrastructure. It will also identify co-created values and potential impacts for all measures, and for developing business models as well as financing and funding schemes. To sum up, the TSL Action Plan will focus on the concrete implementation possibilities for the pilot use cases and demonstrate the real potential for co-creation of a Transition Super Lab by involving stakeholders from all parts of the quadruple helix.

Pilot use case 1: Extension of the Rhine-Herne Canal into a "Hydrogen River”

The Rhine-Herne Canal and adjacent waterways such as the Dortmund-Ems Canal and the Datteln-Hamm Canal together form a dense network for inland shipping that has been tried and tested for more than a hundred years. These waterways have played a major role in energy logistics in the past, such as the transport of hard coal to power plants. Many power plants along these waterways, some with their own port facilities, bear witness to this.

The idea of the Hydrogen River is to make the existing shipping routes a second pillar of the hydrogen infrastructure alongside the pipeline infrastructure. The advantage here lies primarily in the

Funded by the European Union

modularity of the overall pilot use case and the non-pipeline-based supply of hydrogen. Therefore, areas without pipeline connections can also be supplied with hydrogen in a timely manner.

In essence, the pilot use case involves importing hydrogen and, above all, its derivatives via the ports of Duisburg and Wesel and distributing them via inland waterway vessels along the hydrogen route. This would require, for example, the construction of ammonia crackers and corresponding long-distance capacities. In order to decarbonise the transport itself as well, charging infrastructure for hydrogen propulsion of inland vessels would also be an important point. Research and initial projects are already underway at the "DST Entwicklungszentrum für Schiffstechnik und Transportsysteme e. V." (DST Development Centre for Ship Technology and Transport Systems).

Ammonia is one of the most promising options for making hydrogen more transportable. According to the research institute Fraunhofer UMSICHT, various studies show that, according to the most likely scenario, in 20 to 30 years Germany is supposed to be importing about two-thirds of its energy in the form of hydrogen[12]. Against this background, ammonia becomes a very important substance. Especially if the hydrogen is to be transported from further away – for example from North Africa or the Middle East – to decentralised locations and stored there for longer periods.

Thus, the Hydrogen River pilot use case represents a double opportunity for the region and the hydrogen market ramp-up. First, larger areas can be supplied with hydrogen more quickly and more efficiently than would be possible under pipeline expansion. Second, climate-friendly hydrogen technology can be strengthened in inland navigation. In this regard, it is important to know that inland shipping accounts for up to 30 percent of stock emissions, depending on the city[13], for example. Therefore, this pilot use case could make an important contribution to reaching the goal of climate neutrality.

The regional approach is already quickly apparent due to the geographical dimension of this pilot use case, but the market ramp-up also poses the challenge that the demand and supply of hydrogen must be matched. For this purpose, it is necessary to think in terms of larger consumption clusters and to develop corresponding distribution and import strategies. The Hydrogen River pilot use case could open up new possibilities here and also offers the option of a rollout to other regions connected to the inland waterway network if successfully implemented.

With the energy companies, which have coal-fired power plants along the canals, there are also potentially strong project partners available, which have a high interest in new business models and could thus contribute their own funds.

With the phase-out of coal-fired power generation, the relevance of inland navigation in the region has also declined, as the transport of coal is no longer necessary. The associated loss of jobs and value creation is for trade unions and local authorities to be won over to sensible subsequent use and support the pilot use case. From the perspective of the local economy, especially the nearby energy-intensive industry, the option of a timely and secure supply of a climate-neutral energy source is also an attractive idea.

[12] Fraunhofer UMSICHT (2021)
[13] UBA (2018)

Funded by the European Union

With all these advantages in mind, the pilot use case Hydrogen River demonstrates its potential for systemic transformation. First, it would change the energy supply system in the region. Second, with this project idea not necessarily depending on a specific region but applicable in many other regions, scalability is also given here. Third, the aspect of sustainability is central to this pilot use case. It would allow for implementing an energy supply system with a long-term perspective. At the same time, it would be characterised by ecological (decarbonisation), economic (new business opportunities) and social (creation of long-lasting employment) sustainability. Fourth, inclusiveness is one of the principles both in terms of target groups and the actors or stakeholders involved in the development and implementation of the Hydrogen River. Regarding the target groups, the pilot use case would not only address industry but open up new possibilities for private consumers. Furthermore, it will have positive effects on the job market with very different types of employees (skilled workers and less skilled workers) benefitting from this new system of energy supply (the major impact is expected regarding the challenge of securing high-quality jobs in the industrial sector). Some of them will be marginalised groups, such as unemployed people or those in danger of unemployment (less skilled work forces may particularly benefit through job creation in the area of logistics). Long-term unemployment (usually so-called structural unemployment) is one of the main problems of the Ruhr Area, and fighting it is hence one of the central challenges in the process of structural transformation. Regarding the involvement of different actors in the development of the pilot use case, there is a chance to organise it as a true co-creation process with various stakeholders and societal groups. It will be one of the key tasks of the Action Plan for this pilot use case to define how such a process of co-creation could look like. In the meantime, we can assume that it will be important to invite representatives of trade unions to take part in this process.

Last but not least, this pilot use case is characterised by its potential for experimentation and innovation. To our knowledge, there are no similar projects of this size and structural depth. This is an opportunity to solve the chicken-and-egg problem of investing in import infrastructure and at the same time to accelerate the scaling of climate-neutral inland navigation. The modular structure makes it possible to further consolidate the pilot use case in retrospect and to win new project partners. This ensures that initial investments can also be reused and at best only serve as a "kickstarter" for hydrogen distribution by water.

Close cooperation between different stakeholders from business, administration and research is important in this pilot use case. The core of the pilot use case is the import of hydrogen derivatives by ship, so a close cooperation with the ports in the region, first and foremost with Europe's largest inland port in Duisburg, is urgently needed. It is also essential to involve the Water and Shipping Authority (Wasser- und Schifffahrtsamt) as the responsible supervisory authority and the Emschergenossenschaft Lippeverband as the water management association at an early stage. In order to ensure the climate-friendly transport of H2 derivatives, it is also important to approach shipping companies in a targeted manner. This provides the basic prerequisites for modular and non-discriminatory expansion to include other stakeholders.

An important expansion step is the integration of former coal-fired power plant areas including the inland waterway infrastructure available there. Here, a "round table" of the energy industry is important to ensure a coordinated and integrated action concept for the development of these areas in the sense of the pilot use case. This is also in the interest of local politics at the respective locations since high-quality jobs with corresponding added value are created here again without having to fear negative external effects.

Funded by
the European Union

Scientific support of the pilot use case and the concept, for example by the DST Entwicklungszentrum für Schiffstechnik und Transportsysteme e. V. (Development Centre for Ship Technology and Transport System), but also by the ZBT Zentrum für BrennstoffzellenTechnik (The hydrogen and fuel cell centre ZBT) in Duisburg, is important in order to gain structural knowledge, for example about the use of hydrogen in inland shipping, in addition to the large-scale climate protection application of hydrogen and thus to push the rollout to other regions.

