

**HORIZON EUROPE PROGRAMME - HORIZON-CL5-2023-D3-01-01**

*Renewable Energy Valleys to increase energy security while accelerating the green transition in Europe - Innovation action (IA)*

**REFORMERS**  
RENEWABLE ENERGY VALLEYS**REFORMERS****Regional Ecosystems FOR Multiple-Energy Resilient Systems**

Grant Agreement No. 101136211

Duration: 60 months | 1st November 2023 - 31st October 2028

**D7.1: RVS BASELINE REPORT**

---

**Funded by  
the European Union****Project funded by**Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

## DOCUMENT INFO

---

**Deliverable number** D7.1

**Deliverable title** RVs Baseline Report

**Work Package** WP7

**Deliverable type** Report

**Dissemination level** Public

**Due date** M24  
31/10/2025

**Pages** 68

**Document version** 3.0

**Lead author(s)** Alex Felice, Petros Iliadis

**Contributors** VUB, CERTH



**Funded by  
the European Union**

**Project funded by**



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

## DOCUMENT CHANGE HISTORY

| f                           | Date       | Author   | Description                                   |
|-----------------------------|------------|--|---|
| <b>DRAFT</b>                |            |  |   |
| 0.1                         | 18.03.2025 | Petros Iliadis (CERTH)                         | Structure, most of the contents               |
| 0.2                         | 03.09.2025 | Alex Felice (VUB)                              | Consolidation of input from RV templates      |
| <b>FIRST REVIEW</b>         |            |  |   |
| 1.0                         | 21.10.2025 | Philipp Heer (Empa),<br>Arno Peekel (TU Delft) | Proof reading and peer review                 |
| 1.1                         | 28.10.2025 | Alex Felice (VUB)                              | Consolidation of input from reviewers         |
| <b>COORDINATOR APPROVAL</b> |            |  |   |
| 2.0                         | 29.10.2025 | Thierry Coosemans (VUB)                        | Coordinator review                            |
| 2.1                         | 29.10.2025 | Stella Arapoglou (VUB)                         | Consolidated version for coordinator approval |
| <b>FINAL VERSION</b>        |            |  |   |
| 3.0                         | 29.10.2025 | Stella Arapoglou (VUB)                         | Format review, version ready for submission   |



## EXECUTIVE SUMMARY

---

The Replication Valleys (RVs) Baseline Report (Deliverable 7.1) establishes the starting point for all Replication Valleys in REFORMERS. Its purpose is to gather, structure, and assess the baseline data required for subsequent tasks on energy system design (T7.2), environmental assessment (T7.3), and governance and business models (T7.4). The data and information collection campaign was carried out using a common template, bilateral exchanges, and dedicated workshops with local stakeholders and Research and Technology Organisations (RTOs) of each RV. Information was compiled on context and demographics, current energy systems, transition policies, socio-economic conditions, data availability, and technologies of interest for replication.

The analysis shows a diverse picture. Some RVs already have a high share of renewables, while others remain strongly dependent on fossil-based heating and transport. District heating, geothermal, biomass and hydrogen emerge as recurring elements in their strategies, while energy communities and cooperatives are becoming increasingly relevant, although their maturity varies across valleys. Key barriers include financing large-scale projects, retrofitting inefficient building stock, grid and regulatory constraints, and ensuring broad citizen engagement. While significant information was collected, the level of detail varies strongly across valleys, with most lacking systematic, high-resolution consumption and production data. This report also maps where critical gaps remain, forming the basis for targeted follow-up campaigns.

At the same time, the report identifies technologies of interest for replication from the Flagship Valley in Alkmaar, such as district heating networks, geothermal systems, high-temperature thermal storage, peer-to-peer energy exchange, and energy storage solutions. These technologies are expected to play a central role in the upcoming scenario design and optimisation phases.

Deliverable 7.1 provides a comprehensive baseline overview of the seven RVs, highlighting strengths and challenges. This baseline marks the beginning of a dynamic and iterative data collection process. As bilateral exchanges and stakeholder engagement continue, the baseline will evolve to incorporate new insights, fill existing gaps, and better reflect the realities of each RV. This ongoing refinement is essential to ensure robust scenario design and policy evaluation in subsequent phases and will serve as the foundation for system design in T7.2, environmental performance evaluation in T7.3, and business model and governance assessment in T7.4.



## TABLE OF CONTENTS

---

### Contents

|  |           |
|--|-----------|
| <b>D7.1: RVS BASELINE REPORT .....</b>                       | <b>1</b>  |
| <b>DOCUMENT INFO .....</b>                                   | <b>2</b>  |
| <b>DOCUMENT CHANGE HISTORY.....</b>                          | <b>3</b>  |
| <b>EXECUTIVE SUMMARY.....</b>                                | <b>4</b>  |
| <b>TABLE OF CONTENTS.....</b>                                | <b>5</b>  |
| <b>LIST OF FIGURES.....</b>                                  | <b>8</b>  |
| <b>LIST OF TABLES .....</b>                                  | <b>8</b>  |
| <b>1. INTRODUCTION .....</b>                                 | <b>10</b> |
| 1.1. General .....   | 10        |
| 1.2. Scope and objectives of the Deliverable .....           | 10        |
| 1.3. Relations to other WPs and Tasks.....                   | 10        |
| <b>2. DATA COLLECTION METHODOLOGY .....</b>                  | <b>11</b> |
| 2.1. Approach.....   | 11        |
| 2.2. Data Collection Template.....                           | 12        |
| 2.3. Workshops and Bilateral Exchanges.....                  | 15        |
| 2.4. Overview of Data collected from RVs .....               | 15        |
| 2.5. Key Insights and summary analysis.....                  | 16        |
| <b>3. CURRENT STATUS.....</b>                                | <b>17</b> |
| 3.1. Data collected and current Status of DDS (RV#1) .....   | 18        |
| 3.1.1. Current Energy System .....                           | 18        |
| 3.1.2. Policies and Initiatives .....                        | 18        |
| 3.1.3. Socio-economic and Governance Aspects.....            | 18        |
| 3.1.4. Data Availability.....                                | 18        |
| 3.1.5. Challenges .....                                      | 20        |
| 3.1.6. PESTLE Analysis of DDS.....                           | 20        |
| 3.2. Data collected and current Status of Delft (RV#2) ..... | 21        |
| 3.2.1. Current Energy System .....                           | 21        |
| 3.2.2. Policies and Initiatives .....                        | 23        |
| 3.2.3. Socio-economic and Governance Aspects.....            | 23        |



|             |  |           |
|-------------|--|-----------|
| 3.2.4.      | Data Availability .....  | 23        |
| 3.2.5.      | Challenges .....   | 24        |
| 3.2.6.      | PESTLE Analysis of Delft .....   | 24        |
| <b>3.3.</b> | <b>Data collected and current Status of Murau (RV#3) .....</b>                                   | <b>25</b> |
| 3.3.1.      | Current Energy System .....  | 25        |
| 3.3.2.      | Policies and Initiatives .....   | 26        |
| 3.3.3.      | Socio-economic and Governance Aspects.....   | 27        |
| 3.3.4.      | Data Availability .....  | 28        |
| 3.3.5.      | Challenges .....   | 29        |
| <b>3.4.</b> | <b>Data collected and current Status of Konin (RV#4) .....</b>                                   | <b>31</b> |
| 3.4.1.      | Current Energy System .....  | 31        |
| 3.4.2.      | Policies and Initiatives .....   | 32        |
| 3.4.3.      | Socio-economic and Governance Aspects.....   | 32        |
| 3.4.4.      | Data Availability .....  | 33        |
| 3.4.5.      | Challenges .....   | 34        |
| 3.4.6.      | PESTLE Analysis of Konin .....   | 34        |
| <b>3.5.</b> | <b>Data collected and current Status of Western Macedonia (RV#5) .....</b>                       | <b>36</b> |
| 3.5.1.      | Current Energy System .....  | 36        |
| 3.5.2.      | Policies and Initiatives .....   | 37        |
| 3.5.3.      | Socio-economic and Governance Aspects.....   | 37        |
| 3.5.4.      | Data Availability .....  | 37        |
| 3.5.5.      | Challenges .....   | 37        |
| 3.5.6.      | PESTLE Analysis of Western Macedonia .....   | 37        |
| <b>3.6.</b> | <b>Data collected and current Status of Tolosaldea (RV#6) .....</b>                              | <b>39</b> |
| 3.6.1.      | Current Energy System .....  | 39        |
| 3.6.2.      | Policies and Initiatives .....   | 39        |
| 3.6.3.      | Socio-economic and Governance Aspects.....   | 39        |
| 3.6.4.      | Data Availability .....  | 39        |
| 3.6.5.      | Challenges .....   | 40        |
| 3.6.6.      | PESTLE Analysis of Tolosaldea.....   | 40        |
| <b>4.</b>   | <b>PLANNED FUTURE SCENARIOS .....</b>  | <b>41</b> |
| 4.1.        | List of Replicated Technologies and potential issues during Implementation -<br>DDS (RV#1) ..... | 45        |



|   |           |
|---|-----------|
| <b>4.2. List of Replicated Technologies and potential issues during Implementation - Delft (RV#2).....</b>              | <b>47</b> |
| <b>4.3. List of Replicated Technologies and potential issues during Implementation - Murau (RV#3).....</b>              | <b>48</b> |
| <b>4.4. List of Replicated Technologies and potential issues during Implementation - Konin (RV#4).....</b>              | <b>50</b> |
| <b>4.5. List of Replicated Technologies and potential issues during Implementation – Western Macedonia (RV#5) .....</b> | <b>52</b> |
| <b>4.6. List of Replicated Technologies and potential issues during Implementation – Tolosaldea (RV#6) .....</b>        | <b>54</b> |
| <b>5. CONCLUSIONS.....</b>  | <b>55</b> |
| <b>ANNEX A - SATELLITE VALLEY PRELIMINARY DATA COLLECTION TEMPLATE.....</b>   | <b>57</b> |



## LIST OF FIGURES

|  |    |
|--|----|
| Figure 1: RV preliminary data collection template.....   | 14 |
| Figure 2: District heating network connecting geothermal source to the residential buildings in the city of Delft..... | 22 |
| Figure 3: Sankey diagram of the energy flows of the Delft RV.....  | 23 |
| Figure 4: Supply energy plants in Murau (2024).....  | 26 |

## LIST OF TABLES

|   |    |
|---|----|
| Table 1: DDS/Verko 2024 Energy production data.....   | 19 |
| Table 2: DDS/Verko 2024 Energy specifications.....  | 19 |
| Table 3: PESTLE of DDS RV.....  | 20 |
| Table 4: PESTLE of Delft RV.....  | 24 |
| Table 5: Data availability of Murau RV.....   | 28 |
| Table 6: PESTLE of Murau RV.....  | 30 |
| Table 7: Zielona Energia Konin Energy Valley Overview.....                                  | 31 |
| Table 8: PESTLE of Konin RV.....  | 34 |
| Table 9: Primary energy consumption and CO <sub>2</sub> emissions for buildings (2020)..... | 36 |
| Table 10: PESTLE of Western Macedonia RV.....   | 37 |
| Table 11: PESTLE of Tolosaldea.....   | 40 |
| Table 12: Innovative technologies list of interest for the RVs.....                         | 41 |
| Table 13: Standard technologies list of interest for RVs.....                               | 45 |
| Table 14: Technologies of interest for DDS.....   | 45 |
| Table 15: Technologies of interest for Delft.....   | 47 |
| Table 16: Technologies of interest for Murau RV.....  | 48 |
| Table 17: technologies of interest for Konin.....   | 50 |
| Table 18: technologies of interest for Western Macedonia.....                               | 52 |



| Acronyms     |   |
|--------------|---|
| <b>CA</b>    | Consortium Agreement                      |
| <b>CHP</b>   | Combined Heat and Power                   |
| <b>DDS</b>   | Dendermonde-Site (Belgium)                |
| <b>DE</b>    | Iberdrola group (Distribution Operator)   |
| <b>EHBE</b>  | First Aid for Energy Communities          |
| <b>FV</b>    | Flagship Valley                           |
| <b>GDPR</b>  | General Data Protection Regulation        |
| <b>GTD</b>   | Geothermal Delft                          |
| <b>IA</b>    | Innovation Action                         |
| <b>II</b>    | Volume II                                 |
| <b>IT</b>    | Information Technology                    |
| <b>JRC</b>   | Joint Research Centre                     |
| <b>LEC</b>   | Local Energy Community                    |
| <b>LEKP</b>  | Local Energy and Climate Pact             |
| <b>MPEC</b>  | Municipal Thermal Energy Company in Konin |
| <b>MZGOK</b> | Municipal Waste Management Plant in Konin |
| <b>OT</b>    | Operational Technology                    |
| <b>PC</b>    | Project Coordinator                       |
| <b>PPC</b>   | Public Power Corporation                  |
| <b>PV</b>    | Photovoltaics                             |
| <b>RDF</b>   | Refuse-Derived Fuel                       |
| <b>RE</b>    | Renewable Energy                          |
| <b>REC</b>   | Renewable Energy Community                |
| <b>RES</b>   | Renewable Energy Sources                  |
| <b>REV</b>   | Renewable Energy Valley                   |
| <b>RV</b>    | Replication Valley                        |
| <b>TEAH</b>  | Technical Assistance Hub                  |
| <b>TGE</b>   | Polish Power Exchange                     |
| <b>VLES</b>  | Virtual Local Energy Systems              |
| <b>WP</b>    | Work Package                              |



# 1. INTRODUCTION

## 1.1. General

This deliverable presents the baseline assessment of the Replication Valleys (RVs) under Task 7.1. Its primary objective is to establish the status of each RV in terms of energy systems, transition strategies and socio-economic context. The baseline forms the foundation for subsequent activities in WP7, particularly energy system design (T7.2), environmental performance assessment (T7.3) and business model and governance analysis (T7.4). Task 7.1 has been carried out through a structured data and information collection campaign in collaboration with local stakeholders and Research and Technology Organisations (RTOs). A common template was developed to ensure comparability across valleys, focusing on context data, current energy consumption and production, transition policies and investments, socio-economic conditions, data availability, and interest in replicating innovative technologies from the Flagship Valley in Alkmaar. Complementary bilateral exchanges and workshops supported the process, helping to clarify regional priorities and data gaps. The REFORMERS Replication Valleys comprise DDS (Belgium), Delft (Netherlands), Murau (Austria), Konin (Poland), Western Macedonia (Greece), and Tolosaldea (Spain), all of which are examined in this assessment. Together, they reflect a wide diversity of contexts, ranging from former coal-dependent regions undergoing profound structural transitions to rural areas with high shares of renewable energy already in place. The outcomes of this deliverable provide a consistent baseline across all RVs, enabling the project to proceed with scenario design and comparative analysis. By aligning data collection and initial assessment, D7.1 ensures that the planning and evaluation of future energy systems will be grounded in the specific realities and opportunities of each valley.

## 1.2. Scope and objectives of the Deliverable

The objectives of this deliverable include:

- Assessing the current energy status in each replication valley.
- Collecting key data on RV's energy production, consumption patterns, stakeholder objectives, and policy frameworks.
- Identifying regulatory and technical barriers that influence the deployment of renewable energy solutions.
- Laying the groundwork for the tool developed under WP6, which will be used in Task 7.2, 7.3 and 7.4.

This deliverable ensures the planning and designing phases of future renewable energy systems within REVs are based on data-driven insights and evidence-based policy recommendations. The findings of this report will be utilized in shaping subsequent activities under Work Package 7 (WP7), particularly in the areas of energy system planning (T7.2), environmental impact assessment (T7.3), and regulatory adaptation (T7.4).

## 1.3. Relations to other WPs and Tasks

Task 7.1 and Deliverable 7.1 play a crucial role in integrating and supporting various work packages in the REFORMERS project. The focus of Task 7.1 is to launch a data collection campaign in the RVs to gather all required data from an energy system perspective. This data encompasses important information regarding energy consumption and production, insights



into deployment and transition plans, involved stakeholders and their objectives. Based on the data collection and status assessment results, it will be ensured that all six RVs follow the best practices and strategies demonstrated in the Flagship Valley (FV). Deliverable 7.1 (D7.1) serves as the key outcome of this task, documenting the findings, methodologies, and analysis of the Replication Valleys' transition towards renewable energy.

Relationship with WP3 and WP4:

- WP3 focuses on the design and planning of the Flagship Valley (FV) in Alkmaar, where innovative renewable energy solutions are tested
- WP4 handles the implementation and demonstration of these energy solutions
- T7.1 takes advantage of the knowledge generated from WP3 and WP4 to inspire RVs, ensuring that similar strategies are adapted and optimized for different geographical, economic, and regulatory contexts.

Relationship with WP6:

- The toolbox developed in WP6 (T6.1, T6.2, T6.3 and T6.4) will be extensively used for the analysis of each RV energy transition plan. All information and data that feed the various tools, from technical to socio-economic ones, should be documented in this report

Relationship with WP7:

- Task 7.1 is the first step in WP7, establishing the baseline conditions, existing energy systems, and potential future scenarios for each Replication Valley
- D7.1 documents the findings from this task, ensuring that future WP7 tasks (such as D7.2 on environmental impact, D7.3 on policy, and D7.4 on social engagement) are based on accurate and comprehensive data

Relationship with WP8:

- WP8 handles scaling up and sharing knowledge from the REFORMERS project to broader European regions
- The insights from Task 7.1 and D7.1 contribute to WP8 by providing replicable models, case studies, and technical lessons that can be shared with other cities and regions looking to transition to renewable energy

## 2. DATA COLLECTION METHODOLOGY

The baseline assessment of the Replication Valleys was developed through a structured and collaborative data and information collection campaign, designed to capture both qualitative and quantitative information. The methodology ensured consistency across the different RVs while remaining flexible to account for local specificities and data availability.

### 2.1. Approach

Data collection was carried out in close cooperation with local stakeholders and RTOs. The process combined three main methods:



Funded by  
the European Union

Project funded by



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

- The use of a common preliminary data collection template
- A series of workshops and bilateral exchanges with local partners
- The integration of existing reports, statistics and planning documents provided by municipalities, utilities and regional stakeholders

This mixed-methods approach allowed for the collection of technical, socio-economic and governance-related information, while also enabling stakeholders to highlight context-specific challenges and opportunities.

## 2.2. Data Collection Template

The RV Preliminary Data Collection Template was designed to standardise and streamline the collection of key data from each RV participating in the REFORMERS project. It serves as a comprehensive framework for understanding the current energy landscape, technological deployment, policy environment, and socio-economic context of each valley.

