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 **E**cosystems **FOR** **M**ultiple-**E**nergy **R**esilient **S**ystems

Grant Agreement No. 101136211

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

D4.4: REVT5 IMPLEMENTATION AND OPERATION PLAN

Funded by the European Union

DOCUMENT INFO

DELIVERABLE NUMBER	**D4.4**
DELIVERABLE TITLE	REVT5 Implementation and Operation Plan
WORK PACKAGE	WP4
DELIVERABLE TYPE	Report
DISSEMINATION LEVEL	Public[1]
DUE DATE	M24 (October 2025)/ Extended: M26 (December 31, 2025)
PAGES	85
DOCUMENT VERSION	1.1
LEAD AUTHORS	Bart Kaas (TNO) and Rick Gilsing (TNO)
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[1] *Originally D4.4 was classified as Sensitive; involved Partners decided to change this and turn the report into public, to facilitate dissemination of results and replicability. No sensitive data is included in the report, thus there is no privacy issue.*

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DOCUMENT CHANGE HISTORY

Version	Date	Author	Description
DRAFT			
0.1	30.05.2025	TNO: Bart Kaas	Initial structure and first contents
0.2	30.08.2025	TNO: Bart Kaas	New structure
0.3	30.09.2025	TNO: Bart Kaas, Rick Gilsing, Jurgen van der Heijden, Kas Woudstra VUB: Shary Heuninckx	Collection of inputs
0.4	30.11.2025	TNO: Bart Kaas, Rick Gilsing, Jurgen van der Heijden, Kas Woudstra, Aliene van der Veen, Eva Winters, VUB: Shary Heuninckx, Stijn Cousin, ALL: Ben Tubben	Extensive additions in all chapters. Addition of chapter 2 and three annexes
0.5	05.12.2025	TNO: Bart Kaas	Version ready for review
FIRST REVIEW			
1.0	24.12.2025	ALL : Ben Tubben, AIT: Branislav Iglár, EUREC: Nicolas de la Vega, VUB: Thierry Coosemans, TNO: Richard Westerga, Nienke Maas, Marijn Rijken, Julia Jansen	Review
1.1	31.12.2025	TNO: Bart Kaas	Feedback incorporated and version ready for approval
COORDINATOR APPROVAL, FINAL VERSION			
2.0	31.12.2025	VUB: Stella Arapoglou	Format review, version, ready for submission

EXECUTIVE SUMMARY

This report presents the **REVT5 Implementation and Operation Plan** for the Flagship Valley (FV), the main living lab of the REFORMERS project. REFORMERS is a five-year Horizon Europe Innovation Action that aims to strengthen Europe's energy security while accelerating the green transition through the development and replication of **Renewable Energy Valleys (REVs)** — regional energy systems with high shares of renewables that integrate residential and business areas.

The Flagship Valley, located in and around the municipality of Alkmaar (NL), faces a pressing challenge: **severe electricity grid congestion**, with major grid reinforcements not expected before 2035. Within this constrained context, REFORMERS supports local stakeholders in progressing the energy transition by combining technical innovation with new forms of collaboration, governance and coordination.

Central to this deliverable is the introduction and application of a **Holistic Approach for setting up Renewable Energy Valleys**. This approach provides a structured, stepwise framework that integrates technical, social, economic, legal, and governance perspectives. It is designed to guide regions from early initiation to implementation and long-term operation, while building increasing levels of stakeholder commitment along the way. The approach is supported by four REV Toolboxes developed within the project, covering stakeholder engagement and socio-economic impact assessment, energy system design, environmental impact assessment, and business models, governance, and policy & legal analysis.