Pilot use case 2: Hydrogen in neighbourhoods and residential districts: Hydrogen as an energy carrier in municipal heat planning

The heating revolution is a mammoth task for municipalities, public utilities, housing associations and private homeowners. Hardly any energy market is as diversified as “small-scale heating”. There are a number of options available, from heat pumps and geothermal energy to the use of hydrogen. Currently, the heating market consists mainly of natural gas and oil firing. Against the backdrop of the energy transition, oil heating systems must be gradually replaced. Also, the pressure for action is currently rising through increasing political discussions that are taking place in public. However, gas heating systems and the corresponding pipeline infrastructure can generally be upgraded for blending or complete conversion with little effort. This is not only cost- and resource-efficient but can also quickly heat entire neighbourhoods in a climate-neutral manner.

Currently, however, its use in the heating sector is not prioritised. The issue is controversial and economies of scale are difficult to calculate. Other uses of hydrogen, such as in industry and heavy-duty transport, are the focus of subsidies here. This is hampering the widespread testing of hydrogen applications in the building sector, even though the high potential for subsequent use of existing infrastructure and facilities promises rapid climate protection effects and a high level of acceptance among the population.

The idea of the Project is to find intelligent energy solutions at the neighbourhood level in close cooperation with municipalities, public utilities and housing associations. Locally produced hydrogen, for example, can be an important building block for storing energy and making it usable. However, individual solutions are not possible here; instead, a neighbourhood should be considered as a whole and developed in terms of energy.

Within the framework of a pilot use case "Hydrogen in the Neighbourhood", demand-oriented solutions could be found here. It is also conceivable to blend hydrogen into local distribution networks or central electrolysers that convert surplus green electricity from solar plants and make it usable for heat planning or reverse power generation.

Therefore, the difference to previous approaches lies in the step from the individual building to the neighbourhood solution, i.e. to a systemic solution. Here, the coupling of the electricity, heating, cooling and mobility sectors plays an important role. Another new feature compared to the previous components (photovoltaics, heat pump, heat- and air-tight building envelope, heat distribution network) is the production and marketing of green hydrogen, which is fed into the natural gas network and in the future will be supplied directly to industry and mobility via an H2 pipeline.
Part of the green electricity can come from the installed photovoltaic systems on the individual buildings. Solar power can be used primarily to supply residents (tenant power) and e-mobility. The excess electricity is then used in electrolysis to produce green hydrogen. The remaining electricity for hydrogen production can come from other sources (e.g., wind turbines).

Funded by the European Union

It is also important to point out that the principle of current hydrogen heating systems works differently from hydrogen electrolysis and is not entirely climate-neutral: current fuel cell heating systems on the market work in a similar way to the familiar heating systems using natural gas. Here, hydrogen is extracted from the natural gas, which then reacts with oxygen from the environment. This form of hydrogen is also known as "blue hydrogen." This type of heating is significantly lower in emissions than normal gas heaters, but it is not completely climate-neutral, as is the case with hydrogen production by electrolysis.

In contrast to blue hydrogen, however, this energy carrier can also be produced in a completely climate-neutral way by using renewable energy, for example from the solar system on one's own roof. In this case, the term "green hydrogen" is used. When solar energy is converted into hydrogen by electrolysis, it can be stored practically indefinitely. This process makes solar power usable over a long period of time, for example even in winter. The pilot use case would therefore clearly make an important contribution to achieving the goal of climate neutrality.

Approaches for the use of hydrogen as an energy carrier in municipal heating planning have so far only existed on a very small scale (examples can be found in the German municipalities of Esslingen am Neckar and Hohenwart), so it is difficult to derive any concrete findings for a nationwide market ramp-up. The pilot use case aims to show concrete ways for the energy transformation of residential neighbourhoods and to test the role of hydrogen in practice. This is particularly relevant since the reuse of existing natural gas distribution networks throughout Germany is to be decided for long-term heat planning.

The regional dimension of the pilot use case would be given in any case. On the one hand, the pilot use case could be implemented in several neighbourhoods across the region. On the other hand, even in the case of pilot implementation in just one neighbourhood, all the important players at the regional level, such as housing associations and tenants' associations, would be involved from the outset.

The pilot use case “Hydrogen in residential districts and neighbourhoods” has the potential for systemic transformation. First, it would change the system of energy supply and heating in the housing sector. It would introduce a paradigm shift from dependency on external energy sources and corresponding uncertainties to an autonomous way of housing. Moreover, it would enhance the demand for renewable energies and therefore contribute to the already ongoing shift to sustainability-oriented energy sources which is a systemic transformation itself. Second, this pilot use case idea has the potential for scalability. Implementation is basically feasible in every region where heating is necessary and renewable energies are available in the required amount. Third, the aspect of sustainability is central to this pilot use case. It would allow for implementing a system of energy supply and heating with a long-term perspective. At the same time, it would be characterised by ecological (decarbonisation), economic (energy supply for industrial production, new business opportunities) and social (securing energy supply and heating for all residents independently from their income) sustainability. Fourth, inclusiveness is one of the principles both in terms of target groups and the actors or stakeholders involved in the development and implementation of the pilot use case. Regarding the target groups, the pilot use case would not only address private consumers, such as homeowners and tenants but also open up new possibilities for the industry.

Furthermore, at least in a long-term perspective, positive effects on marginalised groups are possible: thanks to partially autonomous solutions (e.g., such as solar energy) there is potential for a better

Funded by
the European Union

affordability of heating. Regarding the involvement of different actors in the development of the pilot use case, there is a chance to organise it as a true co-creation process with various stakeholders and societal groups. It will be one of the key tasks of the Action Plan for this pilot use case to define how such a co-creation process could look like. In the meantime, we can assume that it will be important to invite representatives of tenants' associations and housing cooperatives to take part in this process. In addition, the pilot use case Hydrogen in residential districts and neighbourhoods represents an important opportunity to raise awareness of hydrogen use among very different societal groups and actors. Currently, there are still some prejudices with regard to the use of hydrogen. Subjective estimations and unjustified worries easily eclipse scientific evidence and obvious advantages. Therefore, still quite a lot of work needs to be done in terms of raising awareness in the population regarding the introduction of hydrogen in the economy and society and the advantages of its use.

Due to the complexity of the stakeholder constellation in this pilot use case, it is necessary to select sample municipalities in which initial projects are being implemented. In these municipalities, there should be a corresponding willingness on the part of municipal administrations, distribution network operators and housing associations. This will enable the basic technical requirements for implementing the individual projects to be met. Coordinated project tables should be set up for each individual project so that local politicians and planning authorities can also be closely involved.

For the acceptance and visibility of the pilot use case, it is relevant that tenants are informed and involved at an early stage. In addition to on-site information events, contact with the press and tenant associations is essential for this. In order to give not only tenants but also owners the option to participate, close cooperation with property management companies and associations such as Haus & Grund is also part of the pilot use case.

In addition to the involvement of R&D institutions and universities, close cooperation with existing energy agencies such as NRW Energy for Climate is also crucial for the success of the pilot use case and the subsequent rollout.

Pilot use case 3: H2 system cockpit: recording and connecting existing hydrogen initiatives to achieve optimal systemic synergy effects

The Ruhr Area, the powerhouse of the German and European primary industry, has set itself the goal of becoming the "greenest industrial region in Europe"[14]. Green hydrogen is the link between industrial production, energy supply and climate protection.

The transformation towards a hydrogen world has already begun with the initiation of several major projects in the Ruhr Area. Various networks have been set up in the regions around the cities of the Ruhr and have defined their goals: to create the best conditions for the production, distribution and use of hydrogen along the value chains.