The document consists of multiple sections that guide replication valleys through the data submission process (see ANNEX A). Each participating valley is required to provide detailed insights into their energy profile, technological assets, and ongoing transition efforts. The main sections of the template, as also seen in Figure 1, include:

1. **Energy System Context** - This section captures high-level information about the valley, including a short description, the current energy mix, and an overview of energy demand in different sectors such as buildings, industry, and transportation. Key facts about the valley's infrastructure, including power plants, heating systems, and energy storage solutions, are documented.
2. **Energy Transition Policies and Investments** - The template collects information about ongoing and planned investments in renewable energy infrastructure, district heating, industrial energy use, and smart agriculture. It also tracks funding opportunities and the status of local energy communities, whether Local Energy Communities (LEC) or Renewable Energy Communities (REC).
3. **Main Objectives and Challenges** - The replication valleys are asked to outline their key objectives for decarbonization and the primary challenges they face, including technical, regulatory, and financial barriers. The expected impact-both positive and negative-of transition strategies is also addressed.
4. **Energy Monitoring and Data Availability** - This section assesses whether real-time or historical energy consumption and production data is available. It also includes an evaluation of regional energy pricing structures and contractual frameworks that influence energy costs.
5. **Socio-Economic Data** - Beyond technical data, the template requests insights into local socio-economic conditions, including employment levels, welfare statistics, community engagement initiatives, and environmental indicators. This information is essential for understanding the broader impact of energy transition efforts on society.
6. **Innovative Technologies for Replication** - One of the most important aspects of the template is the section on innovative technologies. Replication valleys are invited to



express their interest in specific energy innovations demonstrated in the Flagship Valley of Alkmaar. These technologies include advanced hydrogen production systems, energy storage solutions, peer-to-peer energy trading, and district heating networks.

7. Short Description of Replicated Technologies - For each technology selected for replication, valleys must provide details about its planned size, location, intended users, operational objectives, and expected value streams (e.g., electricity, heating, cooling). This ensures a clear strategy for technology transfer and implementation.



**Funded by  
the European Union**

**Project funded by**



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
**State Secretariat for Education,  
Research and Innovation SERI**



REFORMERS

Satellite Valley Preliminary Data

## SATELLITE VALLEY PRELIMINARY DATA COLLECTION

### 1.1. How to fill-in the document

Each REFORMERS' Satellite Valley should fill in the document by following the *guiding instructions and questions provided in blue text*. Tables and columns where your input is required are marked with the

yellow background

Refer to Annexes for more information.

### 1.2. Context data

In the following Table 1 general data related with the Satellite Valley is collected through guiding questions.

Table 1 - Satellite Valley context data

| CONTEXT DATA  |
|---|
| <b>Energy Valley #: Short Description</b>   |
|   |
| <b>Energy Valley # current energy mixture profile and level of smartness</b>  |
| <p><i>Building sector: some key facts about the type of buildings, number of buildings it has and key numbers for their consumption (electricity, heat, fuel) on an annual basis.</i></p> <p><i>Industrial Sector: some key facts about the type of industries/commercial activities in the area and key facts about their electricity, heat and fuel needs on an annual basis. If there is an industrial park within the area, please elaborate more (emphasis on synergies if any)</i></p> <p><i>Electricity/Heating/Cooling: a list and key facts of technologies/power plants present on-site (fossil and renewable energy sources) existing/feeding this area and of the current energy mixture for electricity/heating/cooling. Include also available storage systems (i.e., electrical, heating/cooling, H2)</i></p> <p><i>Transportation sector: some key facts related to transportation needs, number of vehicles in circulation, green vehicles, EV chargers available etc.</i></p> |
| <b>Energy Valley # Energy Transition related policies - Investing and Funding in Energy Valley #</b>  |
| <p><i>Key information about on-going local investments and key targets of the local decarbonization roadmap.</i></p> <p><i>Clean Energy:</i></p>  |

Figure 1: RV preliminary data collection template

The structured approach to data collection in this template is critical for ensuring consistency and comparability across different replication valleys. By gathering uniform data points, the REFORMERS project can effectively evaluate the feasibility and impact of different renewable energy solutions. Impact refers to each RV KPIs, which include indicators such as reduction in



Funded by  
the European Union

Project funded by



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

Swiss Confederation

CO<sub>2</sub> emissions, increase in Renewable Energy Sources (RES) share and socio-economic indicators such as energy poverty reduction and job creation.

One of the fundamental challenges in large-scale energy transitions is the variability in local conditions. Each replication valley operates under unique regulatory frameworks, economic conditions, and technical constraints. The use of a standardized template allows for systematic comparison and identification of best practices that can be adapted across different regions.

### 2.3. Workshops and Bilateral Exchanges

To complement the templates, dedicated stakeholder workshops were organised in Murau, Western Macedonia, DDS, Delft and Konin. These sessions enabled local actors to present ongoing projects, identify missing data, and discuss barriers to the energy transition. Additional bilateral meetings were held with Tolosaldea, DDS, Murau and Western Macedonia to clarify specific aspects and to align the scope of their data submissions.

### 2.4. Overview of Data collected from RVs

A key aspect of the data collection process was evaluating the energy consumption and production capacity of industrial facilities across different valleys. Each valley provided information on major industrial consumers, their annual energy usage, and existing or planned renewable energy projects when available. The findings revealed significant variations in the energy mix between regions. While some valleys have made substantial progress in deploying solar, wind, and biomass energy, others remain heavily dependent on natural gas and fossil fuels. Many valleys are actively working to increase their share of renewables and reduce reliance on imported energy sources.

In parallel, public buildings and municipal facilities were assessed for their role in the energy transition. Several valleys reported the installation of solar panels and combined heat and power (CHP) systems on government buildings, along with efforts to monitor and optimize municipal energy consumption. However, a common challenge is the lack of a centralized platform to track real-time energy usage, which hinders energy efficiency improvements.

Existing renewable energy infrastructure was documented, including solar photovoltaic (PV) systems, wind farms, biogas facilities, and battery storage solutions. Additionally, several valleys are conducting feasibility studies on implementing district heating networks and hydrogen storage solutions to further enhance energy resilience.

Energy storage remains a critical challenge across multiple valleys. Some regions are exploring alternative solutions such as hydrogen storage and thermal heat buffering to complement or replace traditional battery systems. Many valleys also expressed interest in decentralized energy storage, such as residential and neighbourhood battery solutions, which would enhance self-consumption of locally produced renewable energy and improve grid stability.

The data collection process also captured information on policy frameworks, government incentives, and investment plans supporting the transition to renewable energy. Some replication valleys benefit from strong policy backing, including feed-in tariffs, tax incentives, and renewable energy grants. Others, however, face regulatory barriers that slow the adoption of energy-sharing models and local energy communities (LECs). One notable example is the



Local Energy and Climate Pact (LEKP) in Flanders, which sets ambitious targets for expanding solar PV installations, district heating networks, and energy-sharing initiatives. Valleys participating in this initiative benefit from government-backed funding mechanisms and technical assistance programs.

Each valley also provided details on its public and private investment strategies, highlighting key mechanisms such as public-private partnerships, community energy cooperatives, and green financing initiatives. Many valleys emphasized the need for additional financial support to scale up energy storage solutions and modernize grid infrastructure.

A key objective of the data collection was to assess each valley's interest in replicating innovative energy technologies demonstrated in the Flagship Valley in Alkmaar. The following technologies were identified as particularly relevant for scaling across the replication valleys (see Section 3 for more details):

- **Hydrogen production from organic waste (Hynoca Technology):** Converts biogenic waste into clean hydrogen for use in fuel cells, heating, and industrial applications.
- **Thermochemical conversion of biomass:** Produces biogas, syngas, and biomethane as alternative energy carriers.
- **Hybrid battery electrolyzers:** Combine water treatment with energy buffering for efficient hydrogen storage and electricity balancing.
- **District heating networks:** Utilize waste heat from industrial processes to provide heating for residential and commercial buildings.
- **Peer-to-peer energy trading platforms:** Facilitate decentralized energy exchange between households, businesses, and local energy cooperatives.
- **Heat buffers and seasonal thermal energy storage:** Enable renewable heating networks to store and utilize excess heat.

Several valleys expressed strong interest in these technologies, particularly district heating networks and peer-to-peer energy trading, as they align with long-term decarbonization goals and energy self-sufficiency strategies.

## 2.5. Key Insights and summary analysis

The collected data reveals a diverse landscape across replication valleys. While some regions have advanced renewable deployment and strong policy support, others remain constrained by fossil fuel dependency and regulatory barriers. Common insights include:

- **Energy Mix Variability:** Renewable penetration ranges from near-autonomous regions to valleys still dominated by natural gas and heating oil
- **Infrastructure gaps:** Lack of centralised energy monitoring platforms and limited grid flexibility hinder optimisation and integration of renewables



- **Emerging trends:** District heating, energy communities and storage solutions are recurring priorities, with growing interest in sector coupling and digitalisation
- **Barriers to implementation:**
  - **Regulatory:** Some regions have restrictive energy-sharing regulations or face grid operator constraints that limit renewable energy injections.
  - **Financial:** High upfront investment costs remain a significant hurdle, particularly for hydrogen storage, district heating, and advanced energy management systems.
  - **Technical:** Grid congestion, lack of real-time energy monitoring, and insufficient energy storage capacity pose difficulties in increasing renewable energy penetration.
  - **Public:** Some valleys reported resistance to projects requiring land-use changes or infrastructure modifications, which could slow implementation efforts.

These insights underline the need for targeted support in financing, regulatory adaptation, and stakeholder engagement. They also highlight opportunities for cross-valley learning, such as leveraging strong community engagement models from regions like Tolosaldea to accelerate adoption elsewhere. The combination of templates, workshops and bilateral exchanges provides a comprehensive picture of the current situation in each Replication Valley. While some gaps remain, the data collected form a coherent baseline for analysis. The following chapter presents the results per valley, outlining their status and planned future scenarios based on the information gathered through this methodology.

### 3. CURRENT STATUS

This chapter presents the results of the baseline assessment for each Replication Valley. The analysis combines the information collected through the common data template, workshops and bilateral discussions with local stakeholders. It outlines both the current energy system and socio-economic context of each valley and the main elements of their planned transition pathways. The Replication Valleys included in this report are DDS (Belgium), Delft (Netherlands), Murau (Austria), Konin (Poland), Western Macedonia (Greece) and Tolosaldea (Spain). Together they reflect a broad diversity of contexts: from coal-dependent regions facing structural transition to rural areas with high renewable penetration and from urban settings with dense housing to dispersed territories with limited grid capacity. A detailed presentation of the collected data for each RV is provided in the following section, containing a summary table with information on every replicated technology that will be applied in each RV together with foreseen issues (collected directly by RV representatives) and finally followed by a PESTLE analysis in order to highlight key political (P), economic (E), social (S), technological (T), legal (L) and environmental (E) factors that can have a hindering impact in renewable energy valley creation. The mitigation activities listed in the PESTLE analysis are indicative and based on general best practices. Responsible actors were not specified by RV stakeholders during data collection, which suggests these steps are currently conceptual rather than assigned to specific entities. This will be refined in later stages when governance models are developed. These



individual analyses form the foundation for the cross-valley comparison in Chapter 6 and will directly inform the scenario design and optimisation work under Task 7.2.

### 3.1. Data collected and current Status of DDS (RV#1)

The DDS region, located in East Flanders (Belgium), comprises eight municipalities with around 181000 inhabitants and approximately 40000 addresses. The area combines urban and rural characteristics, with a local economy driven by industry, a growing tertiary sector and agriculture.

#### 3.1.1. Current Energy System

The industrial sector is central to the valley's energy profile. At the DDS site (Eegene North), annual electricity production reaches 8721 MWh from PV and CHP installations, while biogas production fuels 26 CNG waste collection trucks. Europlay contributes with PV and two small windturbines, and VPK Packaging remains a major industrial consumer and producer, developing biomass-based combustion facilities. The "Warm Dendermonde" project illustrates the potential of industrial heat recovery for a district heating network. On the residential side, about 25% of households are equipped with PV systems. Average household electricity consumption is 3500 kWh per year and gas consumption around 17000 kWh. Several public buildings, including care centres and the local prison, are already equipped with PV and live energy monitoring systems. The transport sector is gradually decarbonising. Alongside the CNG-fuelled municipal waste fleet, two electric shared cars and a limited number of public charging stations are already in use, with plans for further expansion.

#### 3.1.2. Policies and Initiatives

DDS municipalities are signatories of the Covenant of Mayors, committing to a 40% reduction in greenhouse gas emissions by 2030. Key investments include the expansion of PV, industrial thermal recovery projects, digitisation of energy flows, and the creation of energy communities.

#### 3.1.3. Socio-economic and Governance Aspects

The region is engaged in multiple social and governance initiatives. The Local Energy and Climate Pact (LEKP) promote greening, mobility improvements and efficiency. The Technical Assistance Hub (TEAH) supports energy communities, while the First Aid for Energy Communities (EHBE) provides legal and technical guidance. Social housing programmes and employment initiatives complement these actions, reinforcing the integration of energy transition into wider socio-economic development.

#### 3.1.4. Data Availability

Several monitoring systems are already in place for public and industrial sites, but there is no centralised platform yet. Most data remain historical or aggregated, which limits optimisation and cross-sector integration.

Because of the currently available data, the first focus will be on the **DDS-VERKO site**, being the centre of the replication valley (see Table 1 and Table 2).



Secondly, the gathering of data from **households and public patrimony buildings** through the TEAH/EHBE programmes mentioned above in 3.1.3 has started. In this stage the available data still needs to be analysed and structured into useful input. In addition, according to the European Energy Efficiency Guideline, the Flemish Energy Company (VEB) launched the TERRA platform to gather energy consumption data from all the public patrimony buildings in Flanders. This will result in the availability of open data, contributing to potential business models for the replication valleys.

In the next phase data is gathered from **private companies**, such as VPK and Europlay. Non-disclosure agreements still need to be closed for this data transfer.

Table 1: DDS/Verko 2024 Energy production data

| ENERGY TYPE                        | PRODUCTION   | DESCRIPTION                   |
|------------------------------------|--|-------------------------------|
| <b>BIOGAS PRODUCTION DIGESTER</b>  | 2514880 Nm <sup>3</sup> of biogas (ca.60 % CH <sub>4</sub> )   | From organic waste seasonal   |
| <b>BIOMETHANE</b>                  | 1493 MWh (97% CH <sub>4</sub> ) injection Fluvius  |                               |
| <b>CHP</b>                         | 2359617 Nm <sup>3</sup> biogas <sup>1</sup> (ca.60% CH <sub>4</sub> ) converted into<br>5421 MWh electricity + 2885 MWh heat |                               |
| <b>WASTE HEAT RECOVERY</b>         | 412 MWh (digester)<br>2473 MWh (tunnel composting)   |                               |
| <b>PV INSTALLATION</b>             | 3300 MWh   | Optimization planned for 2032 |
| <b>CNG WASTE COLLECTION TRUCKS</b> | 3533 MWh   |                               |
| <b>GAS OIL</b>                     | 171366 litres wheel loaders<br>Circa 20000 litres Heating social building (boiler room)                                      |                               |
| <b>DIESEL</b>                      | 71691 litres diesel waste collection trucks  |                               |

Table 2: DDS/Verko 2024 Energy specifications

| ENERGY TYPE               | PRODUCTION (MWH/YEAR) | CONSUMPTION (MWH/YEAR) |
|---------------------------|-----------------------|------------------------|
| <b>ELECTRICITY (SITE)</b> |                       | 594                    |
| <b>ELECTRICITY (CHP)</b>  | 5421                  | -                      |

<sup>1</sup> 94% of biogas production



|   |       |             |
|---|-------|-------------|
| <b>ELECTRICITY (PV)</b>                         | 3300  | -           |
| <b>HEAT (CHP)</b>                               | 2885  | -           |
| <b>HEAT (REUSE)<br/>DIGESTER<br/>COMPOSTING</b> | -     | 412<br>2473 |
| <b>GAS</b>                                      | -     | 60          |
| <b>BIOMETHANE (CA.60 % CH<sub>4</sub>)</b>      | 1493  | -           |
| <b>BIOMETHANE (97 % CH<sub>4</sub>)</b>         | 2515  | -           |
| <b>CNG WASTE COLLECTION TRUCKS</b>              | -     | 3533        |
| <b>TOTAL</b>                                    | 12644 | 7072        |

### 3.1.5. Challenges

The main challenge for DDS is the limited availability of integrated energy data. While some public and industrial buildings already provide live monitoring, most information is still aggregated or historical, and there is no central platform to optimise local energy flows. In addition, industrial synergies remain under-exploited due to legislative constraints, and the expansion of EV charging infrastructure is progressing slowly. These gaps complicate the planning of coordinated renewable energy scenarios. As mentioned in 3.1.4 also the non-disclosure agreements for data transfer are essential for participation with private companies.

### 3.1.6. PESTLE Analysis of DDS

Table 3: PESTLE of DDS RV

| Barriers |  | Mitigation   |
|----------|--|--|
| <b>P</b> | Legislative constraints limit industrial energy synergies, affecting the optimization of energy flows between businesses. Coordination between municipalities on energy policy implementation remains complex. | Advocate for regulatory reforms to enable industrial energy-sharing. Strengthen inter-municipal governance structures to align policies and enhance collaboration.                                       |
| <b>E</b> | High upfront costs for expanding PV infrastructure, thermal recovery projects, and district heating systems. Variability in energy pricing contracts impacts consumer affordability and participation.         | Secure funding through EU grants, public-private partnerships, and green investment initiatives. Introduce financial incentives and subsidies for energy efficiency projects to encourage participation. |



|          |   |   |
|----------|---|---|
| <b>S</b> | Limited community engagement in energy-sharing initiatives. Social housing and vulnerable populations may struggle to afford energy efficiency improvements.  | Expand public outreach campaigns to increase participation in energy communities. Provide financial support and tailored programs for social housing and vulnerable consumers.  |
| <b>T</b> | Challenges in integrating real-time energy monitoring and digitalization of energy flows across multiple sectors. Limited EV charging infrastructure expansion.<br><br>The current electricity grid infrastructure and capacity is not yet adapted to the increasing production, consumption and buffering of energy. | Accelerate the deployment of smart grid technologies and energy management platforms. Expand EV charging networks and develop digital solutions for optimizing energy distribution.<br><br>Stakeholder dialogue with Fluvius and ELIA. Investigate the development of off-grid, second-grid or on-site solutions. |
| <b>L</b> | Complex permitting processes for renewable energy projects. Unclear legal frameworks for energy-sharing communities create uncertainty for stakeholders.  | Advocate for streamlined permitting regulations and standardized legal frameworks for energy communities. Provide legal guidance and support through initiatives like EHBE.   |
| <b>E</b> | Industrial emissions from biomass combustion raise concerns about air quality. Land-use conflicts may arise with expanding renewable energy infrastructure.   | Implement stricter emission controls and air quality monitoring for biomass projects. Use strategic land-use planning to balance industrial, residential, and renewable energy developments.  |

### 3.2. Data collected and current Status of Delft (RV#2)

Delft is a densely populated city in South Holland with around 106000 inhabitants. It has a long history of scientific innovation and industrial activity, and today sustainability is a central theme for the municipality and local institutions such as TU Delft. The city is planning for strong growth, with an additional 15000 homes expected by 2040.