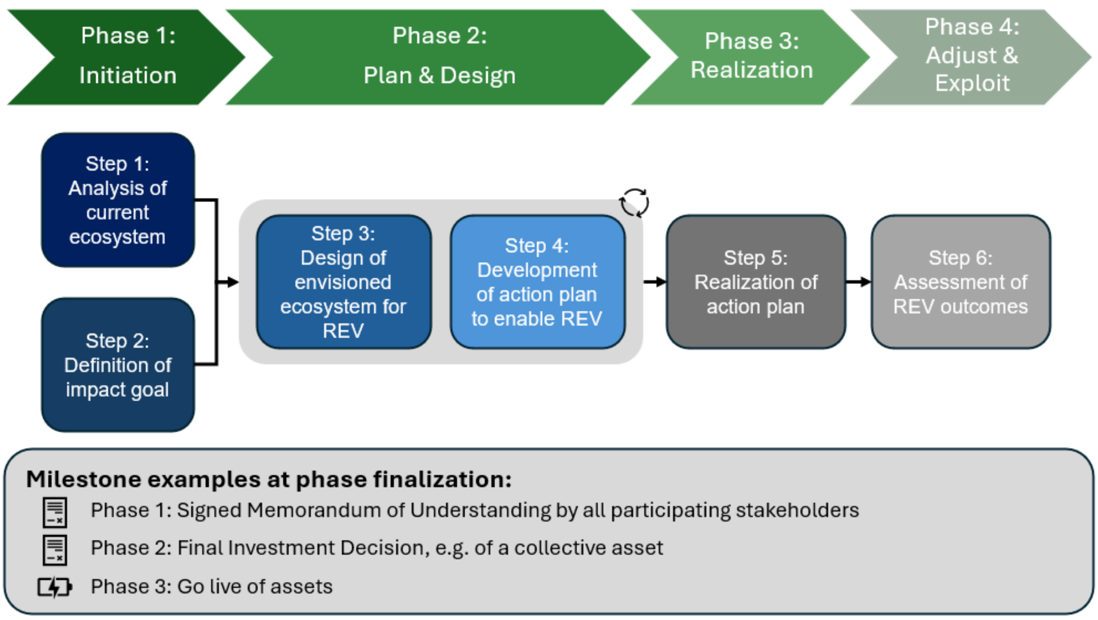

Figure 1: Schematic view of the Holistic Approach for setting up Renewable Energy Valleys

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The Holistic Approach is applied to the Flagship Valley through four initial steps:

1) **Assessment of the current ecosystem**, including energy system characteristics, stakeholder landscape, and policy context;
2) **Definition of impact goals**, with REVT5 focusing primarily on the electricity system;
3) **Design of envisioned future ecosystems** for the FV; and
4) **Development of an action plan** for the next three years.

To manage complexity and reflect differences in grid topology and stakeholder dynamics, the FV is structured into **three focus areas** for REVT5: **Boekelermeer** (industrial area), **Heiloo** (predominantly residential with a small business park), and **Overdie** (mixed residential area). For each area, the report identifies key challenges, stakeholder needs, and opportunities for coordinated energy solutions.

The resulting **REVT5 Implementation and Operation Plan** outlines concrete next steps for stakeholder engagement, ecosystem design, governance arrangements, and business models. Rather than delivering isolated technical solutions, REVT5 focuses on building a **self-sustaining local ecosystem** capable of aligning renewable generation, flexibility, storage, and consumption under constrained grid conditions.

Finally, the report reflects on **lessons learned** from applying the Holistic Approach in practice and highlights their relevance for replication in other European regions. As such, this deliverable not only supports implementation in the Flagship Valley, but also contributes to REFORMERS' broader objective of enabling scalable and replicable Renewable Energy Valleys across Europe.

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LIST OF ACRONYMS

Acronyms	
BRP	Balance Responsible Party
BSP	Balancing Service Provider
CBC	Capacity Limiting Contract (*Dutch abbreviation*)
CSP	Congestion Service Provider
DSO	Distribution System Operator
gTO	Group Transport Agreement (*Dutch abbreviation*)

EMS	Energy Management System
FSP	Flexibility Service Provider
FV	Flagship Valley
KER	Key Exploitable Result
RA	Resource Aggregator
RES	Renewable Energy Sources
REV(T)	Renewable Energy Valley (Track)
RP	Resource Provider
SEIA	Socio-Economic Impact Assessment
SO	Specific Objective
WP	Work Package

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1. INTRODUCTION

REFORMERS – *Regional Ecosystems FOR Multiple-Energy Resilient Systems* – is a five-year Horizon Europe Innovation Action that aims to **increase European energy security while accelerating the green transition**. The project does so by developing, implementing, and replicating **Renewable Energy Valleys (REVs)**: regional energy systems with a high penetration of renewable energy sources that integrate both residential and business areas.

The REFORMERS consortium consists of 28 partners from 10 European countries and brings together expertise spanning energy system design, digitalisation, governance, stakeholder engagement, and policy and regulation. Within the project, REVs are positioned as a means to bridge **bottom-up, local energy initiatives** (such as energy communities) with **system-level energy challenges**, including grid congestion, flexibility needs, and multi-energy system integration.

This deliverable, **D4.4 – REVT5 Implementation and Operation Plan**, presents both:

- a **stepwise Holistic Approach** for setting up Renewable Energy Valleys, and
- the **application of this approach** to the REFORMERS Flagship Valley (FV), resulting in an implementation and operation plan for **Renewable Energy Valley Track 5 (REVT5)** for the remaining three years of the project.