However, in addition to the implementation of various H2 production/import and infrastructure projects, it is particularly important for the Ruhr Area as an industrial region to place these urban or regional projects in the spatial context of the Ruhr Area. This means that they must be coordinated with each other.

[14] RVR (2021)

Funded by the European Union

To this end, the Gas and Heat Institute Essen e.V. (GWI) has developed a project idea together with Rhein Ruhr Power e.V.: The H2 System Cockpit – A model with which the future hydrogen-based energy supply can be simulated and thus optimised by making generation, distribution and consumption more flexible. This increases efficiency and reduces costs. But above all, it saves CO_2 – another important step towards climate neutrality.

Currently, a large number of individual projects are planned and implemented independently of each other in the areas of H2 generation, transport and infrastructure as well as in the area of H2 application. In the process, the actors face various challenges:

- H2 generation: Green hydrogen must be produced from renewable energies, such as wind power, photovoltaic, etc.
- H2 transport/infrastructure: The planning and construction of H2 pipelines (transport networks, distribution networks), the use of existing gas pipelines (transport networks, distribution networks) and the planning of storage facilities (mobile, immobile) take place in an uncoordinated manner.
- H2 application: Competing uses arise between industry, commerce and the heating market.

The Ruhr Area offers ideal structural conditions for the development of an H2 model region:

- High industrial density
- High energy demand
- An already existing H2 infrastructure
- Regional and supraregional networking and cooperation

The municipal and regional subsystems are the building blocks which, in interaction, create the hydrogen model region Ruhr.
Similar to the electricity sector, a balancing group manager will be necessary for the hydrogen sector to manage and optimise the safe operation of the overall system. Therefore, the following actors must be involved from the beginning of the development of the pilot use case to compile data on H2 quantities and make them available to the project internally:

- H2 suppliers compile their data on the H2 quantities that can be generated and provided (is and planned).
- H2 distributors compile their data on the H2 quantities that can be transported and stored (is and planned).
- H2 consumers compile their data on the H2 quantities that are needed for production, mobility, and heat supply (is and planned).

In the initial phase (2 years), which precedes the project, the data of industrial and commercial suppliers and grid operators are collected and synchronised via an analysis tool. The existing tool of the GWI must be successively expanded for this purpose.

The GWI analyses the existing gas, electricity and, if applicable, heat pipelines and synchronises them with existing and planned as well as the necessary (and, if applicable, still to be built) H2 infrastructures. This is done in a GWI calculation model. The data on the existing infrastructures are already available to a large extent. Then, data of the planned H2 infrastructure with H2 feeders

Funded by the European Union

(generators), and H2 exporters (industry, mobility, heat supply) are integrated into the modelling and coordinated with each other, taking into account regulatory and economic framework conditions.

The penetration and reach of the pilot use case into the regional economy can be significantly increased through non-material support from the state of North Rhine-Westphalia and the Hydrogen Metropole Ruhr, Ruhr Area's coordination unit for the topic of hydrogen. Further support of the pilot use case by the hydrogen initiatives and networks in the Ruhr Area increases the transfer of knowledge and information. This will ensure that stakeholders in the Ruhr Area are continuously informed about the progress of the pilot use case, that further stakeholders can be won as project partners and that the analysis results can be further sharpened through the larger data basis. The project is coordinated by Rhein Ruhr Power e.V.

In the next step (3 years), other important balance sheet elements, such as CH4 grid partial reallocations, the tertiary sector, public transport, rail, shipping, etc., will be integrated. Gradually, other sectors, H2 producers and users, storage facilities, etc. will be involved.

Using the digital model of an H2 system cockpit, which functions along the lines of "designetz" (a sub-project of the federal government's SINTEG project[15]), it is then possible to simulate how the integration of individual elements affects the system at any time at any location in the Ruhr Area. This allows the H2 system to be analysed and optimised quickly and at short notice. The more data that is fed into the system, the better the model can reflect reality and forecast possible influencing factors, e.g. grid bottlenecks.

This project idea is supported by the Essen Economic Development Corporation, the WiN Emscher-Lippe Gesellschaft zur Strukturverbesserung mbH (Society for Structural Improvement for the Emscher-Lippe Region), the h2-netzwerk-ruhr and EVONIK Industries.

The innovative character of the pilot use case is reflected in the fact that it is the first attempt to systematically bring together the ongoing and planned H2 projects in the Ruhr Area. For this purpose, an initial tool is to be developed in the initial phase, which will enable a future H2 balancing group manager to control the system in terms of high supply security. In the pilot use case addressed here, this approach is to be further developed in order to flexibly map the respective circumstances and make a commercial tool available. This tool can be used as a blueprint in any other balancing group. In this way, the Ruhr Area can be developed into a national H2 model region.

[15] From 2016 to 2020, five model regions in Germany tested the energy transition in practice. Around 300 project partners from business and science have shown in exemplary fashion how the energy supply in this country can function if renewable energies contribute up to 100 percent. In the process, challenges were identified in the model regions from practical work and practicable solutions were developed to help the energy transition in Germany succeed (BMWK 2022).

Funded by the European Union

Western Macedonia

Introduction

The de-lignitisation of the Western Macedonia Region is consistent with the EU and national targets for the transition to a climate-neutral economy. As a result of the de-lignitisation National policy for the 2019 base year, **a Just Transition Development Plan (2021 TJTP Territorial Just Transition Plan / TJTP Western Macedonia)[16] of lignite-dependent areas has been developed putting** in its core the cessation and/or limitation of lignite mining activities and related industries.

To reverse the negative social and economic impacts of this cessation, the TJTP introduced priorities and measures to adopt a differentiated mixture of electricity production taking advantage of the high energy expertise of the human resources and the well-developed energy infrastructure of the region. Clean energy and smart agriculture are among the five pillars of growth that the TJTP aim to create opportunities and incentives for the restart of the local economy after decarbonisation.

Although the vision was at some point predefined based on the TJTP, three sub-visions for the region were prioritised through the discussion with Western Macedonia TSL as described in D3.1. The three sub-sections are centred on four priority sectors for Western Macedonia: mobility, circular economy, energy, agriculture, and food production. These are in line with the region's main goal of achieving climate neutrality, which will be facilitated by digitalization not only vertically in every sector but also cross-sectorally.

The starting point of the coalition-building activity was the interviews with key stakeholders that were identified through the stakeholders' analysis. The stakeholders were selected for their high relevance to the achievement of the sub-visions either as stakeholders that are important to secure feasibility, involved in the implementation, impacted by the implementation, or transition facilitators. However, their potential ability to involve additional stakeholders and civil society groups in a later stage of the process was also assessed.

During the interviews, the stakeholders were asked about the strengths and weaknesses of the region to achieve the goal of climate neutrality as well as the measures that should be implemented at the technological, political, legal, economic and social levels for accelerating the transition. The goal was to extract stakeholders' perceptions of the transformation challenges and barriers and how these barriers could be removed. While the insights obtained from the interviews were valuable in comprehending the regional context and stakeholder dynamics for organising the initial interactive workshop, the information gathered was rather general in nature.