#### 3.2.1. Current Energy System

The Replication Valley in Delft is focused on TU Delft Campus area, the industrial area Schieoovers, the business park Delftechpark and the residential area Voorhof-East (in total approx. 2.5 km<sup>2</sup>). These areas are all spatially connected and provide different energy profiles and transition pathways.

The city's and RV's energy demand is still largely based on natural gas. Total heat demand is approximately 768889 MWh per year, two-thirds of which comes from residential buildings. In 2019, Delft consumed 72.8 million m<sup>3</sup> of natural gas, resulting in more than 144 kt CO<sub>2</sub> emissions annually. TU Delft is leading the transition with the Geothermal Delft (GTD) project,



which will produce around 83333 MWh of heat per year at 70°C for the campus and surrounding districts like Voorhof-Oost. A High-Temperature Aquifer Thermal Energy Storage (HT-ATES) system is being developed to complement this by storing excess heat and ensuring flexibility. Together, these initiatives are expected to reduce emissions from heating by over 60%. District heating expansion is central to Delft’s strategy (Figure 2). Initial connections will include social rental housing, followed by a broader rollout in residential and commercial areas. In parallel, TU Delft is increasing PV deployment (targeting around 5 GWh per year) and supporting wind energy development at regional scale. In transport, fossil fuels still dominate, though efforts are underway to increase the share of EVs, electric buses and trams.

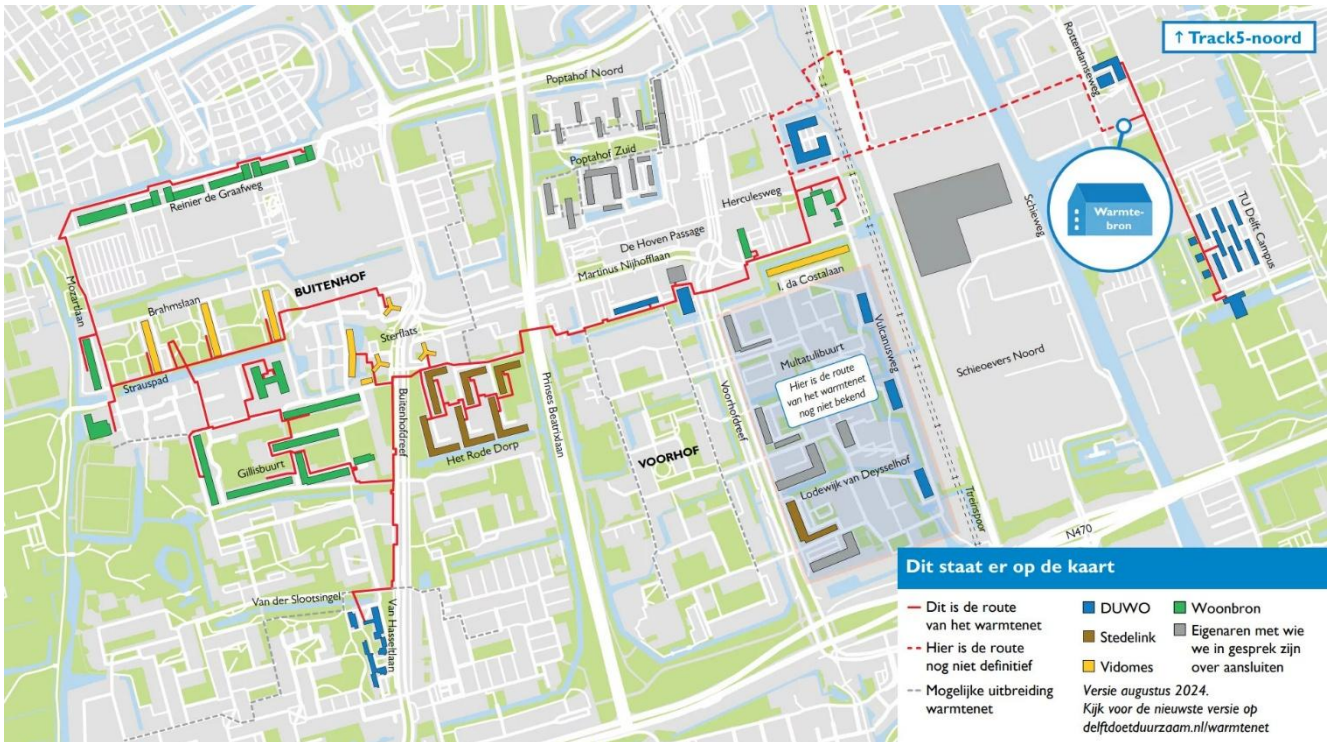


Figure 2: District heating network connecting geothermal source to the residential buildings in the city of Delft

Energy balance for TU Delft Campus is represented in a Sankey diagram in Figure 3, depicting the numbers for natural gas usage, sustainable wind energy (procured) and solar energy produced locally. The diagram also depicts the conversion to heat and electricity by the combined heat power plant and individual boilers in faculty buildings.

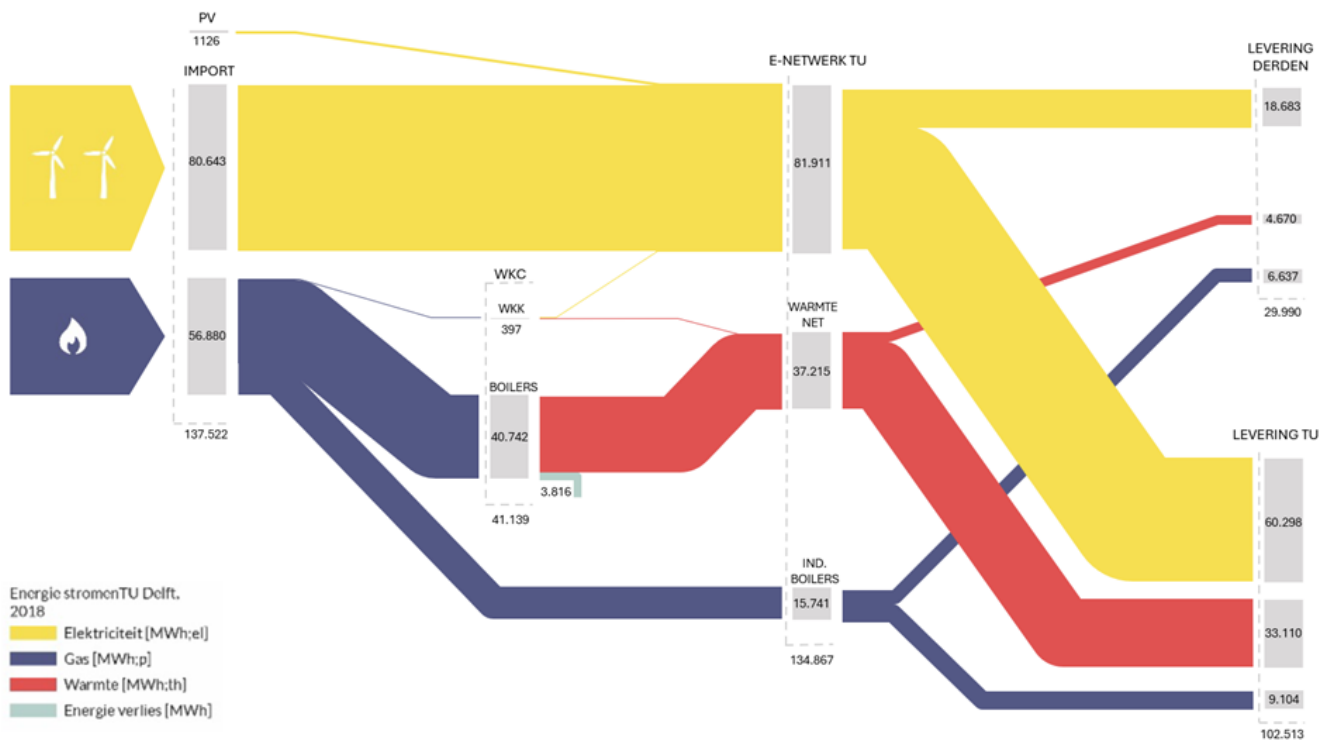


Figure 3: Sankey diagram of the energy flows of the Delft RV

### 3.2.2. Policies and Initiatives

The municipality has committed to becoming fossil-free by 2050, while TU Delft aims for climate neutrality, circularity and climate-adaptiveness by 2030. Major investments focus on geothermal heat, district heating, PV and digitalisation. The innovative “Multi-Smart Commodity Grid” integrates electricity, heat, hydrogen and energy storage into a zero-emission energy system, supported by a Digital Twin developed on campus.

### 3.2.3. Socio-economic and Governance Aspects

Delft benefits from a strong research ecosystem anchored by TU Delft, which acts as both an energy user and innovation driver. Local energy cooperatives are already active and expected to expand as the transition progresses. Challenges remain in mobilising tenant participation for building renovations, since Dutch law requires 70% approval.

### 3.2.4. Data Availability

Detailed data are available for gas consumption and emissions at municipal level, while campus projects provide high-resolution monitoring and modelling. However, large-scale integration of data into a centralised energy management platform is still under development.

Data underlying the Sankey diagram (Figure 3) is available in a monitoring system of TU Delft. Data of the Delftechpark and Schieoevers is currently being gathered as part of a feasibility study for energy hubs but is not disclosed yet in a central data platform. Voorhof-East comprises of mainly social housing dwellings of which data is not readily available because of GDPR compliance issues. The municipality of Delft has gathered aggregated data for this

district, since this district will be one of the first districts to transition from natural gas to district heating network. These data are not disclosed yet in a central data platform.

### 3.2.5. Challenges

For Delft, data availability is also a key issue. While TU Delft campus projects generate detailed monitoring data, citywide information on energy consumption and building performance is fragmented. The lack of a unified energy management platform limits the optimisation of district heating and smart grid initiatives. Socio-economic challenges include mobilising sufficient tenant support for building retrofits and securing stable funding for large-scale infrastructure, which may delay the transition timeline.

### 3.2.6. PESTLE Analysis of Delft

Table 4: PESTLE of Delft RV

| Barriers |   | Mitigation   |
|----------|---|--|
| <b>P</b> | Reduced government funding for research and sustainable energy projects impacts the ability to implement large-scale infrastructure. Delays in regulatory approvals for DH expansion.                   | Advocate for increased public and private investment in sustainable energy projects. Work with policymakers to streamline regulatory approvals and integrate energy transition goals into national strategies.     |
| <b>E</b> | High costs for retrofitting buildings and integrating geothermal heating into the district network. Financial constraints for small businesses and residents in adopting renewable energy technologies. | Secure alternative funding sources, including EU grants, regional investments, and private sector partnerships. Provide financial incentives and subsidies for building retrofits and renewable energy adoption.   |
| <b>S</b> | Public resistance to housing renovations due to required tenant approval (70%). Limited public awareness about the benefits of energy transition projects.  | Conduct awareness campaigns and community engagement programs to increase participation. Offer incentives for housing renovations and streamline tenant approval processes.  |
| <b>T</b> | Delays in implementing DH infrastructure and connecting buildings to geothermal sources. Integration of multiple energy sources into a unified smart grid requires advanced digital solutions.          | Accelerate infrastructure development by collaborating with local energy providers. Expand the use of Digital Twin technology for optimizing energy management. Invest in smart grid and energy storage solutions. |
| <b>L</b> | Complex legal frameworks surrounding tenant rights make it  | Advocate for policy adjustments to facilitate energy-efficient renovations. Work with  |



|          |   |  |
|----------|---|--|
|          | difficult to renovate residential buildings. Regulations on energy pricing impact the feasibility of dynamic pricing models.                        | regulators to develop stable pricing mechanisms that support demand-response models.   |
| <b>E</b> | High carbon footprint from natural gas dependency. Challenges in balancing urban development with the expansion of renewable energy infrastructure. | Expand renewable energy projects, including geothermal, solar, and wind. Integrate green urban planning to ensure sustainable energy infrastructure development. |

### 3.3. Data collected and current Status of Murau (RV#3)

Murau is a predominantly rural district located in Styria, Austria, encompassing 14 municipalities over an area of 1,384 km<sup>2</sup> and hosting a population of approximately 27,000 inhabitants. The district has been experiencing persistent population decline due to out-migration trends that have continued for several decades.

The landscape of Murau is characterized by extensive forest coverage (57.3%) and a strong agricultural base, with forestry constituting a central pillar of the local economy. The economic structure is dominated by small and medium-sized enterprises (SMEs), particularly within the trade and manufacturing sectors.

Murau’s engagement with renewable energy development dates to the early 2000s, when the district formulated its first comprehensive energy strategy, the “Murauer Energievision” (*Energy Vision Murau*). Since then, Murau has actively pursued a sustainable energy transition, positioning itself as a model region for energy autonomy. The RV’s long-term objective is to achieve complete decarbonisation by 2040, followed by the establishment of a net positive energy balance, enabling energy exports beyond that horizon.

#### 3.3.1. Current Energy System

Murau’s annual electricity demand is approximately 128 GWh, while local generation already surpasses 507 GWh (see **Error! Reference source not found.**). The electricity production is primarily dominated by hydropower (366 GWh), supplemented by wind power (75 GWh) and PV generation (43 GWh). The additional renewable potential remains considerable, particularly for PV (estimated at 200–250 GWh) and wind energy (around 170 GWh). Figure 4 presents a map of the main energy assets in the area, along with their capacity and annual energy production.



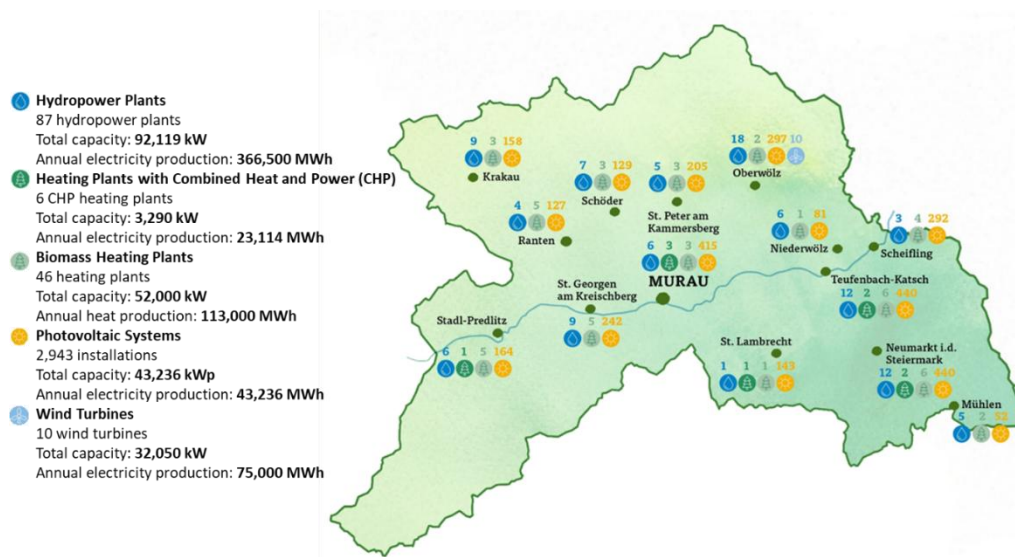


Figure 4: Supply energy plants in Murau (2024)

The annual heat demand amounts to roughly 400 GWh, predominantly for space heating purposes. The current heat supply mix consists of approximately 75% biomass, 20% heating oil, and 5% heat pumps. The district heating infrastructure is mainly supplied by biomass boilers (52 MWth) and a biomass combined heat and power (CHP) plant (3.2 MWe).

Planned interventions include the thermal renovation of buildings, aimed at reducing heat demand by around 7.5%, an expansion of biomass utilization, and a threefold increase in heat pump capacity, targeting a total contribution of approximately 50 GWh.

In contrast, the transport sector remains heavily dependent on fossil fuels, with approximately 22000 petrol and diesel vehicles, compared to only 75 electric and 200 hybrid vehicles. Consequently, Murau continues to import approximately 180 GWh of energy annually to meet its overall demand.

### 3.3.2. Policies and Initiatives

Murau's energy vision originated in the early 2000s, initially emphasizing regional independence in heat and electricity generation through the utilization of renewable energy sources. Over time, this vision has evolved into a comprehensive strategic framework structured around five principal axes:

1. **Murau as a European Energy Beacon:** The district aspires to serve as a model region demonstrating innovative and replicable approaches to sustainable energy transitions across Europe.
2. **100% Renewable Energy Supply:** Murau aims to produce all its electricity, heat, and mobility energy from renewable sources, ensuring full substitution of fossil-based systems.
3. **Needs-Based Renewable Energy Availability:** The renewable energy supply is designed to be **fully demand-responsive**, guaranteeing **continuous availability** on a **24/7, year-round basis (365 days)**.

4. **Regional Innovation Laboratory:** Murau functions as a “living laboratory” for partners, businesses, and research institutions, fostering the development, testing, and implementation of innovative renewable energy solutions that generate added value within the regional economy and value chains.
5. **Environmental and Climate Resilience:** The region is committed to protecting biodiversity, ecosystems, and natural habitats, while adapting local infrastructure to the impacts of climate change.

Since 2010, the association Holzwelt Murau has established itself as a key regional actor in the implementation of energy and sustainability projects at both the local and district levels. Building on this foundation, Holzwelt Murau applied to the national funding programme “Climate and Energy Model Regions” (Klimaund Energiemodellregionen, KEM). By attaining KEM status, the association gained the institutional framework and financial support necessary to implement measures co-developed with municipalities and diverse regional stakeholders, thereby reinforcing Murau’s role as a pioneer in community-driven energy transition.