1.1. Relevance of Renewable Energy Valleys for Europe

Europe's energy system remains strongly dependent on imported fossil fuels and centralised infrastructure. Although recent policy initiatives such as REPowerEU have reduced dependency on Russian imports, geopolitical uncertainty and long-term climate objectives underline the need for a rapid transition towards resilient, decentralised and renewable energy systems.

At the same time, the increasing penetration of renewable electricity, electrification of demand, and coupling of energy carriers are placing significant pressure on existing energy infrastructure. Many European regions are already facing grid congestion, limited connection capacity and increasing system complexity.

Renewable Energy Valleys address these challenges by **linking bottom-up, local energy initiatives with system-level coordination**. By combining energy communities, businesses, local authorities and grid operators within a structured ecosystem, REVs enable:

- accelerated integration of renewable energy sources,
- coordinated use of flexibility and storage,
- improved local energy resilience,
- and increased societal acceptance of the energy transition.

The REFORMERS project positions REVs as a practical and replicable pathway to support European energy security, decarbonisation and regional development objectives.

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1.2. The Flagship Valley

Within the REFORMERS project, an area in the Netherlands has been designated as the **Flagship Valley (FV)**, serving as the main demonstration site and living lab. The FV is located primarily within the municipality of Alkmaar, with a smaller part extending into the municipality of Heiloo.

The FV covers approximately 4 km², includes **over 3,000 households and more than 300 businesses**, and combines dense residential neighbourhoods with one of the largest business parks in the Netherlands. At the centre of the FV lies **Boekelermeer**, a major industrial area that plays a key role in the region's energy demand and flexibility potential.

The **dominant challenge in the FV is electricity grid congestion**. While substantial grid reinforcements are planned, these are not expected to fully alleviate capacity constraints before 2035. As a result, new approaches are required to enable continued electrification and renewable energy deployment within existing grid limitations.

REFORMERS supports local stakeholders in addressing these challenges by combining technical solutions with new forms of collaboration, governance and coordination. A detailed analysis of the current ecosystem in the FV is provided in Chapter 3. Figure 2 presents an overview of the FV and the five areas it consists of:

1. Boekelermeer, a larger business park featuring over 300 companies
2. Overdie, a residential district of mixed high-rise and low-rise buildings
3. Heiloo – Plan Oost, featuring home owners in ground-level homes
4. Heiloo – Oude Werf, a smaller business park featuring some 50 companies
5. Zuidschermer, rural area which can feature the deployment of RES

Figure 2: The five areas within the Flagship Valley

While these boundaries provide focus for project activities, synergies beyond the formal FV borders are considered and incorporated when relevant.

1.3. Role of Renewable Energy Valley Tracks

Project activities in the Flagship Valley are structured into five **Renewable Energy Valley Tracks (REVTs)**, each addressing a distinct but interrelated aspect of the energy valley concept.

REVT1–3 focus on the development and demonstration of technical innovations, including renewable generation, energy storage, conversion, smart buildings, and mobility solutions.

REVT4 develops an operational software infrastructure to enable electricity coordination between stakeholders, including the Distribution System Operator (DSO) and local Energy Management Systems. REVT4 is a key enabler for addressing grid congestion and is closely aligned with the objectives of REVT5.

REVT5, the focus of this deliverable, addresses the **non-technical foundations** required to make a Renewable Energy Valley function in practice. It focuses on:

- stakeholder engagement and ecosystem building,
- governance and business models,
- alignment with policy and regulatory developments, and
- structuring collaboration between public and private actors.

REVT5 builds on the concept of **Orchestrating Innovation**[2], which emphasises the creation of public-private collaborative ecosystems to address complex societal challenges. Given that the FV includes thousands of non-partner stakeholders, REVT5 places particular emphasis on **stakeholder engagement beyond the project consortium** and on building a **self-sustaining local ecosystem** that can continue after the project ends.

1.4. Scope clarification and objectives of this deliverable

Original scope

According to the Grant Agreement, this deliverable was initially intended to present the **Implementation and Operation Plan for REVT5**.

Scope refinement during the project

During the course of the project, it became clear that REVT5 is inherently intertwined with the development of a broader, structured methodology for setting up Renewable Energy Valleys. In parallel with implementation activities in the Flagship Valley, the consortium developed a **Holistic Approach** that integrates technical, social, economic, legal and governance perspectives.