The highlight of the interactive activities was the 1st stakeholders' workshop that took place on 23 February 2023 with the participation of more than 30 representatives of stakeholders. The workshop's goal was to trigger the discussion with the stakeholders about the enablers and the barriers of each possible way to reach the vision in order to gain knowledge on the purposefulness, feasibility, sustainability and risks of these specific ways. To eliminate the risk of having a generic discussion that wouldn't contribute at the later stage of the use cases definition, the methodology of SWOT analysis

[16] Hellenic Ministry of Environment and Energy (2021)

Funded by the European Union

was used as a proxy for purposefulness, feasibility, sustainability and risks aspects. This methodology was implemented successfully, and dedicated questions guided the discussion with the stakeholders through the different possible ways to reach the vision and how these could evolve for concrete use cases to be designed with the ultimate goal of achieving the three sub-visions of TSL:

1. Diversification of clean energy (RES and H2) and clean mobility,
2. Incorporation of green agriculture and circular economy and
3. The transition of Kozani to a zero-pollution city supported from a new open Living Lab).

The stakeholders of the workshop actively participated suggesting different interventions that could be implemented for achieving the sub-visions. The purposefulness, feasibility and sustainability of each of the suggested interventions were openly discussed. Although there were a couple of suggested use cases that could have a similar impact, some of them weren't feasible from a technical aspect or their implementation requires a lot of time. Given the urgency of use cases that will contribute to the achievement of climate neutrality in the short-term, these use cases were rejected. So, the definition of the final use cases has resulted from a completely open and bottom-up approach with the stakeholders:

- Use case 1: Production, transfer and storage of PV energy and consumption in Ptolemaida KTEL PT buses (Ptolemaida KTEL PT buses electrification – PV energy)
- Use case 2: Production, transfer and storage of H2 energy and consumption in Kozani KTEL PT buses (Kozani KTEL PT buses electrification – H2 energy)
- 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)
- Use case 4: Development of Kozani's Living Lab & Data Space

Use cases 1 and 2 will contribute to the achievement of the first sub-vision of ''Diversification of clean energy (RES and H_2) and clean mobility'' while use cases 3 and 4 to the second ''Incorporation of green agriculture and circular economy'' and third sub-vision ''The transition of Kozani to a zero-pollution city supported from a new open Living Lab'' respectively.

The workshop resulted in 3 SWOT-like schemes (one per pathway). Their analysis will be a valuable input for the feasibility studies adding a bottom-up approach to the process and ensuring the integration of stakeholders' needs in the studies. Thus, the use cases described below will be further examined and validated through the feasibility studies that are currently under development.

The coalition-building activities including the interviews and the workshops are part of the first step of the Open Innovation Community life cycle for transition support and innovation that TSL of Western Macedonia follows. Strengthening innovation by consuming the capacities of the local ecosystem and using common knowledge and understanding of the challenges is a critical step to achieving the transition towards climate neutrality.

Funded by the European Union

Pilot use case 1: Production, transfer and storage of PV energy and consumption in Ptolemaida KTEL PT buses (Ptolemaida KTEL PT buses electrification – PV energy)

The transport sector, is responsible for a high percentage of energy consumption and greenhouse gas emissions, especially in urban centres. Especially, road transport is by far the biggest emitter accounting 77% of all EU transport GHG emissions in 2020[17]. In Greece, the contribution of transport in GHG emissions in 2017 was estimated at 24.6%.[18] This is one of the main environmental and indirect energy problems that seek sustainable solutions. The reduction of the emissions produced by PT is one of the main intervention pillars of the Action Plan for Sustainable Energy both in the cities of Kozani and Ptolemaida.

Western Macedonia is endowed with natural capital to take advantage of renewable energy opportunities: excellent solar resources, good wind sites, and substantial land and water bodies available for solar and wind generation. It has the potential worth investigating for energy storage as there are a lot of currently closed power plants that could be used as large-scale stationary storage infrastructure.
Currently, PV panels cover a regional area of more than 300,000 acres and about 550 licences have been provided for the implementation of PV infrastructure.

Emphasis is placed on the construction of photovoltaic parks, with expressed interest in the construction of ~ 2GW, of which ~ 0.4GW are under construction. Specifically:

- PPC already has 230 MW under construction, with an investment of ~ € 133M
- ELPE has under construction 204MW, in an investment of ~ € 130M
- PPC is interested in an additional 1.7GW that are under development

The installation of these parks will contribute to the replacement of lignite power and the transition to "green energy", in accordance with the objectives of the National Energy and Climate Plan. At the same time, the goal of emblematic investments, in addition to the inflow of capital and the restart of the local economy, is to be a centre (beacon) for attracting related investments.

The use case of Ptolemaida KTEL PT buses electrification with PV energy aims to take advantage of the high energy supply produced by PV infrastructure in the region utilising it in the PT sector. It will examine different alternative options on how the production, transfer, storage and consumption of energy could be performed in the most optimal way (optimal locations of production/storage facilities, cost of the transfer, etc). Operational parameters of the PT fleet will be also investigated, such as the number of vehicles to be electrified, the demand for energy for PT vehicles and the location of charging stations among others.

The PT urban fleet consists of 14 buses and 7 minibuses that serve urban routes within the city and connecting routes between Ptolemaida and the surroundings. According to data provided by Ptolemaida's KTEL the energy consumption of the fleet in 2010 was about 760 MW (petrol) and about

[17] European Environmental Agency (2022)

[18] Hellenic Republic Ministry of Environment and Energy (2020)

Funded by the European Union

49 MW (biodiesel) and CO2 produced is about 925 tn[19]. Since the data are referred to more than 5 years ago, it is expected that currently, the numbers are quite higher.

According to the European Commission, more ambitious CO_2 emissions standards for new Heavy-duty vehicles (HDVs) including city buses are crucial for the transition to zero-emission mobility and achieving EU climate and zero-pollution goals. Thus, the Commission proposes new energy efficiency and CO_2 emission standards for these vehicles from 2030 onwards. The use case of Ptolemaida's PT electrification will contribute towards this direction.

The use of PV energy in public transport in Ptolemaida can be an important step towards achieving climate neutrality by reducing greenhouse gas emissions, improving energy efficiency, and promoting sustainable and environmentally friendly transportation options. Firstly, the PT vehicles in Ptolemaida using PV energy sources will produce significantly lower greenhouse gas emissions than the existing traditional fossil fuel-based vehicles. This reduction in emissions can help to mitigate climate change and move towards climate neutrality. Secondly, the use of PV energy in mobility tends to be more energy-efficient than traditional fossil fuels as electric vehicles harness around 95% of the energy used when driving, as opposed to a combustion engine that loses two-thirds of energy as waste heat. This means that the PT in Ptolemaida will achieve higher energy efficiency, reducing energy waste and saving costs in the long term. Thirdly, the air quality in the city will be improved by reducing emissions of harmful pollutants such as particulate matter and nitrogen oxides. This can have positive impacts on public health, reducing the incidence of respiratory illnesses and other health issues. Last but not least, the use of PV in public transport will also eliminate the dependence on fossil fuels, which are a finite resource and subject to price volatility. This can help increase energy security and reduce the risks associated with relying on non-renewable energy sources.