In 2024, Holzwelt Murau applied to the national funding programme “Reallabore Österreich” (*Real Labs Austria*), with the objective of advancing regional innovation in the renewable energy sector. Within this framework, InnoLab Murau was established as a dedicated innovation hub aimed at fostering research, experimentation, and collaboration in the field of renewable energy technologies and systemic energy transition.

Concurrently, the formation of Renewable Energy Communities (RECs), coordinated by Murauer GreenPower, is in progress. The first REC is scheduled to become operational by 2025, marking a significant step toward decentralized, participatory, and community-based energy governance within the district.

### 3.3.3. Socio-economic and Governance Aspects

Murau is characterised by a small but well-connected community, with local businesses and associations closely involved in the energy transition. More than €200 million of investment is planned by 2030, aiming to reduce fossil imports by 40% and create local value through renewable energy.

**Socio-economic aspects:** Due to low population density, networking is very essential in Murau. As already mentioned, economy is dominated by small and medium-sized businesses, which leads to close cross-sectional networks between businesses, organizations/institutions and associations. Early pioneers implemented the idea to become more independent from fossil energy and forcing the energy transition in the early 2000s (see above). This idea was broadly accepted and spread quickly in the population – probably because a lot of people in the region knew those pioneers personally and were very trusting due to the personal closeness (also because the energy transition was suddenly linked to regionally well-known people). Persons involved noticed, that participation is the key for the successful transformation in the field of renewable energy.

Another important factor for successfully implementing renewable energy transition are **governance aspects:** Based on the regional development association Holzwelt Murau, the region started to engage in the national program “climate and energy model regions” (short: KEM). Holzwelt Murau is highly involved in measurements for the transition of the energy



system. Holzwelt Murau acts as: network, Think Tank, strategy and project developer, regional development agency, innovation incubator and sometimes also as project sponsor. The local strategy is always embedded at several levels: regional, national and within the SDGs by the EU. This multi-level governance model linked to the bottom-up-approach already proved a high success rate, especially for the renewable energy transition.

### 3.3.4. Data Availability

Table 5 shows the data Availability for the Energy Sector in Murau. In Murau, comprehensive datasets are available for electricity consumption covering the period 2018–2024, supplemented by estimations of heat demand and fuel consumption. These datasets are further enriched with technical information, including high-resolution (hourly) energy demand and generation profiles, as well as techno-economic parameters characterizing various energy technologies.

Regarding the transport sector, statistical data on fuel types and corresponding consumption levels are available at the Murau level. However, total energy consumption for this sector has been estimated using national statistical parameters, such as the average distance travelled per vehicle and techno-economic indicators related to specific energy consumption by vehicle type.

Detailed end-use breakdowns and socio-economic indicators are predominantly available at the regional scale (Styria). Nevertheless, due to the high degree of socio-economic and infrastructural homogeneity across the region, these indicators can be reliably extrapolated to the Murau context.

Additionally, a clearly defined network of key local stakeholders—comprising technology providers, local enterprises, and academic and research institutions—plays an active role in supporting the regional energy transition. These stakeholders are already collaborating with the municipality and the wider region through the implementation of several projects focused on sustainable energy development and decarbonization pathways.

Table 5: Data availability of Murau RV

| Sector      | Demand   | Supply   |
|-------------|--|--|
| Electricity | <ul style="list-style-type: none"> <li>Annual electricity demand by sector (estimated).</li> <li>Synthetic hourly electricity demand profile.</li> </ul> | <ul style="list-style-type: none"> <li>Total electricity generation by technology.</li> <li><b>Hydropower Run-of-River:</b> locations; installed capacity and annual production; synthetic hourly inflow series; techno-economic parameters.</li> <li><b>Hydropower Reservoir:</b> locations; installed capacity and annual production; synthetic hourly inflow series; techno-economic parameters.</li> </ul> |



|                  |   |   |
|------------------|---|---|
|                  |   | <ul style="list-style-type: none"> <li>▪ <b>Wind:</b> site locations and installed capacity; synthetic hourly generation profiles; techno-economic parameters.</li> <li>▪ <b>Photovoltaics:</b> installed capacity; synthetic hourly generation profiles; techno-economic parameters.</li> <li>▪ <b>Batteries:</b> storage capacity (estimated); techno-economic parameters.</li> <li>▪ <b>Grid connection:</b> transfer capacity; grid topology/map; cross-border energy flows (Murau ↔ Austria).</li> </ul> |
| <b>Heat</b>      | <ul style="list-style-type: none"> <li>▪ Annual heat demand (estimated).</li> <li>▪ Hourly synthetic space-heating demand profile.</li> <li>▪ Hourly synthetic heat-pump load profile.</li> </ul>   | <ul style="list-style-type: none"> <li>▪ Aggregated heat supply by fuel type.</li> <li>▪ <b>District heating (DH):</b> locations, installed capacity, and annual heat production of DH plants; technologies (DH boilers, CHP); fuel types.</li> </ul>   |
| <b>Transport</b> | <ul style="list-style-type: none"> <li>▪ Estimated total energy demand for light-duty (by fuel) and freight vehicles.</li> <li>▪ Vehicle stock by type and fuel</li> <li>▪ Techno-economic data on specific energy consumption by vehicle type and fuel.</li> <li>▪ National average annual kilometres per vehicle.</li> <li>▪ Hourly synthetic charging profiles for battery-electric vehicles.</li> </ul> | n/a.  |

### 3.3.5. Challenges

Despite its robust renewable energy foundation, Murau continues to face several structural and systemic challenges in advancing its energy transition. The heating sector remains predominantly reliant on biomass, which, while renewable, raises concerns regarding long-term sustainability, resource availability, and local air emissions.

The decarbonisation of the transport sector is progressing more slowly, primarily due to the region's dispersed settlement structure, low population density, and insufficient charging infrastructure, which collectively hinder the large-scale adoption of electromobility and alternative fuels.



In parallel, electricity grid capacity limitations are expected to become increasingly critical bottlenecks as renewable generation continues to expand, necessitating strategic investments in grid reinforcement and smart energy management systems.

Moreover, while regional-level datasets are available, granular, valley-specific monitoring and data integration - particularly in the domains of energy performance, socio-economic dynamics, and behavioural aspects - remain fragmented and insufficiently coordinated, constraining evidence-based planning and policy evaluation.

Table 6: PESTLE of Murau RV

| Barriers |   | Mitigation  |
|----------|---|---|
| <b>P</b> | Murau relies on national and EU policies for financial and regulatory support, creating dependency on external decision-making. Uncertainty in hydrogen storage regulations, particularly in underground salt caverns, and permitting delays for large-scale wind and solar expansions hinder deployment. | Advocate for stable and clear regulations on hydrogen storage and decentralized energy systems, enhance regional policy alignment with EU climate goals, and simplify permitting processes to accelerate renewable energy deployment. |
| <b>E</b> | High capital investment is required for hydrogen infrastructure, battery storage, and smart grid technologies. Financial risks exist in large-scale energy storage, and reliance on EU funding poses a challenge for long-term sustainability.  | Secure long-term investment through public-private partnerships and EU grants, create local economic incentives for renewable energy investments, and develop business models that maximize revenue from renewable energy exports.    |
| <b>S</b> | Public resistance to electric mobility adoption is slowing progress due to limited charging infrastructure. The dispersed rural population and reliance on individual car ownership make it difficult to transition to low-carbon transport.  | Expand EV charging networks, offer financial incentives for electric vehicle purchases, improve public transportation options where feasible, and launch awareness campaigns highlighting the benefits of clean mobility.             |
| <b>T</b> | Integration of hydrogen as a storage and energy solution is complex, requiring new infrastructure and sector coupling. Smart grids and decentralized energy trading using blockchain face interoperability and cybersecurity risks.   | Invest in R&D for hydrogen infrastructure and smart grid security, establish interoperability standards for digital energy systems, and enhance predictive AI-driven energy management to optimize supply and demand                  |



|          |  |   |
|----------|--|---|
| <b>L</b> | Existing legal frameworks for decentralized energy communities and hydrogen-based solutions are still evolving, creating uncertainty for investment and project scaling. Biomass utilization must comply with strict environmental regulations, which could limit expansion.     | Work with policymakers to develop clearer legal structures for energy communities and hydrogen projects, provide legal guidance to local stakeholders, and ensure biomass projects adhere to sustainable forestry guidelines. |
| <b>E</b> | Heavy reliance on biomass for heating raises sustainability concerns, including deforestation risks and emissions from biomass combustion. Expanding solar and wind energy requires careful land-use planning to balance environmental preservation with renewable energy goals. | Promote responsible and certified biomass sourcing, integrate reforestation programs to counteract biomass usage, and optimize land-use strategies to support renewable energy while preserving biodiversity.                 |

### 3.4. Data collected and current Status of Konin (RV#4)

Konin is a city in Wielkopolska Province, Poland, with around 66,000 inhabitants. Historically shaped by brown coal mining and lignite power plants, the city is undergoing a profound energy, economic and social transformation following the end of coal mining in 2020. The “Green Energy of Konin” cluster, established in 2018, coordinates the transition towards renewable energy.

#### 3.4.1. Current Energy System

Konin’s district heating, once dependent on coal, now relies largely on renewable sources under an agreement with ZE PAK until 2032. Major local producers are presented in a summary table (Table 7) shown below.

Table 7: Zielona Energia Konin Energy Valley Overview

| Project  | Capacity   | Main Output   |
|--|--|---|
| <b>Municipal Waste Management Plant in Konin (MZGOK)</b> | It is the largest energy producer in the cluster, utilizing a municipal waste incineration plant. It operates a cogeneration unit with an electrical power rating of 7.3 MWe and a thermal power rating of 28.33 MWth, enabling the simultaneous production of electricity and heat. Additionally, a 30 kWp photovoltaic installation operates at the MZGOK site, supporting self-consumption. | Heating and electricity networks, self-consumption. |



|  |   |  |
|--|---|--|
| <p><b>Municipal Water and Sewage Company in Konin (PWIK)</b></p>       | <p>It has numerous photovoltaic installations on its premises, with a total capacity of over 2.5 MWp (including the largest farm with a capacity of 2.2 MW). These PV sources are located near water pumping stations and sewage treatment plants, enabling efficient use of the energy produced for its own needs.</p>     | <p>Self-consumption and the electricity grid</p> |
| <p><b>Municipal Thermal Energy Company in Konin (MPEC)</b></p>         | <p>Its structure includes a small PV farm with a capacity of approximately 39.4 kWp and a 15.6 kWp PV installation on Kotłowa Street. The company plans to launch an 8.1 MWth geothermal source, which will be integrated with the municipal heating network. The company also owns a 1.54 MWth community boiler plant.</p> | <p>Self-consumption and heating network</p>      |
| <p><b>Municipal Housing and Utilities Company in Konin (PGKiM)</b></p> | <p>It has a 48-kWp photovoltaic installation installed</p>  | <p>Self-consumption</p>                          |

The city is also investing in biogas: MZGOK’s facility will process 22500 tons of biodegradable municipal waste per year to produce 3.3 million m<sup>3</sup> of biogas, while the PWiK biogas plant will produce 2.72 million m<sup>3</sup> annually for 1 MWe CHP. A thermal waste-to-energy plant for RDF (112000 t/year) will add 5.6–9.8 MWe and up to 28.2 MWth. The residential building stock is dominated by older blocks with poor efficiency; only one-third are connected to the gas grid. Retrofitting and district heating connections are priority measures. Transport is being modernised, with municipal bus fleets shifting to electric and hydrogen vehicles. A new depot with electrolyser and refuelling station is planned, supporting the broader Wielkopolska Hydrogen Valley initiative (the contract for the construction of the depot was signed on October 17, 2025).

### 3.4.2. Policies and Initiatives

Konin aims to become a national leader in green energy and hydrogen. It participates in the Wielkopolska Hydrogen Valley and has joined Hydrogen Europe. Local strategies include expanding PV and wind, waste-to-energy projects, biogas, and mobility electrification. The city also created an electricity purchasing group to secure lower prices for public institutions.

### 3.4.3. Socio-economic and Governance Aspects

Konin’s economy is diversifying following the coal phase-out. Entrepreneurship is growing, with over 8,600 businesses registered, while the ZE PAK group remains a key employer. The transition is supported by local governance through the Green Energy Cluster and partnerships with municipal companies. Public engagement and social acceptance remain essential, particularly for retrofits and new mobility solutions. Additionally, there is the LIFE After Coal PL program, part of the European LIFE mechanism, supports a just transition in Eastern Greater

Poland<sup>2</sup>, with a strong focus on the Konin area. It aims to mitigate the socio-economic and environmental impacts of lignite phase-out by promoting a green economy. Key actions include investments in renewable energy, rehabilitation of post-mining areas, and the creation of “Jobs After Coal” through training, career counselling, and support for eco-friendly entrepreneurship. The program acts as a catalyst for transforming the region into a model of sustainable development.

#### 3.4.4. Data Availability

Currently, energy data are based mainly on historical invoices and highly aggregated statistics. Real-time monitoring is not yet in place, though a digital energy monitoring system is planned under the Green Energy Konin cluster by 2025. As part of this project, the "Concept of an Integrated Information System on Energy Production and Consumption in the City of Konin as part of the Energy Cluster - Green Energy Konin" was developed. The document's purpose was to describe how to develop and implement an integrated system for monitoring, analysing, and optimizing energy production and consumption within the energy cluster. The documentation was prepared based on an agreement, facility inventory, and arrangements with city representatives.

##### Data already obtained:

The pre-implementation analysis and inventory have already generated a significant amount of data from cluster members. These include:

- **Energy consumption and production data:** total annual electricity consumption in the cluster in 2022 was 22.9 GWh. Total energy production from PV and cogeneration in the same year was 48 GWh. The document also includes a detailed breakdown of energy produced into self-consumption, purchased energy, and total consumption for each cluster member in 2024.
- **Measuring infrastructure:** 506 electricity collection points (PPE) were inventoried, with the majority belonging to the Konin City Hall (298 PPE) and MPEC (107 PPE). Models of electricity and heat meters were also provided.
- **Generation sources:** information was provided on existing energy generation sources, such as the cogeneration installation at MZGOK (electric power 7.3 MWe, thermal power 28.33 MWth), photovoltaic installations at PWiK (over 2.5 MWp), a smaller PV farm at MPEC (approx. 39.4 kWp) and a PV installation at PGKiM (48 kWp).
- **Communications Infrastructure:** Current communication methods, such as GPRS, Ethernet, and fiber optics, were identified. The SCADA systems used by each were also identified.

##### Data planned to be collected

The new ZSIPZE system is designed to collect and process multiple types of data to support its functionalities. These include:

---

<sup>2</sup> <https://aftercoal.pl/en/home-english/>



- **Real-time measurement data:** the system will automatically collect data from energy meters, heat meters, and network analysers. Measurement granularity after device upgrades will be at least one minute.
- **Telemetry data:** Binary (1ms resolution) and analog signals from RTUs/PLCs will be collected, including current, voltage, active and reactive power, power factor and frequency.
- **Historical data:** All collected data will be stored in a central, relational, time-series database for a minimum of five years for analysis, reporting, and forecasting purposes.
- **Operational data and logs:** the system will record all user actions, system events, alarms and control commands, which is required for auditing and security purposes.
- **External data:** the system will integrate data from external sources, such as weather forecasts (e.g. AccuWeather) and market data from the Polish Power Exchange (TGE), to support forecasting and balancing.

### Data that will not be collected/shared

The documentation clearly states that for reasons of security and personal data protection (GDPR) and system integrity, certain data will not be collected or shared in an uncontrolled manner.

- **No user data on local devices:** Dispatch terminals will not store any data on local drives. All sensitive information, including personal data, will be stored exclusively on central servers, ensuring compliance with GDPR.
- **Network separation:** The technology (OT) network for SCADA and telemetry communications will be physically and logically isolated from the office (IT) network. This is to minimize the risk of cyberattacks and prevent unauthorized access.
- **Anonymised data:** the system will ensure the anonymisation of sensitive data and its processing will be in line with the data minimisation principles required by the GDPR.
- **No direct internet access:** The telematics network will not have access to the public internet, and all external communications will take place through encrypted VPN tunnels.

**No access to data without authorization:** data will only be accessible from authorized workstations and communication will be encrypted in accordance with the IEC 62351 standard.

### 3.4.5. Challenges

Konin faces financing challenges for large-scale renewable projects and retrofits and needs to improve public engagement in the transition. Data availability remains limited, with real-time monitoring absent so far. Regulatory uncertainty around hydrogen and waste-to-energy projects adds risk, while legacy pollution from coal mining requires remediation.

### 3.4.6. PESTLE Analysis of Konin

Table 8: PESTLE of Konin RV

| Barriers | Mitigation |
|----------|------------|
|----------|------------|



|          |  |  |
|----------|--|--|
| <b>P</b> | <p>Transition from coal to renewables requires strong government support, but regulatory uncertainties around hydrogen infrastructure and waste-to-energy projects pose risks. Local policies must align with national and EU climate goals.</p> | <p>Strengthen collaboration between local and national authorities, advocate for stable regulations on hydrogen and waste-to-energy projects and integrate Konin's energy strategy into Poland's national energy transition framework.</p>   |
| <b>E</b> | <p>High costs for retrofitting buildings, financing large-scale renewable projects, and transitioning industrial sectors. Dependence on public funding creates financial risk for long-term sustainability.</p>                                  | <p>Secure diverse funding sources, including EU grants, green bonds, and public-private partnerships. Develop financial incentives to attract private investment and reduce dependence on subsidies.</p>   |
| <b>S</b> | <p>Public resistance to renewable energy transition due to economic shifts from coal industry decline. Limited public engagement in energy initiatives and slow adoption of green mobility solutions.</p>  | <p>Launch public awareness campaigns on economic benefits of renewables, provide retraining programs for former coal workers, and create incentives for citizen participation in local energy cooperatives.</p>  |
| <b>T</b> | <p>Need for rapid deployment of smart energy storage, hydrogen infrastructure, and decentralized energy grids. Real-time energy monitoring systems are still underdeveloped.</p>   | <p>Accelerate R&amp;D in hydrogen storage, battery technology, and grid digitalization. Implement a city-wide digital energy monitoring system to optimize energy production and consumption.</p>  |
| <b>L</b> | <p>Complex permitting processes for large-scale renewable projects and hydrogen production. Existing laws on building retrofits and district heating require adaptation to new energy technologies.</p>  | <p>Advocate for streamlined permitting procedures, update building regulations to accommodate energy-efficient retrofits, and develop legal frameworks for hydrogen integration in municipal infrastructure.</p>   |
| <b>E</b> | <p>Legacy pollution from coal mining affects land and water quality. Waste-to-energy projects require strict emission controls. Expanding wind and solar infrastructure may face land-use conflicts.</p>   | <p>Comply to stringent emission standards for waste-to-energy facilities. Implement land remediation programs to address historical contamination, enforce stringent emission standards for waste-to-energy facilities, and utilize strategic land use planning to balance renewable energy development with environmental protection efforts.</p> |



Overall, Konin is positioning itself as a leader in Poland’s energy transition, leveraging hydrogen, biogas, solar, wind, and smart energy systems to build a sustainable and resilient energy future. If successful, its model could serve as a blueprint for other coal-dependent regions transitioning to renewable energy.