Given this integral relationship, and in agreement with the consortium, it was decided to include a first, applied version of the Holistic Approach in this deliverable.

[2] Orchestrating Innovation: engaging in innovation together - TNO Vector

Final scope and objectives

As a result, this deliverable has two closely related objectives:

1. **To present a stepwise Holistic Approach for setting up Renewable Energy Valleys**, supported by the REFORMERS toolboxes and suitable for application and replication across Europe.
2. **To provide the REVT5 Implementation and Operation Plan for the Flagship Valley for the remaining three years of the project**, developed through application of this approach.

This dual scope strengthens the relevance of the deliverable for both local implementation and European replication, and ensures coherence with activities in WP6 (Toolboxes), WP7 (Replication Valleys) and WP8 (Upscaling and policy recommendations).

1.5. Relation to other parts of REFORMERS

REVT5 is closely interlinked with almost all work packages:

- It builds on preparatory work from **WP3 (Setting up the Flagship Valley)**.
- It is strongly aligned with **WP4** as presented in Section 1.3, in particular with REVT4 and Deliverable D4.3, which addresses operational electricity coordination.
- It supports **WP5 (Digital twin for energy valleys)** by building the relations with local stakeholders for the development and testing of the digital twin in the FV
- It contributes to and applies tools developed in **WP6 (Energy Valley Toolboxes)**, especially stakeholder engagement, business modelling, governance and policy analysis.
- It supports **WP7 (Replication Valleys)** by generating transferable lessons and methods.
- It feeds into **WP8 (Replication potential and pathways)**, which focuses on long-term upscaling and policy impact.

This deliverable is aligned with Deliverable D6.4 and will inform subsequent updates of the Holistic Approach in Deliverable D6.3.

1.6. Structure of the deliverable

The remainder of this deliverable is structured along the first four steps of the Holistic Approach:

- **Chapter 2** introduces the Holistic Approach for setting up Renewable Energy Valleys and its relationship to the four REFORMERS Toolboxes.
- **Chapter 3** presents **Step 1**, the assessment of the current ecosystem in the Flagship Valley.
- **Chapter 4** describes **Step 2**, the definition of impact goals for the FV.
- **Chapter 5** outlines **Step 3**, the envisioned ecosystems for the FV and its areas.
- **Chapter 6** presents **Step 4**, the REVT5 Implementation and Operation Plan for the next three years.

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- **Chapter 7** summarises lessons learned and implications for replication and upscaling.

The annexes provide more in-depth information:

- **Annex 1** provides the methodological basis for the Holistic Approach and how it was developed.
- **Annex 2** details the analysis of relevant adopted regional policies for the broader area surrounding the FV.
- **Annex 3** presents the detailed results of the Energy System Design toolbox for the FV.
- **Annex 4** presents the detailed results of the Stakeholder Engagement tools applied in the FV.
- **Annex 5** provides a brief analysis of upcoming changes in some aspects of the European legal and policy domain and the implications for governance in REVs.

2. HOLISTIC APPROACH FOR SETTING UP REVS

Central to this deliverable is the first version of the *Holistic Approach for setting up Renewable Energy Valleys (REVs)*. This chapter presents the outlines of the approach and its link towards the four toolboxes as developed within WP6 of the project.

To set up a REV, often a larger geographical area is involved with hundreds and often thousands of stakeholders. Typically one cannot simply sit together with everyone involved. As such, a stepwise approach becomes beneficial. The project has developed a holistic approach for setting up REVs, which was based on scientific theory and proven in practice. The main structure of four phases is adopted from a successful approach in The Netherlands (and broadly used in project development), the steps are based on the Theory of Change and the integration of expertise areas builds on the insights of Orchestrating Innovation.

This chapter provides insights on the progress of two Specific Objectives (SOs) as were included in the Grant Agreement of the project. The REFORMERS project aims to provide:

- Development of a Holistic Approach that integrates all required expertise areas such that it can be applied for replication to set up Renewable Energy Valleys throughout Europe. (SO4)
- Development of four Toolboxes to support setting up Renewable Energy Valleys. The toolboxes will create a user friendly integrated solution which covers technical and non-technical aspects. Due to application and co-development in 6 REVs across Europe, they will incorporate lessons learned for a wide variety of challenges and locally available natural resources. (SO7)

2.1. The Holistic Approach

The Holistic Approach presents a structured stepwise approach to set up a Renewable Energy Valley. It clarifies when specific tools and insights should be used. The main structure includes four phases, from initiation until exploitation and in between every phase transition a milestone is to be met in the form of growing commitment of involved stakeholders. Aligned within the four phases, six main steps are defined which will provide the level of detail and structure of the remaining chapters of this document.