Benefits would not be just for the city of Ptolemaida alone but also for the whole region and even for the neighbouring regions. Unemployment in Western Macedonia was 29.1% in 2017, the highest rate in the country and the highest among coal platform regions[20]. As the regional employment profile of Western Macedonia is highly concentrated in lignite mining and lignite-fired combined heat and power production, particularly in the Kozani-Ptolemaida-Aminteo-Florina axis, decarbonisation is estimated to result in a loss of about 10.6 thousand jobs from 2019 until 2029 (direct, indirect and induced) according to a study of the Foundation for Economic and Industrial Research[21]. By becoming a centre for renewable energy and energy storage services, Western Macedonia could be a flourishing and innovative centre of economic growth and employment, leveraging its comparative advantage and social capital to the full. This would also enable much higher penetration rates of variable renewables in Greece and the Balkans. Such an energy transition, preserving the current identity of region as an energy pole in Greece and mitigating the negative effects related to job loss through the use of the already skilled human resources, can be expected to greatly facilitate the social acceptability of an overall energy transition in Western Macedonia.

[19] Municipality of Ptolemaida (2016)

[20] Eurostat (2017)

[21] Hellenic Ministry of Environment and Energy (2021)

Funded by the European Union

The key stakeholders involved in the development of the use case are the Public Transport of the City of Ptolemaida and the Union of Investors in Photovoltaics in the Western Macedonia Region. Energy providers and distributors are also important players since they can contribute to the exploration of storage and transfer solutions thanks to their know-how and expertise in the field of power generation. CERTH, University of W. Macedonia and the Technical Chamber of Greece (Department of W. Macedonia) will offer their expertise on the mobility and energy sector being engaged in the examination of the operational and functional parameters of the pilot use case. The Cluster of Bioeconomy and Environment (CLuBE) of Western Macedonia region covering the entire triple helix of the regional bioenergy and environment sector will be a critical stakeholder providing its expertise and enabling the scalability and replicability of the use case after its first implementation. Last but not least, as soon as the feasibility study of the use case will be completed, the Region of Western Macedonia in cooperation with the municipality of Eordaia and other municipalities in the region will examine the adjustment and adoption of the use case by other cities in the region.

The citizens of the city of Ptolemaida, like many other Greek cities, are reluctant with the use of electric vehicles or vehicles with alternative fuels, although there have been actions for the inclusion of clean vehicles in the city. This leads to the "slow" entry of private electric vehicles into the market and thus the domination of internal combustion vehicles combined with the fact that there is no infrastructure for electric vehicles in the cities. The implementation of the use case will have benefits for PT transport excluded groups and citizens in general including students, since the decrease in the ticket price and provision of incentives for the use of the electric PT will be examined in the cost-benefit analyses that will be performed through the feasibility study. Although marginalised groups and civil society (e.g., equality research & social inclusion NGOs, environmental NGOs) haven't been involved so far in the co-creation process of use cases development, it is planned to be involved in a later stage through social and communication campaigns.

Currently, there are two initiatives related to the use of electric PT vehicles launched by the Ministry of Infrastructure and Transport in Greece for the supply of 650 buses in Athens-Thessaloniki with a budget estimated at 154 million euros. These new vehicles will be called upon to partially renew the ageing fleet owned by the country's two largest cities, making a big leap in "greening up the transport". Of the 650 buses, 350 are electric and the other 300 use natural gas, which is considered more environmentally friendly. Especially for Thessaloniki, the plan is for the supply of only electric buses, as there are no CNG storage tanks in the city. Regarding this funding, it will come from two sources, the NSRF and the Recovery Fund. The next step is the announcement of another tender for city buses (1000 in Athens and 300 in Thessaloniki approximately) with the most likely scenario now being 100% for electric vehicles. Under this light, the use case in Ptolemaida is both innovative and experimental as it is the first time that the use of stored PV energy in Public Transport will be examined, instead of electric and natural gas, for covering the transport needs in a small town and its surroundings in Greece.

The use case of Ptolemaida KTEL PT buses electrification using PV energy can be a starting point for systemic transformation in the transport sector. Firstly, it would change the way the PV energy production of the region is used. So far, the high PV energy supply is used for the electricity of the houses and no storage facilities exist in the region. Its transfer, storage and use in the PT will introduce a paradigm shift from diesel-dependent buses to electric ones. Secondly, this use case has high

Funded by the European Union

scalability potential. Taking into account that PV energy production is highly promoted and increased in WM, the replacement of public bus fleets in all cities of the region will be feasible, changing the operational structure of the PT company and contributing to the decarbonisation of the mobility sector in the region. Moreover, during the 1st workshop of TRANSFORMER stakeholders, the Greek Ministry of Infrastructure & Transport has shown high interest in the progress of the use case specifically in order to examine the financial support of such a project, along with its replicability and scalability on a national scale.

Pilot use case 2: Production, transfer and storage of H2 energy and consumption in Kozani KTEL PT buses (Kozani KTEL PT buses electrification – H2 energy)

The establishment and development of an innovation hub for hydrogen (H2), green energy and environmental technologies was announced in 2021. Green hydrogen will signal a new environment for the diversification of the new economy in Western Macedonia through the production of climate-neutral energy production. A hydrogen technology park will be developed in order to rapidly promote the use of green hydrogen and favour the investment environment in WM. The park will be complemented by a Center for Hydrogen Studies based at the University of Western Macedonia, a cluster of hydrogen companies based at CERTH facilities in Ptolemaida and an electronic platform of hydrogen technologies applications.

Additionally, the Hydrogen Valley of Western Macedonia is a new initiative related to H2. Last July the European Commission approved the "Green HiPo" project submitted by Advent Technologies under the Important Projects of Common European Interest ("IPCEI"), an investment to be made in Western Macedonia. Green hydrogen will help in the sustainable energy transition of a variety of polluting industrial activities. This is a factory that will manufacture the equipment, i.e., the hydrogen generators. Funding has been launched, as it was officially notified to the IPCEI for the hydrogen sector of the Commission.

The use case of Kozani KTEL PT buses electrification with H2 energy aims to examine different alternative option of potential facilities locations for H2 production and storage, energy supply, transfer ways etc. Operational parameters of the Kozani's PT fleet will be also investigated, such as the number of vehicles to be electrified, the demand for energy for PT vehicles and the location of charging stations among others.

PT within the city of Kozani is carried out by municipal minibuses. Today there are 2 lines, the "red" and the "green" (Figure 3). The two routes have common stops and are differentiated mainly in the eastern part of Kozani, as the green line extends to the University, in order to serve the large daily volume of movements towards it. Kozani is also connected to a large number of settlements by the Kozani PT minibuses.