### 3.5. Data collected and current Status of Western Macedonia (RV#5)

Western Macedonia, in north-western Greece, has about 270000 inhabitants. The region has long been the country’s energy heartland, providing the majority of Greece’s electricity from lignite power plants operated by the Public Power Corporation (PPC). With lignite production to be phased out completely by 2028, the region faces both an environmental necessity and a major socio-economic challenge.

#### 3.5.1. Current Energy System

District heating in Kozani, Ptolemaida and Amyntaio has traditionally been supplied by lignite-fired power plants such as the St. Demetrios complex. Around 99% of buildings in Kozani, Nea Haravgi and ZEP (a newly developed residential and administrative district located just outside Kozani) are connected to district heating. However, with the phase-out of lignite, alternative systems based on natural gas, electric boilers, large-scale heat storage and heat pumps are under development. Residential buildings are the largest energy consumers. Most were built before modern insulation standards: those before 1980 have no insulation, and those from 1980–2010 follow only minimal regulations. The Regulation for the Energy Performance of Buildings (KENAK, 2010) introduced higher standards, but only a small share of the stock complies. National retrofitting programmes have had increasing impact since 2020, with 657 households renovated in 2022 alone. The tertiary sector (businesses and services) consumed about 73 GWh of electricity in 2010, producing 56 kt CO<sub>2</sub>. In 2020, its consumption reached nearly 88 GWh. Heating in this sector also relies on district heating and fuel oil, with emissions exceeding 30 kt CO<sub>2</sub>. Industry plays a smaller role, with electricity consumption estimated at ~15 GWh in 2010 and associated emissions of ~12 kt CO<sub>2</sub>. Transport is another major source of emissions. Public transport, private vehicles and the municipal fleet together account for over 250 GWh of energy use annually, with emissions exceeding 60 kt CO<sub>2</sub> in 2010. Diesel dominates the vehicle stock, although mobility strategies and electrification initiatives are now emerging. Table 1 consolidates the primary energy consumption and CO<sub>2</sub> emissions for the building sector.

Table 9: Primary energy consumption and CO<sub>2</sub> emissions for buildings (2020)

| Buildings           | Energy source    | Energy consumption [MWh] | Primary energy consumption [MWh] | Emission [tn CO <sub>2</sub> /year] |
|---------------------|------------------|--------------------------|----------------------------------|-------------------------------------|
| Municipal buildings | Electricity      | 3192.40                  | 9257.96                          | 1251.42                             |
|                     | District Heating | 6451.96                  | 4516.37                          | 2238.83                             |
|                     | Heating (oil)    | 2206.15                  | 2426.77                          | 589.04                              |



|                       |                  |           |           |          |
|-----------------------|------------------|-----------|-----------|----------|
| Residential buildings | Electricity      | 90776.50  | 263251.85 | 35584.39 |
|                       | District Heating | 194457.90 | 136120.53 | 67476.89 |
|                       | Heating (oil)    | 60942.37  | 67036.61  | 16271.61 |

### 3.5.2. Policies and Initiatives

The national lignite phase-out is the most decisive policy framework for the region. Western Macedonia is prioritising renewable energy generation, smart grids, energy storage, electrification of district heating, hydrogen production and sustainable mobility. The Municipality of Kozani participates in EU projects such as NEUTRON and ProLight, supporting digital twins, smart buildings and circular economy practices. Pilot projects also include hydrogen technologies (H2 Innovation Hub), large PV parks, and potential pumped-storage facilities in former coal mines.

### 3.5.3. Socio-economic and Governance Aspects

The transition will directly or indirectly affect about 16000 jobs. Authorities aim to mitigate these impacts through retraining, diversification into green industries, and attracting investment into renewables and energy storage. The region is actively engaged in European initiatives (e.g. NetZeroCities, EHHUR, STARDUST) to secure funding and exchange knowledge. Governance efforts focus on ensuring a just transition, with social acceptance seen as a key enabler.

### 3.5.4. Data Availability

Historical data on energy consumption and emissions are available for main sectors, although often aggregated at the regional scale. Building-level detail is limited, and real-time monitoring systems are not yet in place.

### 3.5.5. Challenges

Western Macedonia’s greatest challenge is managing the socio-economic consequences of the lignite phase-out while ensuring reliable and affordable energy supply. Large investments are required for retrofitting the inefficient building stock and developing alternative heating systems. Regulatory clarity and financing will be critical, and data gaps at local level hinder optimisation. Public acceptance of new large-scale renewable projects, particularly wind and PV parks, is not guaranteed and could slow progress.

### 3.5.6. PESTLE Analysis of Western Macedonia

Table 10: PESTLE of Western Macedonia RV

| Barriers |   | Mitigation   |
|----------|---|--|
| P        | Transition from lignite to renewables requires strong government support, | Advocate for stable and clear regulations on hydrogen, district heating, and |



|          |   |   |
|----------|---|---|
|          | but regulatory uncertainties around hydrogen infrastructure, district heating alternatives, and grid modernization create risks. Policies must align with EU and national decarbonization targets.                                  | renewable energy projects. Strengthen collaboration between regional and national authorities to ensure policy alignment and accelerate permitting processes.   |
| <b>E</b> | High investment costs for large-scale renewable energy projects, hydrogen infrastructure, and grid modernization. The decline of the coal industry has caused job losses, affecting regional economic stability.                    | Secure diverse funding sources, including EU Just Transition Fund, green bonds, and public-private partnerships. Develop retraining programs and employment incentives to support workers transitioning from coal-based industries to renewable energy sectors. |
| <b>S</b> | Public resistance to the energy transition due to job losses and economic uncertainty. Slow adoption of energy efficiency measures in old residential buildings and limited public awareness of green energy benefits.              | Launch public education campaigns on the benefits of renewables, provide financial incentives for energy efficiency improvements, and expand workforce retraining programs to integrate coal workers into the green economy.                                    |
| <b>T</b> | The electricity grid requires modernization to handle decentralized renewable generation, battery storage, and hydrogen integration. Limited infrastructure for electric and hydrogen vehicles slows sustainable mobility adoption. | Invest in smart grid technology, develop large-scale battery storage projects, and expand EV and hydrogen refueling infrastructure to support green mobility. Implement digital monitoring systems to optimize energy efficiency.                               |
| <b>L</b> | Complex permitting and regulatory processes for renewable energy projects, particularly for hydrogen production and district heating alternatives. Unclear legal frameworks for energy storage and decentralized energy trading.    | Streamline permitting procedures for renewable and hydrogen projects, establish legal frameworks for decentralized energy trading, and create clear regulations for energy storage solutions.   |
| <b>E</b> | Legacy pollution from lignite mining impacts soil and water quality. Expansion of renewable energy infrastructure must be balanced with environmental conservation efforts.   | Implement land remediation and reforestation programs, enforce strict environmental regulations for new projects, and ensure sustainable land-use planning to balance renewable energy expansion with biodiversity protection.                                  |



### 3.6. Data collected and current Status of Tolosaldea (RV#6)

Tolosaldea is a district in Gipuzkoa (Basque Country, Spain) with 28 municipalities and a population spread between rural areas and more urban centres. About 65% of residents live in apartments, while rural households are more often in traditional detached houses. The region has a long industrial tradition, particularly in paper mills, alongside more than 600 SMEs across 53 industrial areas.

#### 3.6.1. Current Energy System

According to a 2022 study, annual energy consumption is around 371 GWh, of which 77% is industry, 12% housing and 11% services. Fuel consumption totals 74 GWh, heavily concentrated in industry. Energy production in Tolosaldea is very limited (about 33 GWh, or 3.2% of consumption), based mainly on small hydro (72%), biomass (21%), PV (5%) and marginal contributions from wind and geothermal. Buildings in urban areas largely rely on natural gas for heating, while rural areas increasingly use heat pumps and biomass. Transport demand is high, with most families owning at least one vehicle (more in rural areas). Less than 10% of vehicles are electric, and charging infrastructure remains scarce.

#### 3.6.2. Policies and Initiatives

There are currently 19 active energy communities in Tolosaldea, most set up as associations with a collective PV installation. A few are cooperatives with multiple projects, and more are expected in coming years. A service cooperative for the Energy Communities is expected to be created in 2025. This cooperative is going to be focused in giving services to Energy Communities and also analysing-promoting-investing district view Renewable Energy projects.

#### 3.6.3. Socio-economic and Governance Aspects

Tolosaldea benefits from a strong culture of local associations and social cohesion. Energy communities are part of this broader cooperative tradition. The region also has relatively low inequality compared to other European areas, which supports inclusive transition efforts.

#### 3.6.4. Data Availability

Electricity consumers already have smart meters, and a pilot monitoring system is being deployed in Orexa with the aim of expansion. This monitoring system is part of the smart control system for photovoltaic self-consumption with a battery: the battery is part of the generation, and monitoring is required in each consumers' house, to allow the system to decide when to feed the generated power into the net and when to charge the battery. This system is expected to be operational by the end of 2025.

The smart meters belong to the distribution operator, of which there are two. One of them is I-DE (Iberdrola group) and the other one is Tolargi (municipal distributor of Tolosa). Getting hourly consumption data of Tolosaldea from these two distributors is not going to be easy. Data from Tolargi is expected to be easier to get because it is public and the owner is Tolosa municipality. In any case, as it is a very small distributor with probably lack of resources, getting the information could take a long time. Hourly generation data is not expected to be possible to obtain. Energy pricing varies between free market and regulated contracts; the latter increasingly used for gas. However, detailed historical consumption and socio-economic data



at valley level remain limited. For example, detailed mobility demand data was not collected in this phase due to limited availability and stakeholder input. This may indicate that mobility is not a primary focus for the RV at this stage, but it will be revisited in subsequent scenario development tasks

### 3.6.5. Challenges

The main challenges are the very low level of local energy production compared to consumption, limited charging infrastructure for e-mobility, and incomplete data for building-level energy demand. Financing mechanisms to scale up energy communities will also be critical. Additionally, information on small DSO grid topology and resource constraints was not provided in detail. This likely reflects limited engagement or prioritisation of grid expansion planning by local DSOs at this stage.

### 3.6.6. PESTLE Analysis of Tolosaldea

Table 11: PESTLE of Tolosaldea

|          | Barriers  | Mitigation  |
|----------|---|---|
| <b>P</b> | Limited integration of local initiatives with broader regional and national energy strategies. Municipalities vary in their commitment to energy transition.  | Strengthen coordination with Basque Country regional policies and align local energy communities with national climate goals. Promote cooperation across the 28 municipalities.                               |
| <b>E</b> | Low share of local energy production (3.2%) means continued reliance on external energy supply and vulnerability to price fluctuations. Limited investment capacity of small municipalities and SMEs. | Expand cooperative financing models for energy communities. Seek regional/EU funds to support PV, biomass and electrification projects. Promote clustering of SMEs to share costs and benefits of renewables. |
| <b>S</b> | High dependence on private vehicles, with low EV adoption. Risk of unequal participation in energy communities if initial costs remain high.  | Develop awareness campaigns and incentives for EV adoption. Strengthen cooperative structures to include vulnerable households. Use existing strong local association culture to promote inclusivity.         |
| <b>T</b> | Scarce public EV charging infrastructure and limited deployment of renewable technologies beyond small hydro and PV. Lack of centralised data monitoring across the valley.                           | Expand EV charging points in both rural and urban areas. Support distributed PV, wind and biomass projects. Scale up the pilot monitoring system in Orexa to cover the whole valley.                          |



|   |   |  |
|---|---|--|
| L | Complexities in cooperative and community energy regulation may slow expansion. Limited clarity on frameworks for collective self-consumption and grid sharing.                   | Advocate for clearer regulation on community energy projects. Engage with regional regulators to streamline approvals for shared PV, biomass and district heating.                   |
| E | Very low renewable self-sufficiency results in high energy imports and associated emissions. Limited space for large-scale renewables due to dense settlement and industrial use. | Prioritise rooftop PV, agro-PV and small-scale biomass solutions. Explore synergies with industry for waste heat and bioenergy. Encourage modal shift to reduce transport emissions. |

## 4. PLANNED FUTURE SCENARIOS

This chapter builds on the baseline information presented in Chapter 3 by outlining the future pathways foreseen in each Replication Valley. The analysis highlights both the technologies of interest for replication from the Flagship Valley in Alkmaar and the local initiatives already under discussion or development in each RV. These scenarios reflect the ambitions of local stakeholders, their energy transition strategies for 2030 and 2050, and the expected role of innovative solutions in achieving climate neutrality. The information has been compiled directly from the data collection templates, bilateral discussions and workshops with local actors. While the level of detail varies between valleys, the scenarios provide valuable insights into their priorities and into the barriers that may affect implementation. Issues such as financing, regulatory clarity, and social acceptance were identified across multiple valleys as key factors that could either accelerate or slow down progress. The following subsections summarise the planned scenarios per RV, with an emphasis on the technologies identified as most relevant for replication and the challenges that may arise during their deployment.

A comprehensive overview of the list of Standard and Innovative Technologies to be potentially demonstrated in all six RVs is presented in Table 12 and Table 13, respectively. Regarding Table 12, synergies between technologies were not assessed in this deliverable due to lack of detailed input from RVs. Technology selections appear to be driven primarily by RV-specific needs and expectations. The topic of synergies between technologies will be explored further during scenario design and integration analysis in WP7. In the following sub-chapters, a detailed table containing these technologies and potential issues that could raise during implementation are provided.

Table 12: Innovative technologies list of interest for the RVs

| A/A Name of the Technology | Short description | Of interest for the RV (Y/N). |       |       |       |                |            |
|----------------------------|-------------------|-------------------------------|-------|-------|-------|----------------|------------|
|                            |                   | DDS                           | Delft | Murau | Konin | West Macedonia | Tolosaldea |
|                            |                   |                               |       |       |       |                |            |



|  |   |   |   |   |   |   |   |
|--|---|---|---|---|---|---|---|
| <b>1.1 Hydrogen NO Carbon</b>                            | Production of clean hydrogen from organic waste products via thermolysis with byproduct being biochar that acts as a carbon sink.   | N | N | N | N | N | N |
| <b>1.2 Biological Carbon Capturing and Usage (B-CCU)</b> | Fixating CO <sub>2</sub> from biogas originating from a digester through the cultivation of algae in a photobioreactor.   | N | N | N | Y | N | N |
| <b>1.3 Thermochemical energy production</b>              | Production of renewable energy carriers such as biogas, syngas, hydrogen and biomethane through gasification or other thermo-chemical technologies.                             | N | N | Y | Y | Y | Y |
| <b>1.4 Unlocking existing large-scale RES assets</b>     | Unlocking existing Renewable Energy Sources for optimised control through Teleports (gateway to control energy assets).   | Y | Y | Y | Y | Y | Y |
| <b>2.1 Hydrogen infrastructure</b>                       | Connecting local hydrogen producers and consumers by realizing a local hydrogen infrastructure comprising of pipelines, compressor and docking station (to balance the system). | N | N | Y | Y | Y | N |
| <b>2.2 Hybrid battery electrolyser</b>                   | A hybrid system for production of green H <sub>2</sub> and storing energy, that operates based on a zinc intermediate step electrolysis (ZZE). In                               | Y | N | Y | N | N | N |



|  |   |   |   |   |   |   |   |
|--|---|---|---|---|---|---|---|
|  | <p>this way, hydrogen production and energy storage functionalities are integrated in one system and thus offer efficient grid-serving use of renewable energies.</p>   |   |   |   |   |   |   |
| <b>2.3 Residential and neighbourhood battery</b> | <p>Individual batteries at residential dwellings and/or a collective neighbourhood battery to increase the energy self-sufficiency of the residents and thereby also reduce the pressure on the grid.</p>                                 | Y | N | Y | Y | Y | Y |
| <b>2.4 Flow battery</b>                          | <p>A type of rechargeable battery in which two chemical components are dissolved in liquids separated by a membrane. Compared to more traditional battery systems, the (redox) flow battery enable to store power for longer periods.</p> | N | N | N | Y | N | N |
| <b>2.5 Batteries as part of VLES</b>             | <p>The implementation of stationary batteries as part of a (virtual) local energy systems in which peers exchange available electricity and where the battery balance the remaining mismatch in electricity demand and supply.</p>        | Y | N | Y | N | N | Y |
| <b>2.7 Energy conversion and</b>                 | <p>To integrate multiple clean energy carriers, conversion</p>  | Y | N | Y | N | N | Y |



|  |  |   |   |   |   |   |   |
|--|--|---|---|---|---|---|---|
| <b>integration technologies</b>              | technologies such G2P, G2H, P2H, H2P and P2G will be demonstrated to balance the FV.   |   |   |   |   |   |   |
| <b>2.8 Large-scale heat buffer</b>           | A large-scale heat buffer fed by a local/regional heat source. The heat buffer allows for (sustainable) heating provisioning during peak demand.   | Y | Y | N | N | Y | Y |
| <b>2.9 (PCM) heat buffer</b>                 | Individual, small scale, phase-change material (PCM) heat buffers, in combination with water/water heat pumps able to be used at residential dwellings for heat storage.                                 | N | N | Y | N | N | Y |
| <b>3.1 District heating connection</b>       | Connecting residents and/or businesses to a local or regional heating grid fed by a local heat source (and potentially in combination with a heat buffer).   | Y | Y | Y | N | N | Y |
| <b>3.2 P2P energy exchange</b>               | Physical and/or virtual exchange of electricity between local peers (residents or businesses) to increase the self-sufficiency and reduce the pressure on the electricity grid within the Energy Valley. | Y | N | Y | Y | N | Y |
| <b>3.3 Battery integrated smart chargers</b> | A battery integrated smart/fast EV charger for heavy duty battery electric vehicles. The   | N | N | Y | Y | Y | N |



|                                     |   |   |   |   |   |   |   |
|-------------------------------------|---|---|---|---|---|---|---|
|                                     | integrated solutions to provide fast EV charging services even with limited available grid capacity.  |   |   |   |   |   |   |
| <b>3.4 BEV and FCEV integration</b> | The integration of heavy-duty 1) Battery Electric Vehicle (BEV) and 2) Fuel Cell Electric Vehicles to reduce greenhouse emissions in transportation | N | N | Y | N | Y | N |

Table 13: Standard technologies list of interest for RVs

| Name of the Technology         | Interest for the RVs (Y/N). |       |       |       |                |            |
|--------------------------------|-----------------------------|-------|-------|-------|----------------|------------|
|                                | DDS                         | Delft | Murau | Konin | West Macedonia | Tolosaldea |
| Photovoltaics (PV)             | Y                           | Y     | Y     | Y     | Y              | Y          |
| Wind turbines                  | Y                           | N     | Y     | Y     | N              | Y          |
| Boilers (natural gas/ biomass) | Y                           | N     | Y     | N     | Y              | Y          |
| EV chargers                    | Y                           | N     | Y     | Y     | Y              | Y          |
| Bio-energy plant               | Y                           | N     | Y     | Y     | Y              | Y          |
| Electrolyser                   | Y                           | N     | Y     | Y     | Y              | N          |
| Hydro-power                    | Y                           | N     | Y     | N     | N              | Y          |
| Geothermal energy              | N                           | Y     | Y     | Y     | Y              | Y          |

#### 4.1. List of Replicated Technologies and potential issues during Implementation - DDS (RV#1)

DDS has expressed interest in a range of innovative technologies demonstrated in the Flagship Valley. The region sees particular potential in expanding solar PV, biomass and district heating, while also exploring digitalisation and energy communities to improve energy management. Transport decarbonisation is also on the agenda, with interest in hydrogen and EV charging infrastructure. Table 14 below summarises the technologies of interest as indicated in the data collection template. For each technology marked “Yes,” DDS provided a short description outlining potential capacity, location, beneficiaries and expected value streams.