The approach is referred to as holistic as it ensures integration between many different expertise areas and includes all possible energy carriers and type of initiatives to be developed in setting up a REV.

This paragraph proposes an initial version of the Holistic Approach, which is illustrated in Figure 3. The approach is the result of a combination of several methods and was based on scientific theory and has been proven in practice, Annex 1 presents the methodological basis for the Holistic Approach for interested readers.

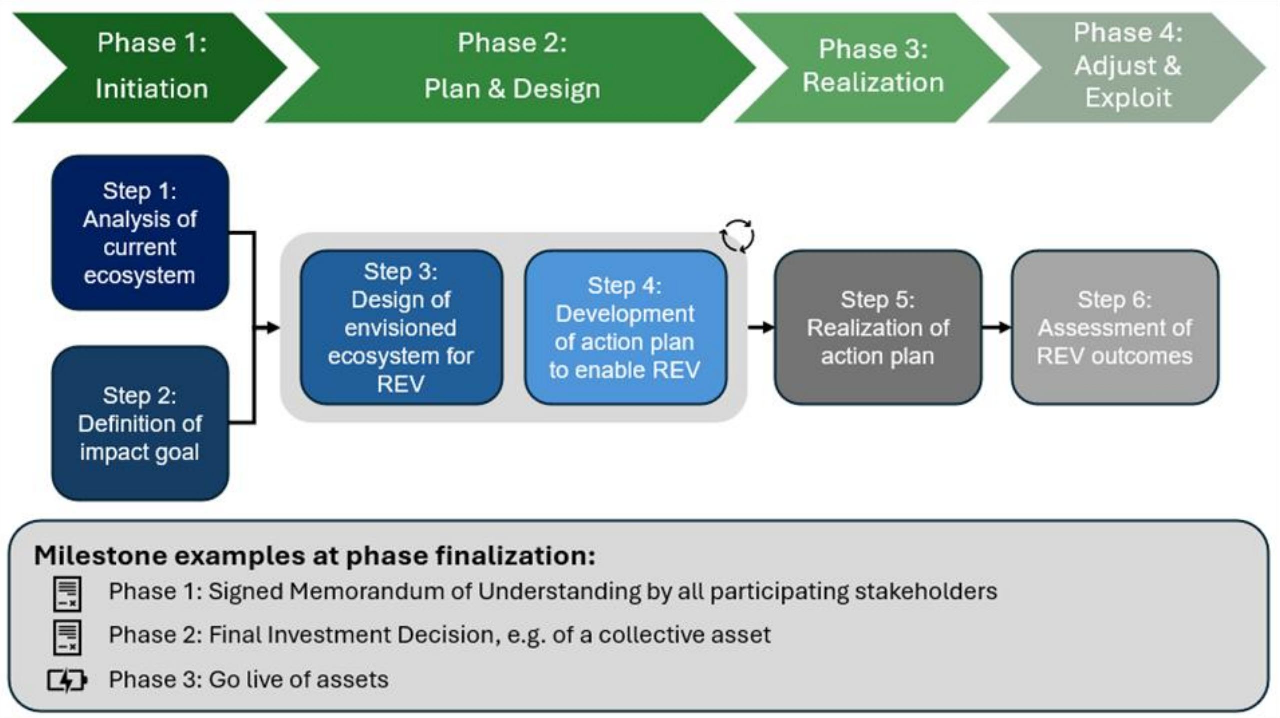

Figure 3: Schematic view of the Holistic Approach for setting up REVs

The following paragraphs will explain the several elements of the Holistic Approach. First, more background to the four phases is discussed. Second, the main required expertise areas are introduced in setting up REVs and third the six steps are explained in relation to the expertise areas and the Toolboxes as developed as part of the project.

Four Phases

The main structure of the approach consists of four phases, these are quite broadly adopted as the phases in project development. However these phases have proven very useful in all types of conversations and decision making in the Netherlands for the domain of Energy Hubs.

It must be stressed **that setting up larger regional energy collaborations is not a linear process**, all kinds of dynamics give reason to re-iterate on previous steps. For clarity purposes however, these natural iterations are omitted in the approach as one can never know when these will occur. However one can be reassured re-iteration is very common process. As such, even though presented here almost as a blueprint, setting up a REV will often be a dynamic journey, involving a larger geographical area with hundreds or even thousands of stakeholders which can not possibly be all engaged at the start. The initiative to set up a REV typically starts with a group of enthusiastic stakeholders, referred to as frontrunners. For example, the geographical definition of the Flagship Valley includes thousands of households and hundreds of companies.