Funded by the European Union

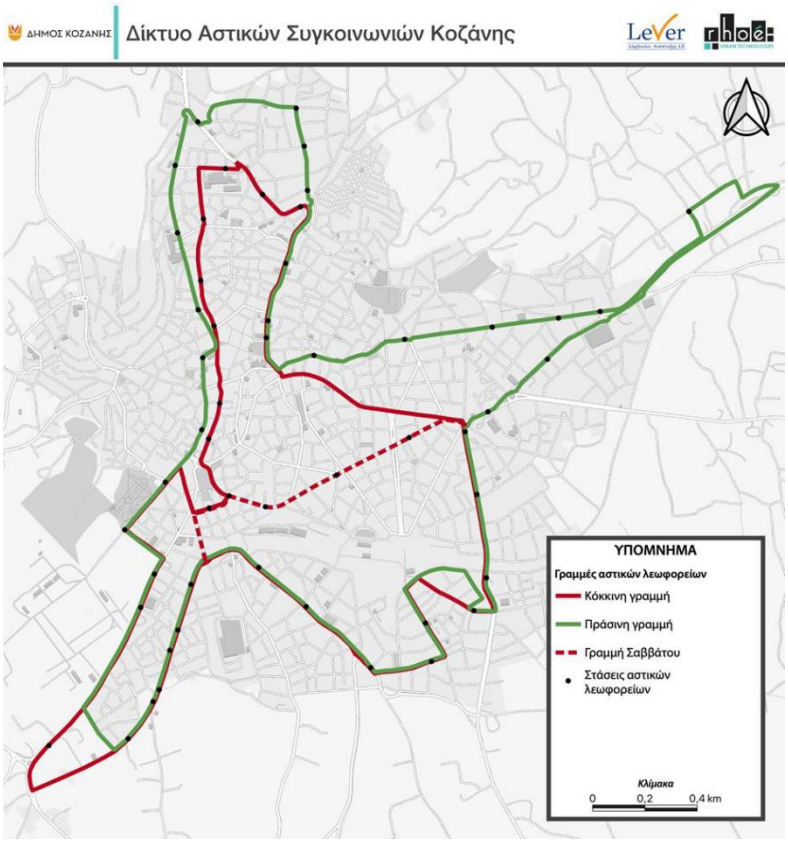

Figure 3: PT lines within the city of Kozani[22]

According to data provided by the Public Transport operator of Kozani-Kozani's KTEL, the energy consumption by the PT of Kozani's municipality was about 14,300 MWh in 2010 and the CO2 produced is about 4,000 tn. 25% of the energy is consumed by the PT within the city of Kozani[23]. Since the data are referred to more than 10 years ago, it is expected that currently, the numbers are quite higher.

The regional approach to the production and use of H2 in the PT of Kozani city lies on the scalability of the use case. The examination of the feasibility, sustainability and purposefulness aspects of the use case will provide arguments to policymakers to further investigate and prioritise the upgrade and capitalization of the existing energy infrastructure (electricity grids and natural gas pipelines). Natural gas pipelines, in particular, could be used for the transfer and indirect storage of green hydrogen. Since the hydrogen economy in Greece is currently in a very early stage, the establishment of a regulatory framework for Energy Net Metering could work as an incentive for the community, accelerating the launch of the H2 market. Further steps will include the preparation of the National Natural Gas Transmission System to receive growing rates of hydrogen, reducing the carbon footprint of the fuel and accelerating the advancements in this sector.

The key stakeholders involved in the development of the use case are the Public Transport of City of Kozani and the Cluster of Bioeconomy and Environment (CLuBE) of Western Macedonia region having experience in research activities about the penetration of biofuels and biohydrogen in the energy mix of transportation fuels will be the key stakeholders of the H2 use case. Energy providers and

[22] Lever Electric LLC (2022)

[23] University of Western Macedonia and Municipality of Kozani (2013)

Funded by the European Union

distributors are also considered key players since they can contribute to the exploration of storage and transfer solutions thanks to their know-how and expertise in the field of power generation. CERTH, University of W. Macedonia and the Technical Chamber of Greece (Department of W. Macedonia) will offer their expertise on the mobility and energy sector being engaged in the examination of the operational and functional parameters of the pilot use case. The Region of Western Macedonia in cooperation with the municipality of Kozani and other municipalities in the region will examine the adjustment and adoption of the feasibility and purposefulness aspects of the use case by other cities in the region. A lot of discussion has been made about the location of H2 production facilities and their proximity to urban areas. The feasibility study will provide useful insights to be used as arguments for citizens (as they are considered a marginalised group in this use case), and their involvement will be defined at a later stage of the process. Steps for the involvement of equality research & social inclusion NGOs and environmental NGOs will also be further exploited.

The use of hydrogen in the public transport of Kozani will contribute to the acceleration of the region's transition towards climate neutrality as hydrogen fuel cells used in public transport produce zero greenhouse gas emissions. This can significantly reduce the carbon footprint of Kozani's public transport and contribute to mitigating climate change in the city. Additionally, hydrogen fuel cells are more energy-efficient than traditional internal combustion engines, which means that less energy is wasted in the form of heat and more energy can be used to power the vehicle. This can lead to significant cost savings and reduce the overall energy consumption of public transport. Improved air quality with a direct positive impact on public health and the reduced dependence on fossil fuels are also among the benefits of the use of hydrogen as a fuel source in PT.

This use case is characterised by its high potential for experimentation and innovation since there are no similar projects in Greece.

Also, the use case, dealing with the feasibility of a project that could lead to the finance of the replacement of the fleet of local buses, will examine potential systemic transformation, mainly technologically (as there is no production of energy from H2 in the region, although it is highly promoted) and also environmentally and financially, as part of the regional policy in Western Macedonia. Finally, the use of hydrogen in public transport can raise public awareness and engagement in sustainable transportation solutions. This along with technological innovation and advancements in the energy sector can help to shift attitudes and behaviours towards more sustainable mobility forms, contributing to systemic transformation.

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)

The strategic documents of Western Macedonia include measures that promote the value-addition of existing production chains and make linkages to other burgeoning sectors (such as biomass and waste management). They propose the incorporation of digitization and new technologies in food systems and agriculture to make farming and the food industry of the region more environmentally and economically sustainable. Agriculture and agrifood seems to be a promising sector, especially when it comes to the use of innovative processing techniques, setting the basis for what will be the norm in agricultural supply chains in the next decade.

Funded by the European Union

On the other hand, the circular economy is a key element of the country's Development Strategy, and its implementation includes, among others, a four-year strategic plan that permeates the entire spectrum of the value chain. In this context, the axes of the circular policy are also presented in the National Plan for Energy and Climate. Also, the Circular Economy is of particular importance for the region of Western Macedonia as it has been directly linked to the future of the region and its economic development in the de-lignitisation context.

The use case aims to explore the benefits of the application of CO_2 capture and emission reduction technologies in local farms and how this could be transferred, stored and reused by the agro farms. The regional dimension of the use case is clear as the new technologies could be implemented in several farms across the region. The process of CO_2 storage & reconsumption could be implemented within the regional circular economy park creating the appropriate conditions for developing synergies and offering a high potentiality of replication.

Along with the agro farms that will test the innovative technologies of CO_2 capture, DIADYMA S.A will be benefited from synergies and scale economies that will be developed among agro farms located in the circular economy park. The cluster of Bioeconomy and Environment (CLuBE) of the Western Macedonia region is also considered a key stakeholder for the replicability of the solution helping in its implementation to CLuBE members such as the Agricultural Cooperative ''DIMITRA''. In this use case, the target group, namely the small agro farms, is considered a marginalised group since their needs are barely taken into account during the development of policies related to the agriculture and agri-food sector. In TRANSFORMER, different agro farms (e.g., Proud Farm, Bisiritsas Brothers Farm SA etc) were involved from the beginning in the coalition-building activities including the interviews and the 1st stakeholder workshop. Environmental NGOs and interest groups (including students) that may be identified by DIADYMA S.A will be involved in a later stage.