Table 14: Technologies of interest for DDS

| 1.4 Unlocking existing large-scale RES assets   |
|---|
| The DDS/Verko (I-1.1) and VPK (I-2) sites generate surplus electricity and gas that is currently injected into the grid without direct local use. Additionally, these sites produce large amounts of unused heat that could be repurposed for district heating. The CHP system generates 2885 MWh of heat annually, primarily for drying 30000 tons of digestate at the composting site. The composting process itself produces additional heat, resulting in a total of 6000 MWh of non-recovered heat |



|   |
|---|
| <p>(theoretical approach). If captured, this heat could provide heating for approximately 300 households and offices through a district heating network or on-site heating.</p>   |
| <p><b>2.2 Hybrid battery electrolyser</b></p> <p>The DDS-Verko site lacks a sewer system and instead operates a self-contained water treatment facility that processes 60000 litres of water daily before discharging it into the Schelde River. The presence of both water and surplus electricity creates an opportunity to establish hydrogen production as an energy buffer. A hydrogen pipeline has already been installed south of the Eegene industrial area, facilitating potential hydrogen-powered transport for trucks and ships in the future.</p>  |
| <p><b>2.3 Residential and neighbourhood battery</b></p> <p>Energy storage is another challenge, particularly for residential and neighbourhood applications. Collective energy storage is difficult due to individual ownership rights. However, a pilot project could be tested in Wichelen, where DDS owns a neighbourhood of 16 rental homes. This area presents a controlled environment to explore the feasibility of a neighbourhood battery. The project TEAH/EHBE provides the possibility to gather the data.</p>  |
| <p><b>2.5 Batteries as part of VLES</b></p> <p>A Virtual Local Energy System (VLES) could be introduced to optimize energy use across the Eegene business park (I-1.1/I-1.2), integrating solar, wind, and CHP resources to enhance efficiency and communication between different renewable sources.</p>   |
| <p><b>2.7 Energy conversion and integration technologies</b></p> <p>Considering the presence of electricity, gas, and heat production, the sites of DDS and VPK can be used as a hybrid solution to balance the different energy flows.</p>   |
| <p><b>2.8 Large-scale heat buffer</b></p> <p>The CHP system already produces nearly 3000 MWh of heat annually, which is doubled by the composting process. A heat buffer could capture and reuse part of this lost caloric energy, reducing the continuous need for the CHP system to operate and improving overall energy efficiency.</p>  |
| <p><b>3.1 District heating connection</b></p> <p>The DDS-VERKO (I-1) and VPK (I-2) sites have the potential to supply their excess heat to households in the districts of Appels and Oudegem. Currently, no district heating network is planned for Appels, but the Warm Dendermonde project is already studying the feasibility of a heating network for Oudegem.</p>  |
| <p><b>3.2 P2P energy exchange</b></p> <p>Peer-to-peer (P2P) energy exchange could help distribute the 5000 MWh per year of surplus electricity from the DDS site within the energy valley. This energy could be allocated to rental homes in Wichelen, government buildings in Wichelen and Berlare, and nearby businesses. Gregoir, a car dealership, has a demand for EV charging infrastructure, while 't Klokhuis, a restaurant, urgently requires a high-voltage connection for its induction-based kitchen and additional charging infrastructure.</p>  |
| <p><b>Foreseen issues for RV</b></p> <p><b>Data Sharing &amp; Privacy</b><br/>Private households and businesses are often reluctant to share their energy consumption data due to concerns about privacy and regulatory scrutiny. Non-disclosure agreements are still needed for this data transfer, as mentioned in 3.1.4.</p> <p><b>Political &amp; Economic Barriers</b><br/>While renewable energy projects receive strong initial support, enthusiasm tends to decline when financial commitments must be made. Ensuring sustained political will and financial investment will be essential for the long-term success of these initiatives.</p> |

In addition to these specific technologies, DDS foresees a strong role for sector coupling and digital optimisation of local energy flows. The creation of energy communities is expected to accelerate self-consumption and strengthen citizen involvement in the transition. The main barriers identified are related to regulatory constraints on industrial energy sharing, financing

of large-scale infrastructure such as district heating, and the need for better real-time data integration across sectors.

## 4.2. List of Replicated Technologies and potential issues during Implementation - Delft (RV#2)

Delft’s future energy strategy is centred on the large-scale deployment of geothermal heat and the expansion of district heating networks, supported by storage solutions and digital optimisation tools. TU Delft plays a key role in this vision through the Geothermal Delft (GTD) project and the development of a Digital Twin to simulate and optimise energy flows. The city also aims to increase the contribution of PV and wind, while advancing sustainable mobility with electrification of public transport and integration of EV charging infrastructure. Table 15 below summarises Delft’s expressed interest in replication technologies from the Flagship Valley. For each technology marked “Yes,” short descriptions were provided on possible application in the Delft context.

Table 15: Technologies of interest for Delft

|   |
|---|
| <p><b>1.4 Unlocking existing large-scale RES assets</b></p>   |
| <p>As part of its Sustainability Strategy, the TU Delft Campus aims to expand solar energy production by installing photovoltaic panels on building facades and rooftops. The projected solar capacity is approximately 5 GWh per year, with the generated electricity dedicated to campus operations. A significant portion of additional electricity demand will be covered by purchases from offshore wind farms. The objective is to maximize self-consumption of solar energy, reducing reliance on external power sources and increasing campus energy independence</p>   |
| <p><b>2.8 Large-scale heat buffer</b></p>   |
| <p>TU Delft has developed a geothermal well to supply heat to faculty buildings, ensuring a steady year-round heat supply. However, because heating demand fluctuates, an integrated high-temperature aquifer thermal energy storage (HT-ATES) system will optimize energy usage by storing excess heat for later use. Depending on the scenario, the geothermal well and HT-ATES together could provide between 49.4 and 102.2 GWh of heat annually. Initially, the system will supply heating to TU Delft buildings, covering up to 89% of the university’s heating demand from sustainable sources. If expanded to include the city of Delft, the total heat supplied could increase by 52.8 GWh, supporting both campus operations and surrounding districts.</p> |
| <p><b>3.1 District heating connection</b></p>   |
| <p>Beyond the TU Delft campus, a portion of the geothermal heat will be allocated to the city of Delft, with about one-third of the total output directed toward municipal heating needs. The district heating system will serve the Voorhof and Buitenhof districts, with the first connections targeting social rental housing owned by local housing corporations. However, implementation remains uncertain as construction of the district heating network by NetVerder has not yet begun, potentially delaying the connection to the city.</p>  |
| <p><b>Foreseen issues for RV</b></p>  |
| <p><b>Financing Constraints</b><br/> A major obstacle in TU Delft’s energy transition is securing adequate funding. Recent budget cuts in education and research by the Dutch government have reduced the university’s capacity to invest in sustainable infrastructure, potentially slowing down energy-related projects.</p> <p><b>Infrastructure Delays</b><br/> The integration of geothermal heat into the city’s district heating network depends on the timely completion of infrastructure by NetVerder. Any delays in implementation could hinder the transition to sustainable heating for both the university and Delft’s residential areas.</p>   |



**Housing Renovation Barriers**

Housing corporations intend to synchronize district heating connections with building renovations. Dutch law requires 70% tenant approval before renovations can proceed, which has proven difficult in past projects. Similar challenges may arise in Delft, potentially delaying the adoption of district heating solutions.

In addition to these specific technologies, Delft highlights the importance of a “Multi-Smart Commodity Grid” that integrates electricity, heat, hydrogen and storage into a coherent system. Planned future scenarios include the extension of geothermal-based district heating to residential and commercial districts, scaling up PV on rooftops and public buildings, and developing smart grid and storage solutions to handle flexibility needs. Key challenges remain the financing of infrastructure, tenant approval for building renovations, and regulatory procedures for district heating expansion.

**4.3. List of Replicated Technologies and potential issues during Implementation - Murau (RV#3)**

The Municipality of Murau envisions achieving regional energy autonomy by maximizing the use of renewable energy sources for both heat and electricity generation. This vision is anchored in the goal of reaching a 100% renewable energy supply and ensuring a needs-based, continuous, and reliable provision of renewable energy on a continuous basis. It also promotes the implementation of innovative and replicable solutions that drive the energy transition while safeguarding biodiversity, ecosystems, and natural habitats.

In pursuing these objectives, the Municipality of Murau demonstrates strong interest in various solutions and technologies developed and tested within the *Flagship Valley* initiative. The municipality aims to identify and replicate those approaches that are most relevant to the local context, thereby facilitating the implementation of sustainable and context-specific energy transition measures at the regional level.

Table 16: Technologies of interest for Murau RV

|   |
|---|
| <p><b>1.3 Thermochemical energy production</b></p> <p>This process involves converting renewable energy carriers such as biogas, syngas, hydrogen, and biomethane through gasification or other thermochemical technologies. It is particularly relevant for Murau, where the wood industry produces substantial residual biomass that can be valorised to support local energy self-sufficiency and the circular bioeconomy.</p>   |
| <p><b>1.4 Unlocking existing large-scale RES assets</b></p> <p>Murau is already a net energy-positive region on an annual basis; however, its strategic objective is to advance toward a fully reliable and continuous supply of renewable energy on a 24/7/365 basis. To achieve this goal, the municipality leverages its high potential for photovoltaic and wind power generation, complemented by the sustainable utilization of biofuels and sector coupling (i.e. P2G and P2H)</p> |
| <p><b>2.1 Hydrogen infrastructure</b></p> <p>The development of hydrogen infrastructure constitutes a key pillar of Murau’s decarbonization strategy, enabling the production of clean hydrogen derived from photovoltaic (PV) energy. In this context, the establishment of a dedicated hydrogen (H<sub>2</sub>) pipeline is in the last phase of planning to facilitate the efficient distribution of hydrogen from local producers to end users across the region.</p>                 |
| <p><b>2.2 Hybrid battery electrolyser</b></p> <p>The integration of this technology can enhance the regional hydrogen balance by aligning supply with demand, while simultaneously maximizing the utilization of photovoltaic and wind energy</p>   |



Funded by the European Union

Project funded by



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

Swiss Confederation

|  |
|--|
| <p>generation. Moreover, it can contribute to stabilizing local electricity markets and optimizing economic benefits through more efficient energy management.</p>   |
| <p><b>2.3 Residential and neighbourhood battery</b></p> <p>Batteries can enhance local grid stability and potentially provide ancillary services to the local distribution system operator (DSO). Simultaneously, they facilitate the seamless integration of local photovoltaic (PV) generation and strengthen the role of energy communities within the regional energy system.</p>  |
| <p><b>2.5 Batteries as part of VLES</b></p> <p>The high penetration of local photovoltaic (PV) and wind generation will necessitate the deployment of such technologies to optimize energy flows across the region. These measures will help alleviate network bottlenecks, enhance service quality, enable the development of innovative business models, and contribute to the long-term stability of electricity prices.</p>  |
| <p><b>2.7 Energy conversion and integration technologies</b></p> <p>Sector coupling represents a fundamental component of the local energy transition, necessitating the effective interaction among the electricity, heating, and gas sectors. In this context, the integration of local renewable energy sources (RES), heat pumps, electrolysers, and combined heat and power (CHP) plants is essential to enhance overall system efficiency and operational flexibility.</p>   |
| <p><b>2.9 (PCM) heat buffer</b></p> <p>This technology is interesting for Murau RV as it optimises and enhance the efficiency of individual thermal systems, particularly considering the anticipated expansion of local heat pump deployment to meet individual heating demands.</p>  |
| <p><b>3.1 District heating connection</b></p> <p>The expansion and enhancement of the district heating network, combined with the utilization of local biofuels and waste heat, present significant potential for improving the region's energy efficiency and sustainability.</p>   |
| <p><b>3.2 P2P energy exchange</b></p> <p>Although the implementation of this technology in Austria is currently constrained by existing regulatory frameworks, its potential to enable transparent and efficient energy trading among participants within energy communities is highly significant. This concept warrants further exploration to lay the groundwork for future deployment once legal and regulatory barriers are lifted, thereby contributing substantially to the advancement of smart energy communities.</p>  |
| <p><b>3.3 Battery integrated smart chargers</b></p> <p>This initiative is closely linked to the development of grid-friendly charging infrastructure. Battery storage systems represent a key technological element to be further explored in the region, as they can alleviate existing bottlenecks in the distribution grid and unlock the region's high potential for electricity export.</p>   |
| <p><b>3.4 BEV and FCEV integration</b></p> <p>The integration of this type of vehicle will support the region's strategy to decarbonize the transport sector while simultaneously fostering the convergence of the transport and energy systems. Furthermore, these technologies offer added value by enabling the provision of ancillary services to the local distribution system operator (DSO), thereby helping to mitigate existing limitations within the distribution grid.</p>   |
| <p><b>Foreseen issues for RV</b></p> <p><b>Data Sharing and Privacy:</b> Both companies and citizens often exhibit reluctance to share information and personal data, which poses a significant challenge to the development of digital infrastructures. Such infrastructures rely on effective coordination and management of diverse assets, which in turn require robust data exchange mechanisms and clear privacy safeguards.</p> <p><b>Legal Barriers:</b> The absence of comprehensive legislation and regulatory frameworks impedes the implementation and large-scale deployment of innovative energy infrastructures and digital solutions. Establishing supportive legal mechanisms is therefore essential to facilitate progress in this domain.</p> |



**Technical Barriers:** Uncertainties regarding the real-world performance and reliability of innovative technologies present a major technical challenge. Demonstrating the robustness and scalability of these solutions under actual operating conditions remains a critical prerequisite for broader adoption.

**Business, Financing and Service Barriers:** There is considerable uncertainty surrounding the viability of business models, financing and service frameworks necessary to ensure the long-term sustainability of these solutions. The development of appropriate market structures and financial mechanisms is vital to support their effective implementation and operation.

#### 4.4. List of Replicated Technologies and potential issues during Implementation - Konin (RV#4)

Konin’s planned future scenario builds on its ongoing transformation from a coal-based economy to a green energy hub. Local stakeholders, coordinated through the Green Energy Cluster, have expressed strong interest in replicating several flagship and standard technologies, particularly in the areas of geothermal energy, biogas, waste-to-energy, PV, hydrogen, and smart storage solutions. Table 17 below summarises Konin’s responses to the replication template. For each technology marked “Yes,” a short description was provided by the valley.