Within the four phases of the Holistic Approach one can make a distinction between the first and the last two phases. Phase 1 and 2 focus on the initialization and creation of the commitment for success. These lay the foundations of the future REV and can take years to complete, depending on the complexity of the envisioned REV. Building commitment with a group of frontrunners and attracting financial means to set the first steps should not be underestimated. It also includes setting up proper governance structures and often the creation of legal entities such as a cooperation. Phase 3 and 4 focus on implementation of the plans, which then have their own dynamics. The focus of the approach lies with the first two phases, as most of the complexity in setting up REVs needs to be tackled at that point.

At the end of every phase a form of increased commitment needs to be provided by all participants in the approach. At the end of Phase 1 this can be in the form of a Memorandum of Understanding (Letter of Intent), however if possible a small financial contribution shows real commitment. The end of Phase 2 typically involves a Final Investment Decision of some sort, for example for the investment in acquiring assets or services. The end of Phase 3 is typically the hand-over from asset development towards operation. As every REV initiative is different, the described phases are indicative of the typical process.

Many expertise areas are needed to set up a REV

In the successful development of a Renewable Energy Valley different expertise areas are required at different points in time. Figure 4 presents the main eight areas of expertise and each offers insights, tools and methods. The Holistic Approach as presented in this chapter builds on these eight expertise areas and integrates them to a replicable approach which can be applied to set up REVs throughout Europe.

As part of the project the tools, methods and aids of the eight expertise areas are combined in four Toolboxes. These Toolboxes are developed in WP6 of the project and are represented by the colours in Figure 4. The Holistic Approach clarifies when specific tools and insights should be used.

First the steps in the Holistic Approach are now introduced and thereafter one can find an elaboration on the four toolboxes as developed by the project.

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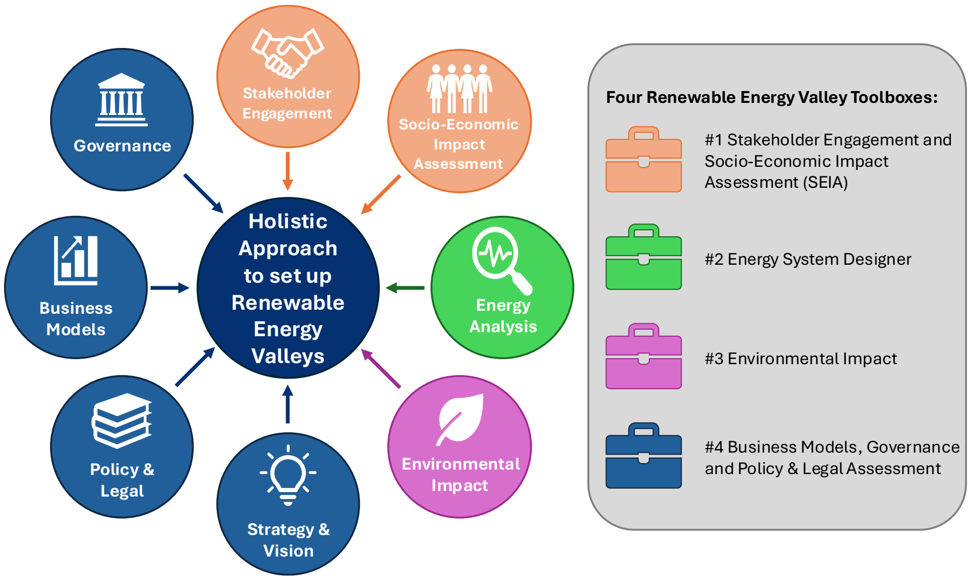

Figure 4: Key expertise areas coupled to the four Toolboxes and integrated within the Holistic Approach for REVs

Six steps and link with required expertise areas

The Holistic Approach as shown in Figure 3 presents six steps, of which the first two often are performed approximately in parallel and the remaining four steps are sequential. Practice has taught that Phase 2 is often very dynamic with new insights coming up, as such Steps 3 and 4 are presented with an iteration symbol. The steps were based on the back casting principle from the Theory of Change, details are presented in Annex 1.

Every step needs different expertise areas. The link between the six steps and the expertise areas is presented in Figure 5.