Any pathway to mitigate climate neutrality requires the rapid reduction of CO_2 emissions and negative-emissions technologies to cut atmospheric concentrations. Growing concerns about climate change are intensifying interest in advanced technologies to reduce emissions in sectors, such as farming, and also to draw down CO_2 levels in the atmosphere. High on the list is carbon capture, use, and storage (CCUS), the term for a family of technologies and techniques that do exactly what they say: they capture CO_2 and use or store it to prevent its release into the atmosphere. Through direct air capture (DAC) or bioenergy with carbon capture and storage (BECCS), CCUS can actually draw down CO_2 concentrations in the atmosphere— "negative emissions," as this is called. In some cases, that CO_2 can be used to create products ranging from cement to synthetic fuels. Application of CO_2 capture/emission reduction technologies in farms & transfer, storage & re-consumption of CO_2 in farms with links to the forthcoming circular economy park of the region is directly contributing to the goal of climate neutrality according to the former.

All over the world, farmers have for years known about their theoretical ability to offset carbon emissions by managing their land in a way that captures carbon dioxide from the atmosphere and stores it in the soil – a set of practices sometimes referred to as regenerative agriculture. But measuring the carbon drawdown within the soil as a result of such practices has proven difficult and nuanced over time, and farmers have mostly eschewed these practices, which require more labour

Funded by the European Union

than conventional agriculture. In general, farming can reduce CO_2 emissions by using livestock feed additives, practising rotational grazing to sequester carbon in the soil, selecting high-quality feed that will reduce methane released from enteric fermentation, managing manure to reduce methane and nitrous oxide and covering manure storage facilities. The use case will examine such innovative and/or experimental technological solutions in farms in Western Macedonia, where there is no significant experience and know-how yet.

Regenerative agriculture practices — such as no-till farming, composting, and cover cropping — can help store carbon in the ground. They also provide benefits to farmers, including healthier soil and increased water retention. For example, a number of companies are piloting novel remote imaging technologies that could help streamline how farmers measure the amount of carbon in their soils. Until now, the expense and time associated with measuring soil carbon content has been a major hurdle for farmers hoping to generate carbon offsets on their land. If these new technologies prove effective, and that's why a feasibility study for such a use case is absolutely needed, they could greatly accelerate the ongoing effort to make the agricultural industry carbon-negative. Due to new technological developments, there is potential that the incentive structure can change for farmers, who collectively can make a significant dent in carbon emissions achieving systemic transformation in the near future.

Pilot use case 4: Development of Kozani's Living Lab & Data Space

Western Macedonia needs to foster innovation performance and digital transformation of the local economy. Kozani's Transition Living Lab will provide a fertile ground for new synergies to be developed linking them to a major and shared local resource (data space) with great potential and will lead to dynamic, mutually supportive, long-term and sustainable growth.

The Data space at the regional level will operate as a coherent data and metadata governance mechanism/tool (synchronisation of the data centres of ''big'' players). Being a one-stop source for cross-sectorial data and services in the region, the data space will enable the region to monitor and analyse KPIs important for achieving climate neutrality in different sectors (mobility, energy etc) and operate in parallel as the collaborative basis of cross-sectorial synergies within the region enabling the acceleration of the innovation (it is under discussion to be open for stakeholders but also for the civil society).

The Data space will collect, filter, process and correlate data related to different sectors with a regional focus. Always open to adopting cutting-edge tools and technologies, it will ensure and validate data quality and provide value added to raw data by combining multiple sources and contents. At the same time, following the principles of the "open and linked data" movement, some datasets will be available to the public (always complying with privacy as foreseen in the General Data Protection Regulation), contributing to the upgrade of everyday life.

The first period of the Laboratory's activities will be mainly dedicated to enlarging the cross-sectorial ecosystem by attracting data providers, which allows to significantly increase the offer of dedicated added-value services and create emblematic projects, aiming at keeping ecosystem members' interest and engagement in the living lab.

Funded by the European Union

The stakeholders sharing their data will be able to be benefited from innovative climate-neutral services and methodologies provided by the Transition Super Lab (e.g., methodology of CO2 capture). This ''win-win'' model will ensure the appropriate data flow ensuring the sustainability of the Data space. At a later stage, the data-based services developed within the Living Lab could be commercially exploited and provided to third parties, ensuring its long-term self-sustainability, stability, continuity and reliability.

Kozani's Living Lab will be an interdisciplinary project, with an open governance, involving several regional stakeholders from the quadruple helix (Region of Western Macedonia, Municipality of Kozani, CERTH, University of Western Macedonia, DIADYMA SA, CLuBE, private companies, Technical and economic chambers of Greece (departments of Western Macedonia, etc) and supporting the design, the implementation and the evaluation of new processes for co-designing smart and sustainable services. It will encompass an innovative cross-sectoral eco-system including the Region of Western Macedonia, the municipality of Kozani, public and private transport and service providers and technology suppliers, aiming to provide technological solutions for different sectors and support innovative enterprises in smart sectoral issues. B2B, B2H, H2B and H2H will be also examined supporting the match between citizen's needs and the services providers.

Among the main objectives of Kozani's LL will be to become a certified member of the European Network of Living Labs. This will open new cross-border collaboration potentiality between Living Lab experts and practitioners and enhance the activities performed through new tools and services.

Although in the beginning, Kozani's LL may be a project-fed LL, in the long term it will be fully sustainable by its own resources in terms of infrastructure and staff. The Laboratory aims to ensure its sustainability by its own resources through the value-added services offered to third parties at local, regional, national and international levels. Its participation in funded projects will also operate as a channel of networking and the creation of innovation. An important step towards this direction will be the definition of the new governance scheme that will be led by ANKO, the definition of the role of each stakeholder involved and the signature of a joint agreement between ANKO and the ecosystem. The business plan will be continually updated on the basis of new market trends and technological evolutions.

Kozani's Living Lab will operate as a stakeholder and user-driven innovation environment where users and producers co-create innovation in a trusted, open ecosystem that enables business and societal innovation. Its contribution to systemic transformation lies in the change of the way that stakeholders operate and cooperate both for the improvement of their current activities and the development of new cross-sectorial initiatives. During the interviews and the first workshop of TRANSFORMER, all the participants admitted that there is a lack of data sources related to the transition at regional and local levels. Moreover, all stakeholders expressed their concerns about what will be their role in the transition process and how they could be contributed according to their field of activity. The creation and use of a data space by the stakeholders that will be involved in Kozani's LL will help to overcome this bottleneck contributing to planning effective and even more innovative projects especially related to climate neutrality. By involving users and stakeholders from different sectors, disciplines, and backgrounds in the co-creation process, the LL will ensure that the solutions to be developed are

Funded by the European Union

tailored to their needs and preferences. This approach breaks down silos, facilitates knowledge exchange and addresses the root causes of problems, leading to systemic transformation as it will introduce a user-centric approach and a new collaborative framework among stakeholders that haven't been followed so far, supported by a data space.

Additionally, as such an initiative hasn't been implemented before at this scale in the region of WM, it is an innovative approach that will test and implement new systems, policies, and regulations, supporting systemic change both at the local regional level through the involvement of stakeholders from different administrative levels and the collaboration among them. The citizens' engagement including marginalised groups will be one of the greater challenges for Living Lab and specific actions towards the achievement of this goal will be examined and defined in the Action Plan.