Table 17: technologies of interest for Konin

|  |
|--|
| <b>1.2 Biological Carbon Capturing and Usage (B-CCU)</b>   |
| The Biological Carbon Capturing and Usage (B-CCU) technology in Konin aims to fixate CO <sub>2</sub> from biogas produced in a digester by cultivating algae in a photobioreactor. The processed CO <sub>2</sub> will be used to generate spirulina from algae, creating a valuable byproduct. This system will be implemented at MZGOK ul. Sulańska 13, utilizing the site's existing energy resources, including electricity and heat from municipal waste thermal processing. Future plans include integrating bio gasification to enhance energy utilization and CO <sub>2</sub> conversion into high-value products.      |
| <b>1.3 Thermochemical energy production</b>  |
| This process involves the conversion of renewable energy carriers such as biogas, syngas, hydrogen, and biomethane through gasification or other thermochemical technologies. The thermochemical energy production system will process up to 112307.7 Mg of RDF per year at maximum capacity (8760 hours per year) and 102400 Mg at nominal capacity (8000 hours per year). The facility will generate electricity within a range of 5.6 to 9.8 MW and heat energy between 0.3 and 28.2 MW. The installation will be located on a plot owned by MZGOK, ensuring efficient integration into the region's energy infrastructure. |
| <b>1.4 Unlocking existing large-scale RES assets</b>   |
| The integration of existing Renewable Energy Sources (RES) into an optimized energy control system will be achieved through Teleports, a gateway for energy asset management. This initiative includes the development of an integrated energy management and accounting system for the energy cluster and valley. Located at MZGOK ul. Sulańska 13, this system will support energy commercialization efforts, enabling better energy trading within the cluster and improving overall efficiency in renewable energy utilization.  |
| <b>2.1 Hydrogen infrastructure</b>   |
| A local hydrogen infrastructure will be established to connect producers and consumers within the Konin energy system. This includes the installation of pipelines, compressors, and docking stations to balance hydrogen supply and demand. Hydrogen production will occur during periods of low or negative energy prices (such as in summer months) to stabilize production and provide fuel for MZK city transport. MZGOK, which already has its own electricity and heat from municipal   |



|   |
|---|
| waste processing, will supply hydrogen for city buses, ensuring an efficient transition to clean transport energy.  |
| <b>2.4 Flow battery</b>   |
| The implementation of a flow battery system will enable long-term energy storage by utilizing two liquid electrolyte solutions separated by a membrane. This storage system will provide a stable power supply, allowing surplus energy to be stored during low-demand periods and sold at higher prices when demand increases. The facility, located at MZGOK ul. Sulańska 13, will have an energy generation capacity of 6.75 MW using CHP technology, ensuring efficient energy storage and grid stabilization.  |
| <b>3.2 P2P energy exchange</b>  |
| A P2P energy exchange system will facilitate both physical and virtual electricity trading among local peers, including residents and businesses, to enhance energy self-sufficiency and reduce grid pressure. The project includes the construction of approximately 5 km of a 15 kV network to connect existing power grid sections owned by KE ZEK partners. Konin's municipal power grid spans 7536 meters, including transformer stations and various transmission lines, ensuring a robust foundation for local energy trading. The integration of overhead lines and underground cable systems will enable efficient power distribution to investment areas and nearby industrial zones.   |
| <b>3.3 Battery integrated smart chargers</b>  |
| To support heavy-duty battery electric vehicles, a battery-integrated smart charging system will be installed. This solution will allow for fast EV charging services even in areas with limited grid capacity. The facility, located at MZK ul. Brunatna, will primarily serve the municipal transport company, enabling efficient charging for the growing fleet of electric buses. This infrastructure will play a crucial role in Konin's transition toward sustainable urban mobility by ensuring reliable and rapid charging solutions for public transportation.   |
| <b>Foreseen issues for RV</b>   |
| <p>The biggest challenge is financing, as the transition requires high costs for building modernization, large-scale renewable projects, and industrial sector transformation. Konin must diversify its sources of financing to reduce its dependence on public subsidies.</p> <p>Another problem is the limited availability of digital and monitoring data. Currently, energy data is mainly based on historical invoices and aggregated statistics, which means there is no real-time monitoring. This lack of detailed information makes it difficult to optimize energy production and consumption within the cluster. An additional problem is the dispersion of some information across different entities.</p> <p>In the legal and political sphere, regulatory uncertainty is a significant barrier, especially in the areas of hydrogen infrastructure and waste-to-energy projects. Complex permitting processes for large renewable and hydrogen production projects also slow down progress.</p> <p>The transition also faces social barriers, including public resistance resulting from economic changes associated with the decline of the coal industry. There is limited public engagement in energy initiatives, which hinders the implementation of solutions and requires retraining programs for former mine workers.</p> <p>Finally, environmental challenges include the need to remediate areas affected by legacy pollution from coal mining and the need for rigorous enforcement of emission standards for new installations. The expansion of renewable energy infrastructure must also be carefully balanced with land-use planning.</p> <p>Despite these challenges, Konin is actively implementing an ambitious transformation plan, integrating geothermal energy, biogas, and hydrogen to become a leader in Poland's green transition.</p> |

In summary, Konin's future scenario demonstrates a comprehensive and ambitious plan that combines geothermal, waste-to-energy, biogas, hydrogen, PV and storage solutions.



Funded by  
the European Union

Project funded by



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

Together, these investments are expected to secure a renewable-based district heating supply, decarbonise public transport, and strengthen the valley’s role as a leader in Poland’s green transition.

#### 4.5. List of Replicated Technologies and potential issues during Implementation – Western Macedonia (RV#5)

Western Macedonia is undergoing a profound transformation as lignite, the region’s historical economic backbone, is phased out by 2028. This shift threatens around 16,000 direct and indirect jobs and creates pressing socio-economic and energy security challenges, particularly in heating and electricity supply. In this context, the replication of innovative technologies is not only an environmental imperative but also a socio-economic necessity. The selected solutions – ranging from biogas CHP and large-scale solar parks under municipal energy communities, to the Hydrogen Innovation Hub, decentralised batteries, a large-scale heat buffer, and electromobility measures – aim to diversify the regional energy mix, reduce dependence on lignite, and open pathways for new skills, industries, and employment. Their replication is intended to secure reliable, affordable, and sustainable energy while supporting a just transition for local communities. Nonetheless, implementation may face barriers linked to high investment needs, grid saturation, regulatory uncertainty, and public acceptance, which must be addressed to ensure long-term success.

Table 18: technologies of interest for Western Macedonia

|  |
|--|
| <p><b>1.3 Thermochemical energy production</b></p>   |
| <p>Thermochemical energy production through biogas generation will employ anaerobic digestion of local agricultural residues to produce both electricity and heat via a combined heat and power (CHP) unit based on internal combustion engines with an installed capacity of 1 MWe. The facility will be in the Municipality of Kozani and is expected to provide heating energy for approximately 2500 to 3000 households. The electricity will be injected into the grid and remunerated through the applicable tariff scheme, while the generated thermal energy will support district heating needs in small settlements currently lacking direct connection to the Kozani system. Overall, the installation is projected to yield around 1 MWe of electrical output and 5-8 MWth of thermal output, contributing to both energy diversification and rural decarbonisation.</p>   |
| <p><b>1.4 Unlocking existing large-scale RES assets</b></p>  |
| <p>The unlocking of existing large-scale renewable energy sources, specifically through the development of a 7 MW solar park composed of seven separate PV facilities distributed across the Kozani municipality, particularly in the Drepano area. The initiative will be developed under the Kozani municipal energy community, which brings together a wide range of local stakeholders, including municipal authorities, the water and sewerage utility, the municipal waste management company, schools, and cultural institutions. Electricity generated by the solar park will be allocated to its members using a virtual net metering scheme, thereby reducing their dependence on fossil-based electricity and lowering operational costs. The estimated annual contribution to the grid is between 10000 and 12000 MWh, which will significantly strengthen the role of energy communities as local actors of the transition.</p> |
| <p><b>2.1 Hydrogen infrastructure</b></p>  |
| <p>The hydrogen infrastructure foreseen for Western Macedonia represents one of the most ambitious demonstration projects. A Hydrogen Innovation Hub will be developed (from CERTH through JTF) at the former AEVAL industrial site in Ptolemaida, in the Municipality of Eordaia. The hub will integrate the entire hydrogen value chain, encompassing production, storage, and use. It will include a 1 MW photovoltaic park, two alkaline electrolysers with a total capacity of 900 kW, two fuel cells (100 kW and 60 kW), a 370 kWh battery system, and a hydrogen refuelling station.</p>  |



The hub is designed to produce between 100 and 300 kilograms of hydrogen per day. While its initial focus is on research and demonstration, it will also provide direct value to mobility, as it will support two fuel cell electric cars and two planned hydrogen-powered municipal garbage trucks. In addition, the electricity from the PV park will power the electrolyzers, while the heat generated by the electrolyzers and fuel cells will be recovered via a 75 kW thermal heat pump for on-site heating. The Hydrogen Innovation Hub is expected to become a cornerstone of the regional innovation ecosystem, fostering research partnerships, industrial applications, and skills development in a field of strategic importance for the European energy transition.

**2.3 Residential and neighbourhood battery**

Decentralized storage is also a priority, with residential and neighbourhood batteries planned as demonstration pilots. Ten public buildings in Kozani and Ptolemaida, mainly offices, will each be equipped with a 10 kWh battery, providing a combined storage capacity that could cover up to 3,000 kWh of annual consumption. These systems will enhance the self-sufficiency of the buildings, reduce pressure on the regional grid, and allow for better integration of intermittent renewable generation. A larger 100 kWh battery is also foreseen for installation at a business utility in the Kozani–Eordaia industrial zone. The main objective of these pilots is to test the role of distributed storage in strengthening local resilience and providing flexibility to the grid.

**2.8 Large-scale heat buffer (Extended heat capacity)**

At the level of district heating, the installation of a large-scale heat buffer is foreseen in Ptolemaida. The planned buffer will have a storage capacity of between 2000 and 4000 cubic meters, supporting the local district heating company (DHCP) which supplies approximately 4500 buildings. The buffer will enable the storage of surplus thermal energy during periods of low demand and its release during peak demand periods, thereby improving the overall efficiency and reliability of the district heating system. By providing flexibility, this measure will also facilitate the integration of renewable and alternative heat sources, reduce operational costs, and limit CO<sub>2</sub> emissions. The estimated energy contribution is between 10000 and 15000 kWh annually, which will directly benefit the households connected to the district network.

**3.3 Battery integrated smart chargers**

In the field of electromobility, two complementary technologies have been prioritised. The first is the deployment of a battery integrated smart charger with a capacity of 100 kWh, which will be installed at the premises of the Hydrogen Hub in Ptolemaida. This infrastructure will enable fast charging services for three to five private electric vehicles, as well as for a planned municipal electric truck. It will be directly linked to the adjacent 1 MW PV park, using surplus production for charging when hydrogen production is not required. By integrating a battery, the charger will deliver fast services despite the limited local grid connection, offering a scalable solution for other areas facing similar constraints.

**3.4 BEV and FCEV integration**

The integration of battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) will be pursued through a portfolio of vehicles to be operated in conjunction with the Hydrogen Hub. This fleet will include two hydrogen fuel cell cars purchased for the Hub personnel, two hydrogen garbage trucks planned by the Municipality of Eordaia, one electric truck for municipal services, and three to five additional electric cars belonging to staff and visitors. In total, the infrastructure will support up to ten vehicles, combining both battery and hydrogen drivetrains. The dual provision of hydrogen refuelling and fast electric charging will not only serve operational needs but also act as a demonstration platform for future mobility solutions, linking research, public services, and citizen use.

**Foreseen issues for RV**

The replication of innovative technologies in Western Macedonia is likely to face several challenges. For thermochemical energy production, the availability and stable supply of agricultural residues, together with permitting and environmental concerns, may hinder deployment, while profitability remains sensitive to feed-in tariffs and market support. The solar parks planned under energy communities face grid saturation problems, with high rejection rates



for new PV connections, alongside regulatory uncertainties and possible land-use conflicts. The hydrogen innovation hub represents a flagship initiative, yet its success depends on overcoming high capital costs, the immaturity of the hydrogen market, gaps in safety regulations, and potential concerns over public acceptance. Small-scale residential and neighbourhood batteries may struggle with cost-effectiveness and regulatory barriers, and their long-term scalability remains uncertain. Similarly, the integration of a large-scale heat buffer in Ptolemaida is technically feasible but poses financing challenges as its benefits are largely indirect, while dependency on lignite replacement pathways may affect its utilisation. The battery-integrated smart charger is constrained by weak local grids and currently low EV adoption, raising concerns over demand and economic viability. Finally, the integration of BEVs and FCEVs in municipal fleets is constrained by high vehicle costs, the absence of a robust refuelling and charging network, and operational risks linked to early-stage technologies. Overall, the cross-cutting issues for Western Macedonia revolve around financing, grid capacity, regulatory clarity, and social acceptance, which will determine whether these technologies can scale beyond pilot applications.

Western Macedonia seeks to replicate these seven technologies to replace lignite-based energy, safeguard district heating, and accelerate the shift toward renewables and clean mobility. Together, they are expected to diversify the energy mix, create new employment opportunities, and enhance system flexibility while reducing emissions. Ultimately, their deployment will support a just transition, ensuring energy security and socio-economic resilience for the region.

**4.6. List of Replicated Technologies and potential issues during Implementation – Tolosaldea (RV#6)**

Tolosaldea’s transition pathway emphasises decentralised, community-led electrification and flexibility. Rooftop and community PV will be scaled rapidly targeting around 50% household coverage in ~5 years and ~75% in ~10 years, largely for self-consumption (~30% of demand); with wind, small hydro, biomass and site-specific geothermal added where feasible. To raise local matching and ease LV/MV constraints, the valley prioritises residential and neighbourhood batteries and deployment of batteries within Virtual Local Energy Systems (VLES), complemented by P2P energy exchange and enhanced monitoring/control to unlock existing RES assets. Heat decarbonisation will pair district-heating connections (in suitable dense clusters and around anchor loads) with thermal storage: large-scale heat buffers at network level and (PCM) building-level buffers to smooth heat-pump operation and peak loads. Thermochemical energy production (biogas/syngas/biomethane) is considered to support process heat and provide dispatchable renewable supply. Energy-carrier integration (P2H, G2H, H2P, P2G at modest scale) is foreseen where it adds clear system value. On mobility, the near-term focus is a broad rollout of standard EV charging across municipalities; heavy-duty fast-charging/battery-integrated solutions are not a short-term priority.

|   |
|---|
| <b>1.3 Thermochemical energy production</b>   |
| Production of biogas for local usage is an option that will be considered. The neighbouring valley (Goierri) is considering producing biogas with farm residue and if this should prove to be a success, it’s quite probable to replicate it in Tolosaldea.   |
| <b>1.4 Unlocking existing large-scale RES assets</b>  |
| As part of its Sustainability Strategy, Tolosaldea aims to expand solar energy production by installing photovoltaic panels on building facades and rooftops. The projected solar capacity is approximately 5 GWh per year (5MW PV and 1MWh battery). The objective is to maximise self-consumption of solar energy, reducing reliance on external power sources. |
| <b>2.3 Residential and neighbourhood battery</b>  |

|  |
|--|
| As electricity production during solar hours is increasingly intense, electricity prices are dropping during the daytime. However, residential consumption is more concentrated during evening hours. As a result, there is a good case for neighbourhood batteries.   |
| <b>2.5 Batteries as part of VLES</b>   |
| The implementation of stationary batteries as part of a local energy system in which peers exchange available electricity and where the battery balances the remaining mismatch in electricity demand and supply.  |
| <b>2.7 Energy conversion and integration technologies</b>  |
| To integrate multiple clean energy carriers, conversion technologies such G2P, G2H, P2H, H2P and P2G will be demonstrated to balance the FV. The most probable carriers will be the EVs. Hydrogen is not expected to be a good option in Tolosaldea.   |
| <b>2.8 Large-scale heat buffer</b>   |
| The demonstration of a large-scale heat buffer fed by a local/regional heat source. The heat buffer allows for (sustainable) heating provisioning during peak demand. Tolosaldea will need to understand this technology and the advantages before considering it a good option  |
| <b>2.9 (PCM) heat buffer</b>   |
| As above, in 2.8. In addition, during the H2020 project CHESTER, an analysis of a PCM-based thermal storage system in combination with a high-temperature heat-pump and ORC generator, showed that the economic case for this kind of system is still unviable.  |
| <b>3.1 District heating connection</b>   |
| Renovation of residential buildings is being pushed by public institutions, and we expect that District Heating is going to be considered as a good option for those renovated neighbourhoods  |
| <b>3.2 P2P energy exchange</b>   |
| This is still an unknown activity, but we expect a development and public acceptance in the near future. The required legislation is not yet in place.   |
| <b>Foreseen issues for RV</b>  |
| <p><b>Financing Constraints</b><br/>A major obstacle in Tolosaldea for vulnerable families</p> <p><b>Infrastructure Delays</b><br/>Public institutions are very much focused on PV but expected to address energy efficiency soon.</p> <p><b>Lack of public acceptance</b><br/>Any Renewable Energy Project that occupies natural sites (in particular wind) will provoke a big public response and resistance.</p> <p><b>Housing Renovation Barriers</b><br/>Most of the housing apartments are owned by citizens and any intention of neighbourhood renovation needs a wide acceptance of the project.</p> |

Overall, Tolosaldea’s scenarios favour small-/mid-scale assets, cooperative governance, and digital coordination to lift self-consumption and resilience, while deferring capital-intensive hydrogen and heavy-duty mobility options to later iterations.

## 5. CONCLUSIONS

Deliverable 7.1 has successfully established the baseline assessment for all Replication Valleys (RVs), documenting their current energy systems, socio-economic contexts, transition policies, and data availability. The structured data collection - through templates, workshops, and bilateral exchanges - provides a coherent and comparable foundation for the next steps in WP7.

The analysis confirms that RVs are at different stages of development. DDS and Delft are advancing in district heating and digitalisation; Murau is already a net renewable electricity



exporter; Konin is undergoing a major coal-to-renewables transition; Western Macedonia is navigating the phase-out of lignite while maintaining energy security; and Tolosaldea is building on strong grassroots initiatives despite limited local energy production. These differences highlight the diversity of contexts in which the REFORMERS approach must be adapted.

A central outcome of this deliverable is the identification of data gaps and variability in granularity. While all valleys have completed the replication template, including technology descriptions and implementation challenges, the level of detail and resolution of available data still varies. Addressing these gaps will be essential to support robust system design (T7.2), environmental impact assessment (T7.3), and governance and business model analysis (T7.4).

Importantly, data collection is an evolving process. This deliverable marks the beginning of a continuous effort to refine and expand the baseline through ongoing bilateral exchanges, stakeholder engagement, and targeted follow-up campaigns. This iterative approach ensures that future modelling and assessments are grounded in accurate, context-specific information.

Beyond replication from the Flagship Valley, the baseline analysis revealed valuable opportunities for cross-learning among Replication Valleys themselves. While each RV operates under distinct technical and regulatory conditions, several strengths emerged that could inspire others. For example, Tolosaldea's strong community engagement and cooperative governance model offers lessons for regions where citizen participation remains limited. Similarly, Murau's experience with integrated renewable strategies and Konin's approach to digital energy monitoring could inform valleys facing data and infrastructure gaps. These insights highlight the potential for peer-to-peer exchanges and thematic workshops within the REFORMERS consortium, fostering knowledge transfer on social innovation, governance, and technical integration. Such cross-RV collaboration will complement replication from the Flagship Valley and accelerate the overall transition by leveraging diverse experiences across Europe.

In conclusion, Deliverable 7.1 provides a solid and actionable baseline for the REFORMERS Replication Valleys. It mobilises local actors, identifies opportunities and barriers, and sets the stage for the replication of innovative energy solutions across Europe.



## ANNEX A - Satellite valley preliminary data collection template

The circulated template is included here.

### 1.1 How to fill-in the document

Each REFORMERS' Satellite Valley should fill in the document by following the *guiding instructions and questions provided in blue text*. Tables and columns where your input is required are marked with the

yellow background

Refer to Annexes for more information.

### 1.2 Context data

In the following Table 1 general data related with the Satellite Valley is collected through guiding questions.