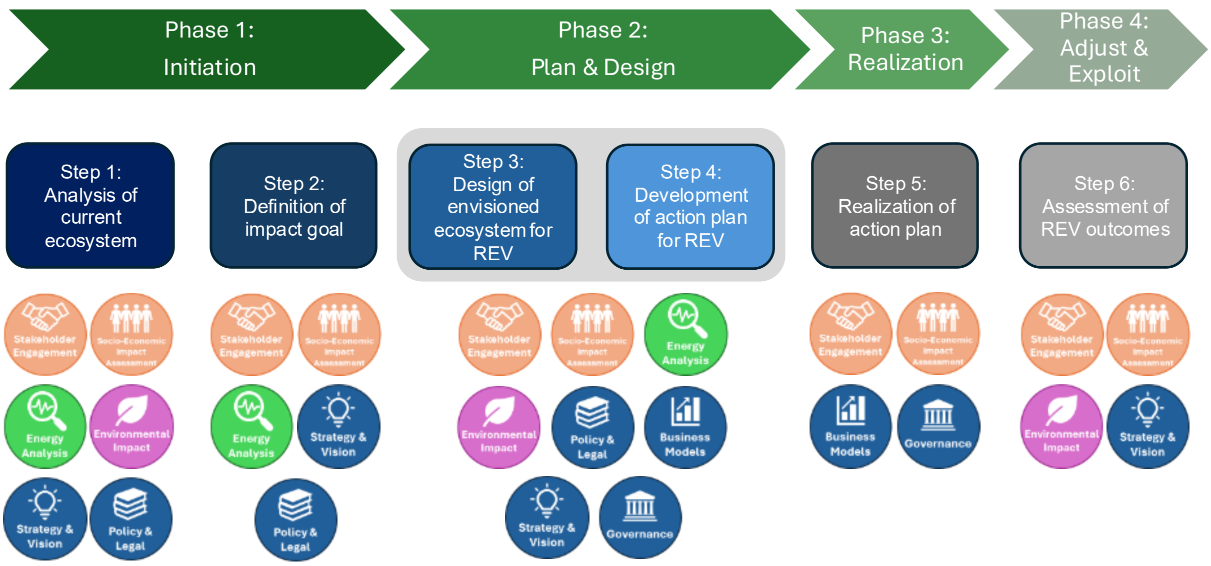

Figure 5: Link between the steps of the Holistic Approach and the expertise areas

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In each step, several tools from the four toolboxes can support the activities and goals of that step:

- **Step 1: Analysis of the current ecosystems**
  In this step, the focus is on generating a detailed understanding of the current ecosystem in the area, to 1) capture the starting point for REV development, 2) to understand in greater detail the challenges faced and as such inform the impact goal and design of the 'future' ecosystem. The importance of Strategy & Vision, Policy & Legal and Stakeholder Engagement is stressed, investigating the current legal framework as well as an in-depth investigation of the needs of stakeholders in the area. In addition, one also needs to understand the technical infrastructure for the energy grid and consumption and production insights (Energy Analysis) and to assess the current area performance (Environmental Impact Assessment) to substantiate and validate what the current challenges are.

- **Step 2: Definition of impact goal**
  In this step, the motivations for enabling a REV are defined, resulting in strategic objectives that lead the analysis, design and development of the REV in practice. To this end, one can build upon the insights and tools offered through Strategy & Vision. Here, one also needs to be aware of what developments are taking place (and are expected to take place) as part of Policy and Legal to inform the strategic objectives. Finally, one needs to engage and understand the high-level needs of the most relevant stakeholders in the REV through Stakeholder Engagement, which helps kickstart the process as well as helps to inspire the strategic objectives.

- **Step 3 and 4: Design of the envisioned ecosystem for REV and Development of Action Plan to enable REV**
  In this step, the envisioned ecosystem for the REV is sketched. It means finding solutions to the problems identified as part of Step 1 and 2, and defining how relationships can be established between private and public energy stakeholders to co-create value and leverage synergies between concurrent initiatives taking place in the REV. To do so, technological solutions (solving current technical or energy challenges posed) as well as business model solutions (solving business challenges posed) will be explored (business models and technological integration) and integrated as part of an action plan that will help to roll-out the REV. As new technological and business solutions are introduced, one also needs to investigate how such solutions will be adopted, operated and maintained over time (Governance). Stakeholder engagement is used to co-design and gather feedback on proposed solutions, to assure supported outcomes, democratize decision-making, and facilitate the later implementation process. To reduce complexity, breaking up the REV into smaller initiatives can help to work towards local solutions first before scaling / integrating such solutions across the REV.