4 Conclusions and Outlook

The aim of this report was to provide the documentation of the process of co-creation of use cases in the four regions of the TRANSFORMER project that are developing pilots for Transition Super Labs as well as to present these use cases in detail. Pilot use cases are the core of the Transition Super Labs in the four TRANSFORMER regions. They allow for an application of the TSL concept in practice. Designing and developing them together with regional stakeholders is the most practical part of the project. It is the first ''space'' where the TSL concept is tested, where project partners can learn to what extent the concept is accepted and what needs to be improved in the post-pilot phase.

Each TSL has been working on creating concrete project ideas for Transition Super Labs that would help test the approach. While the coalition-building processes in these four regions shared common elements such as stakeholder engagement, collaboration, and goal alignment, there were also specific differences based on the regional context and requirements. These differences allowed each region to tailor their approach to suit their unique circumstances, ensuring that the coalition-building processes were effective and relevant to their respective challenges.

In all four TSL regions, processes of use case development were characterised by creativity, critical discussions and openness towards new, unexplored ideas. At the same time, even as pilots, the TSLs are real spaces, they are ecosystems of actors determined by various conditions that cannot be always influenced by the project partners. Such factors are, for example, political situation, budgetary limits, and stakeholders' priority setting in an increasingly complex world with many competing initiatives. What might be a brilliant idea for a pilot use case in theory, is not necessarily a potentially successful project in practice.

All pilot use cases have been developed through co-cocreation processes, although the degree of co-creation might differ from case to case. One challenge can be to balance the involvement of the different stakeholders from all parts of the quadruple helix. Because of path dependencies, but stakeholders' preferences, interests or just availability, in practice, it is very difficult to ensure equal participation from all parts. However, there should be always an effort to make such an involvement possible. Another challenge is to involve stakeholders according to the different steps in the decision-making process. Sometimes, fast and effective decision-making is essential for project development,

Funded by the European Union

but stakeholders should not be overlooked in such a process. TRANSFORMER project partners have faced these challenges during this first phase of TSL development. Not least, the short project lifetime is an issue that cannot be neglected here. They are aware of these and other challenges and will explicitly address them when working on the Action Plans, but also when developing the TSL Roadmap.

For the TSLs, the challenge is to focus on project ideas with a value creation evident in practice without giving up the ambitions for contributing to systemic transformation. Again, this can only be achieved in collaboration with stakeholders, and this was precisely what all four TSLs demonstrated, even though they did it in different ways according to the specific circumstances in the respective regions. Therefore, it was absolutely indispensable to develop a catalogue of some fundamental criteria for pilot use cases to ensure that the concept of Transition Super Labs is sufficiently considered and implemented.

Nevertheless, this concept is still under development, and, thus, it is a dynamic discussion about the criteria for pilot use cases. There are several conflicts or at least critical moments that just cannot be neglected within the debate on Transition Super Labs. Is it all about speed or is there an explicit claim for a profound systemic transformation? Both are not always possible at the same time, and it depends on the concrete situation to demonstrate which aspect needs to be prioritised in order to achieve the best result and not to get lost in idealistic expectations. Is it all about as many bottom-up methods as possible and equal participation by all parts of the quadruple helix or is it more important to find a pragmatic solution that requires political support and decision-making power? Again, both are not always possible at the same time.

All these questions are not trivial at all. On the contrary, they need to be addressed through an open and honest debate. The experience of the TRANSFORMER project shows that such discussions are necessary, and they have been very important for the development of TSL pilot use cases in all four regions. The next step will be to continue this debate at a more concrete level through the definition of tangible goals for pilots and further coalition-building in the framework of Action Plans.

Funded by
the European Union

References

BMWK – Bundesministerium für Wirtschaft und Klimaschutz (2022). SINTEG. https://www.bmwk.de/Redaktion/DE/Dossier/sinteg.html (last access: 31.05.2023)

European Commission (2019). The European Green Deal. Brussels

European Environmental Agency (2022). Greenhouse gas emissions from transport in Europe. https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport (last access: 31.05.2023)

European Environment Agency (2023). Transport and Mobility, https://www.eea.europa.eu/en/topics/in-depth/transport-and mobility (last access: 31.05.2023)

Eurostat (2017). Regional Statistics, https://ec.europa.eu/eurostat/documents/2995521/8830865/1-26042018-AP-EN.pdf/bb8ac3b7-3606-47ef-b7ed-aadc4d1e2aae (last access: 31.05.2023)

Fraunhofer UMSICHT (2021). Transport von Wasserstoff, https://www.umsicht.fraunhofer.de/de/presse-medien/interviews/transport-von-wasserstoff.html (last access: 31.05.2023)

Hellenic Ministry of Environment and Energy (2021). 2021 TJTP Territorial Just Transition Plan

Hellenic Republic Ministry of Environment and Energy (2020). Fourth biennial report under the United Nations framework convention on climate change, https://unfccc.int/sites/default/files/resource/BR4_Greece.pdf (last access: 31.05.2023)

Infunti, M. (2019). Mobility Management: a best practice guide, iMpronta

Lever Electric LLC (2022). Electric Vehicle Charging Plan of Kozani

Municipality of Ptolemaida (2016). Sustainable Energy Action Plan Ptolemaida -SEAP. Ptolemaida

Regione Emilia-Romagna (2020). PAIR: Piano Aria Integrato Regionale, https://ambiente.regione.emilia-romagna.it/it/aria/temi/pair2020 (last access: 31.05.2023)

RER (2020). “Pact for Work and Climate. In Emilia-Romagna we build the future together.” Available at: https://www.regione.emilia-romagna.it/pattolavoroeclima/ese-patto-per-il-lavoro-17x24cm_en_web.pdf (last access: 31.05.2023)

RVR – Regionalverband Ruhr (2021). Wie wird die Metropole Ruhr grünste Industrieregion der Welt?, https://www.rvr.ruhr/service/presse/pressemitteilung-detailseite/news/wie-wird-die-metropole-ruhr-gruenste-industrieregion-der-welt/ (last access: 31.05.2023)

Funded by the European Union

Sadura, P., Biliński, K., Dańkowska, A., Dobrowolska, K., Flur, B., Gołdys, A., Gołoś, A., Kamiński, P., Ledzion, B., Mróz, A., Polańska, Z., Popis, Z., Skubida, A. (2021). Rybnik. A research report on the narratives of Rybnik's inhabitants. Transition City, Brussels. Available at: https://www.climate-kic.org/wp-content/uploads/2021/11/Rybnik-360-Deep-Demonstration_Full-Report_Deep-Listening-phase-of-the-project_Przemyslaw-Sadura-19.11.2021.pdf (last access: 19.11.2022)

TRANSFORMER Grant Agreement

TRANSFORMER Project Proposal

UBA – Umweltbundesamt (2018). Stickstoffoxid-Emissionen durch Binnenschiffe, https://www.umweltbundesamt.de/themen/stickstoffoxid-emissionen-durch-binnenschiffe (last access: 31.05.2023)

United Nations (2015). Paris Agreement, https://treaties.un.org/Pages/showDetails.aspx?objid=0800000280458f37&clang=_en (last access: 31.05.2023)

University of Western Macedonia and Municipality of Kozani (2013). Sustainable Energy Action Plan Kozani-SEAP. Kozani

Funded by the European Union