Table 1 - Satellite Valley context data

| CONTEXT DATA  |
|---|
| <b>Energy Valley #: Short Description</b>   |
|   |
| <b>Energy Valley # current energy mixture profile and level of smartness</b>  |
| <p><i><b>Building sector:</b> some key facts about the type of buildings, number of buildings it has and key numbers for their consumption (electricity, heat, fuel) on an annual basis.</i></p> <p><i><b>Industrial Sector:</b> some key facts about the type of industries/commercial activities in the area and key facts about their electricity, heat and fuel needs on an annual basis. If there is an industrial park within the area, please elaborate more (emphasis on synergies if any)</i></p> <p><i><b>Electricity/Heating/Cooling:</b> a list and key facts of technologies/power plants present on-site (fossil and renewable energy sources) existing/feeding this area and of the current energy mixture for electricity/heating/cooling. Include also available storage systems (i.e., electrical, heating/cooling, H2)</i></p> <p><i><b>Transportation sector:</b> some key facts related to transportation needs, number of vehicles in circulation, green vehicles, EV chargers available etc.</i></p> |
| <b>Energy Valley # Energy Transition related policies - Investing and Funding in Energy Valley #</b>  |



Key information about on-going local investments and key targets of the local decarbonization roadmap.

**Clean Energy:**

**District Heating:**

**Industry and Trade:**

**Smart Agriculture:**

**List any on-going activities, serving this scope:**

What regional investments are foreseen in the Valley by 2030 and by 2050? What is the status about local Energy Communities foreseen to be formed? What type, LEC or REC?

### Main Objectives / Challenges for Energy Valley # towards decarbonization - Expected Impact

List briefly objectives and challenges for your site's transition towards decarbonization and expected – negative and positive - impacts:

### Energy Valley current state of data monitoring and availability

- Are there any measurements of energy production/consumption currently available? Historical or real-time data available?
- Energy prices/contracts of the region

### Energy valley socio-economic data

- Some key facts about the socio-cultural context and community initiatives in the area, not necessarily related to energy aspects (e.g. local associations, community groups including energy communities, initiatives promoting social cohesion, participatory processes etc..)
- Are there socio-economic databases, statistics or reports available open access or accessible by REFORMERS' partners through local administration on the REPLICATION VALLEY area, including:
  - Local development and economic activities (e.g. % new sustainable businesses, Human Development Index)
  - Employment
  - Welfare, health
  - Environmental indicators
  - Energy poverty
- Who are the relevant stakeholders we shall reach out for to have an overview on socio-economic aspects?



### 1.3 List of innovative technologies deployed in the Flagship Valley

Since replication is the main objective of this WP, the Replication Valleys should **examine some of the Innovative Technologies, called ‘Energy-Innovations’ (IE), present in the Flagship Valley of Alkmaar**. Figure 1 provides a geographical overview of the to be demonstrated energy-innovations as part of Renewable Energy Valley Tracks 1 – 3 in:

1. Boekelermeer, business park
2. Overdie, populated residential area
3. Heiloo, light residential area
4. Heiloo, industrial zone
5. Zuidermeer, rural expanse



Figure 1. Flagship valley Innovative Technologies location

Table 2 includes the list of technologies that will be demonstrated in Alkmaar. Please fill in the last column of the table according to your interest in one or more specific **Innovative Technology**. In ANNEX I, a detailed explanation of each Innovative Technology can be found. Table 3 includes a list of standard technologies that may be considered by the Satellite Valley.

Table 2: List of Innovative Technologies to be demonstrated at the Flagship Valley and are of interest for replication in the Satellite Valley.

| <b>A/A Name of the Technology</b>                        | <b>Short description</b>  | <b>Interest for the Satellite Valley # (Y/N).</b><br><br><i>In case of Y, you need to provide the following information stated in the below paragraph entitled as “Short Description for each of the replicated Technology”</i> |
|--|---|---|
| <b>1.1 Hydrogen NO Carbon</b>                            | Production of clean hydrogen from organic waste products via thermolysis with byproduct being biochar that acts as a carbon sink.   |   |
| <b>1.2 Biological Carbon Capturing and Usage (B-CCU)</b> | Fixating CO <sub>2</sub> from biogas originating from a digester through the cultivation of algae in a photobioreactor.   |   |
| <b>1.3 Thermochemical energy production</b>              | Production of renewable energy carriers such as biogas, syngas, hydrogen and biomethane through gasification or other thermo-chemical technologies.   |   |
| <b>1.4 Unlocking existing large-scale RES assets</b>     | Unlocking existing Renewable Energy Sources for optimized control through Teleports (gateway to control energy assets).   |   |
| <b>2.1 Hydrogen infrastructure</b>                       | Connecting local hydrogen producers and consumers by realizing a local hydrogen infrastructure comprising of pipelines, compressor and docking station (to balance the system).   |   |
| <b>2.2 Hybrid battery electrolyser</b>                   | A hybrid system for production of green H <sub>2</sub> and storing energy, that operates based on a zinc intermediate step electrolysis (ZZE). In this way, hydrogen production and energy storage functionalities are integrated in one system, and thus offer efficient grid-serving use of renewable energies. |   |

|   |  |  |
|---|--|--|
| <b>2.3 Residential and neighborhood battery</b>           | Individual batteries at residential dwellings and/or a collective neighborhood battery to increase the energy self-sufficiency of the residents and thereby also reduce the pressure on the grid.                                  |  |
| <b>2.4 Flow battery</b>                                   | A type of rechargeable battery in which two chemical components are dissolved in liquids separated by a membrane. Compared to more traditional battery systems, the (redox) flow battery enable to store power for longer periods. |  |
| <b>2.5 Batteries as part of VLES</b>                      | The implementation of stationary batteries as part of a (virtual) local energy systems in which peers exchange available electricity and where the battery balance the remaining mismatch in electricity demand and supply.        |  |
| <b>2.7 Energy conversion and integration technologies</b> | In order to integrate multiple clean energy carriers, conversion technologies such G2P, G2H, P2H, H2P and P2G will be demonstrated to balance the FV.  |  |
| <b>2.8 Large-scale heat buffer</b>                        | The demonstration of a large-scale heat buffer fed by a local/regional heat source. The heat buffer allows for (sustainable) heating provisioning during peak demand.  |  |
| <b>2.9 (PCM) heat buffer</b>                              | Individual, small scale, phase-change material (PCM) heat buffers, in combination with water/water heat pumps able to be used at residential dwellings for heat storage.   |  |
| <b>3.1 District heating connection</b>                    | Connecting residents and/or businesses to a local or regional heating grid fed by a local heat source (and potentially in combination with a heat buffer).   |  |
| <b>3.2 P2P energy exchange</b>                            | Physical and/or virtual exchange of electricity between local peers (residents or businesses) to increase the self-sufficiency and reduce the pressure on the electricity grid within the Energy Valley.                           |  |

|  |   |  |
|--|---|--|
| <b>3.3 Battery integrated smart chargers</b> | A battery integrated smart/fast EV charger for heavy duty battery electric vehicles. The integrated solutions to provide fast EV charging services even with limited available grid capacity. |  |
| <b>3.4 BEV and FCEV integration</b>          | The integration of heavy-duty 1) Battery Electric Vehicle (BEV) and 2) Fuel Cell Electric Vehicles to reduce greenhouse emissions in transportation   |  |

Table 3. List of standard RES technologies of interest for replication in the Satellite Valley.

| <b>A/A Name of the Technology</b> | <b>Interest for the Satellite Valley # (Y/N).</b><br><i>In case of Y, you need to provide the following information stated in the below paragraph entitled as "Short Description for each of the replicated Technology"</i> |
|-----------------------------------|---|
| Photovoltaics (PV)                |   |
| Wind turbines                     |   |
| Boilers (natural gas/ biomass)    |   |
| EV chargers                       |   |
| Bio-energy plant                  |   |
| Electrolyzer                      |   |
| Hydro-power                       |   |
| Geothermal energy                 |   |
| <b>Other technology</b>           |   |

### 1.4 Short Description for each of the replicated Technology (RV#)

Copy/paste the following table and complete required data per each of the technologies of interest for your Satellite Valley

| <b>[Name of Technology of interest #1]</b>   |
|--|
| <p><i>Shortly describe</i></p> <p>i) <i>the size/expected capacity</i></p> <p>ii) <i>ii) where (area of the region) this will be installed,</i></p> <p>iii) <i>iii) how many consumers/residents it will serve,</i></p> <p>iv) <i>iv) the relevant scope/objective of operation and</i></p> <p>v) <i>v) the associated value streams (input-output) (e.g. electricity, heating, cooling, vehicles)</i></p> |

### Foreseen issues for Energy Valley



*This can include missing any type of data or information on current energy system, lack of any possible future changes to energy system due to external factors (financial, political, etc.) or conflicts with other ongoing similar projects.*

...

## Detailed description of each of the innovative technologies deployed and demonstrated in the flagship

Table 4. Energy innovation actions grouped by REVTs

| Name and description of innovation  | Level of interest (1-low 5-high) |
|---|----------------------------------|
| 1.1 Hydrogen NO Carbon (Hynoca Technology): HYNOCA will produce clean hydrogen at InVesta's center of expertise. HYNOCA will produce 30 kg of H <sub>2</sub> per hour from organic waste products via thermolysis with the byproduct being biochar that acts as a carbon sink. The produced hydrogen will (partly) feed a local hydrogen infrastructure (REVT2) and be distributed to NXT Mobility's hydrogen filling station (REVT3).  |                                  |
| 1.2 Biological Carbon Capturing and Usage (BCCU): Sustenso will connect its digester, located opposite from InVesta, to a Photobioreactor at InVesta to fixate CO <sub>2</sub> through the cultivation of algae. The digester annually produces 5 – 7.5 million m <sup>3</sup> biomethane to be fed into the existing natural gas grid, and the photobioreactor will capture 12,600 kg CO <sub>2</sub> per year.  |                                  |
| 1.3 Thermochemical energy production: Multiple SMEs will locate at the indoor and outdoor facilities of InVesta's center of expertise and produce renewable energy carriers such as biogas, syngas, hydrogen and biomethane through gasification or other thermo-chemical technologies.   |                                  |
| 1.4 Unlocking existing large-scale RES assets: Existing renewable production assets – such as HVC's 2.4MW solar, 4.6MW wind and 100MW bio-energy plant – will be unlocked for monitoring, optimization as further delineated in REVT4.  |                                  |
| 2.1 Hydrogen infrastructure: To connect the hydrogen producer(s) to hydrogen consumers within the FV, Alliander and HYNOCA will demonstrate a local hydrogen infrastructure at InVesta. This hydrogen infrastructure entails a storage vessel, distribution pipelines, compressor and docking station. The hydrogen will partly be locally taken off by NXT and potential other local consumers, and the surplus of produced hydrogen will be transported to external off-takers through tube trailers. |                                  |
| 2.2 Hybrid battery electrolyser: The hydrogen infrastructure (EI2.1) will further be extended with STOFF2's Hybrid Zinc-Intermediate Electrolyser (ZZE) with integrated storage unit. This hybrid electrolyser with a capacity of 2 MWh will annually produce 18,000 kg H <sub>2</sub> .  |                                  |



|   |  |
|---|--|
| <p>2.3 Residential and neighborhood battery: Duurzaam Heiloo will demonstrate ten individual batteries (10kWh) at residential dwellings and one collective battery (100 kWh) at a neighborhood within the Eastern part of Heiloo. The collective is most likely to be implemented at CiRoPack, a packaging company, situated at 'De Oude Werf 10'. The demonstration of the energy storage systems (ESS) will increase the energy self-sufficiency of the residents and reduces the dependence on the regional electricity grid and thereby also reducing the pressure on the grid.</p> |  |
| <p>2.4 Flow battery: Repowered will demonstrate a business level (1 MWh) flow-battery for which InVesta will open up their facilities including the grid connection at their center of expertise.</p>   |  |
| <p>2.5 Batteries as part of VLES: The municipality of Alkmaar will implement two batteries (3.3 and 1.1 MWh) in which the 3.3 MWh battery will be part of a Virtual Local Energy System (VLES) that will circumvent the grid constraints for +/- 7 businesses at the new harbour at the Boekelermeer. The 1.1 MWh battery is intended to support the electricity peak demand at InVesta.</p>  |  |
| <p>2.6 Remote controlled MV switchgear: Alliander will monitor and intelligently optimize the current state of the medium voltage switch gear using the ENTRNCE platform (REVT3) to balance electricity flows and avoid overloading the electricity grid.</p>   |  |
| <p>2.7 Energy conversion and integration technologies: The energy carriers produced at InVesta will be distributed, converted and directly utilized within the FV. Conversion technologies such G2P, G2H, P2H, H2P and P2G will be demonstrated to balance the FV.</p>  |  |
| <p>2.8 Large-scale heat buffer (Extended heat capacity): With an emphasis on the storage and distribution of heat, HVC will demonstrate a 2,000–4,000 m<sup>3</sup> heat buffer installed in connection to the bio-energy plant. The buffer allows for a more optimal balance in heat and electricity production and for peak heat demand to be covered by the heat buffer instead of the bio-energy plant directly.</p>  |  |
| <p>2.9 (PCM) heat buffer: Duurzaam Heiloo will facilitate the demonstration of individual, small scale, (PCM) heat buffers, in combination with water/water heat pumps at five dwellings in Heiloo.</p>   |  |
| <p>3.1 District heating connection: A high-rise building, owned by Woonwaard consisting of 112 dwellings, will be connected to HVC's district heating network. The dwellings, located at Overdie, Melis Stokelaan 49 – 271, will be equipped with indirect delivery sets that HVC and Woonwaard first demonstrated as part of POCITYF.</p>  |  |



3.2 P2P energy exchange: Peer-to-peer energy exchange will be made available for a number (+/-7) of businesses that face severe grid constraints. The businesses will be connected through a virtual local energy system (VLES) physically tied to GP Groot's, NXT Mobility's mother company's, existing grid capacity. To further compensate for short-term and seasonal fluctuation in energy availability, the system covers a 3,3 MWh battery and the potential usage of biogas or hydrogen to supplement the electricity provisioning (G2P) being produced.

3.3 Battery integrated smart chargers: NXT Mobility will demonstrate a battery integrated smart/fast EV charger at their premises (Diamantweg 18) for heavy duty battery electric vehicles. The integrated solution, consisting of a 200-kWh battery, enables fast charging services despite only having a small grid connection.

3.4 BEV and FCEV integration: GP Groot will utilize three fuel cell electric vehicles for which the hydrogen is produced by HYNCOCA (REVT1), and directly being distributed via the local hydrogen infrastructure (REVT2) to the hydrogen filling station operated by NXT Mobility (Diamantweg 32). Also, the battery integrated EV charger (EI3.3) will be utilized by a heavy-duty battery electric vehicle. The heavy-duty BEV will collect agricultural and organic waste residues that serves as the input for the production of biomethane by Sustenso or hydrogen by HYNCOCA.



## List of technologies per each REFORMERS' Research tracks

Detailed description of how each innovative technology deployed in the flagship contributes to the three technological RESEARCH TRACKS.

| Renewable energy valley track | Flagship Valley location                         | Energy Innovation (EI)                         | EI-number       | Responsible partner |
|-------------------------------|--|--|-----------------|---------------------|
| REVT#1                        | Boekelmeer                                       | Hydrogen NO Carbon                             | 1.1             | HYNOCA              |
|                               |  | Biological Carbon Capturing and Usage (B-CCU)  | 1.2             | Sustenso            |
|                               |  | Thermochemical energy production               | 1.3             | InVesta             |
|                               |  | Unlocking existing large-scale RES assets      | 1.4             | WiththeGrid         |
| REVT#2                        | Boekelmeer                                       | Hydrogen infrastructure                        | 2.1             | Alliander           |
|                               |  | Hybrid battery electrolyser                    | 2.2             | Stoff2              |
|                               |  | Flow battery                                   | 2.4             | Repowered           |
|                               |  | Batteries as part of VLES (3,3 MWh)            | 2.5a            | Municipality        |
|                               |  | Batteries as part of VLES (1,1 MWh)            | 2.5b            | Municipality        |
|                               |  | Remote controlled MV switchgear                | 2.6             | Alliander           |
|                               |  | Energy conversion and integration technologies | 2.7             | InVesta             |
|                               | Large-scale heat buffer (Extended heat capacity) | 2.8  | HVC             |                     |
| Heiloo                        | Residential and neighborhood battery             | 2.3  | Duurzaam Heiloo |                     |

|        |                  |                                   |     |                 |
|--------|------------------|-----------------------------------|-----|-----------------|
|        |                  | (PCM) heat buffer                 | 2.9 | Duurzaam Heiloo |
| REVT#3 | Overdie          | District heating connection       | 3.1 | HVC             |
|        | Boekelerm<br>eer | P2P energy exchange               | 3.2 | Municipality    |
|        |                  | Battery integrated smart chargers | 3.3 | NXT Mobility    |
|        |                  | BEV and FCEV integration          | 3.4 | NXT Mobility    |

The implementation and operation of Renewable Energy Valley Tracks 1 through 3 (REVT1 to 3) contributes to the Flagship Valley and the overall project in several ways. Such contributions include enhancing the deployment of renewable energy sources (RES), fostering energy independence, reducing greenhouse gas emissions, promoting sustainable development and societal change. Moreover, these three tracks will produce data that will subsequently be utilized by Tracks 4 and 5 of the Flagship Valley, as well as by other work packages within the project.

Specifically:

- REVT1 supports the diversification of energy supplies and contributes to the decarbonization of the energy sector by promoting the use of sustainable biomethane and hydrogen, thereby aligning with the EU's goal of reducing greenhouse gas emissions and achieving climate neutrality.
- REVT2 focuses on the development and integration of conversion, storage, and grid-related technologies. By enhancing the capacity for energy storage and improving the efficiency of energy conversion and distribution processes, this track contributes to the security and autonomy of local and regional energy supplies and also helps to relieve the severe grid congestion in the area. This aligns with the objectives of REFORMERS to increase the share of consumed energy produced locally, thus supporting the EU's ambition to enhance energy security and autonomy.
- REVT3 aims at the implementation of smart renewable energy solutions by consumers across various sectors, including mobility, residential, industry, and businesses. This track encourages active involvement and citizen engagement in renewable energy communities, fostering a participatory approach to energy production and consumption. By promoting energy efficiency and the integration of renewable energy solutions into daily operations, REVT3 contributes to the economic, societal, and environmental objectives of REFORMERS and the broader EU energy and climate goals.





**Funded by  
the European Union**