- **Step 5: Realization of the Action Plan**
  Execution of the action plan will result in unforeseen challenges which should be addressed by updating the design of the envisioned ecosystem. Moreover, new

opportunities, but also threats to the ecosystem can occur as part of market and societal dynamics (e.g., policy making or shifting market needs). Accordingly, these steps are conducted in an iterative manner, gradually working towards the development and roll-out of the Renewable Energy Valley.

- **Step 6: Assessment of REV outcomes**
  Once the contours of the REV have been established, the predicted performance of the REV can be assessed. This means that one can reflect on whether the strategic objectives have been realized, as well as to assess the energy, business and environmental performance of the REV. This assessment may spark a revisit of the design and action stages in case additional scaling strategies or adaptations are needed.

2.2. The four REV Toolboxes of REFORMERS

Within WP6 of the project, four REV toolboxes are under development, these are aimed at broader European application. Most of the tools were or will be applied to the FV for development purposes and will be tested in the Replication Valleys for validation.

Toolbox 1: Stakeholder engagement and Socio-Economic Impact Assessment (SEIA)

This toolbox consists of two main elements, various stakeholder engagement tools and the Socio-Economic Impact Assessment (SEIA) tool. The stakeholder engagement tools are aimed at facilitating stakeholder mapping and engagement to achieve energy valley transformation. The stakeholder engagement approach consists of two components: raising the knowledge and awareness of stakeholders on the topic, and the design of and decision-making on the energy valley. The Socio-Economic Impact Assessment (SEIA) is a tool aimed at providing guidance to any Renewable Energy Valley promoter group to design, plan and implement a SEIA that fits their energy transition projects. It allows them to monitor socio-economic impacts in the short, medium and long term. The SEIA is designed to ensure that the development of REVs is not only technically sound, economically viable and environmentally sustainable, but also beneficial for the people and their wellbeing. This toolbox is developed in Task 6.4 and has been presented in Deliverable 6.4, also defined as Key Exploitable Result (KER) #1.

Throughout the remainder of the document, the application of this toolbox is depicted with the orange suitcase.

Toolbox 2: Energy System Designer

The Energy System Designer is a software tool to support energy planning of the valleys' energy systems transformation by optimizing size and location of technologies to satisfy specific needs (i.e., energy cost reduction, emission reduction, fuel independence, etc.). It focuses on power, heating, cooling, gas, hydrogen and mobility sectors and is based on a graphical user-friendly interface. This toolbox is developed in Task 6.1 and will be presented in Deliverable 6.1, it is also defined as KER #2.

Throughout the remainder of the document, the application of this toolbox is depicted with the green suitcase.

Toolbox 3: Environmental Impact Assessment.

This software tool is dedicated to assisting regions in evaluating the environmental impact of the measures they select for their transformation to an energy valley. It is designed following a component-based life cycle approach and can assess the energy sectors and variable systems configuration, in agreement with the Energy System Designer tool (i.e., power, heating, cooling, gas, storage, hydrogen and mobility). This toolbox is developed in Task 6.2 and will be presented in Deliverable 6.2, it is also defined as KER #3.

Throughout the remainder of the document, the application of this toolbox is depicted with the pink suitcase.

Toolbox 4: Business models, Governance and Policy & legal assessment.

This toolbox provides several tools aimed at supporting the identification of structure and design for governance, business models and the assessment of policy and legal aspects needed to establish and keep alive future energy valleys. It builds upon the Collaborative Business Modelling approach for Energy Hubs developed as part of the EIGEN project[3]. This toolbox is developed in Task 6.3 and will be presented in Deliverable 6.3. It is also defined as KER #4.

Throughout the remainder of the document, the application of this toolbox is depicted with the blue suitcase.

2.3. Application of the Holistic Approach to the FV

The Flagship Valley consists of many individual initiatives. The broader approach in the FV is now in Phase 2 and recently the first couple of initiatives moved towards Phase 3.

The original aim of this project deliverable was to present the Implementation and Operation Plan for REVT5, which aligns with the result of Step 4. As such, this deliverable focusses on the first two phases of the Holistic Approach and the following chapters are structured in terms of the first four steps of the Holistic Approach.

As many activities in the FV are part of the project, the impact goals for the FV were already mostly defined in the Grant Agreement. The project also has a limited duration, as such it is crucial that the developed ecosystem in the FV is self sustaining and no dependencies are created. This underlines the requirement of capacity building and local governance.

Scope impact: This deliverable focusses on the first two phases for the FV.

[3] https://www.eigen-energyhubs.nl/kennisdeling/eigen-cbm-aanpak-2/

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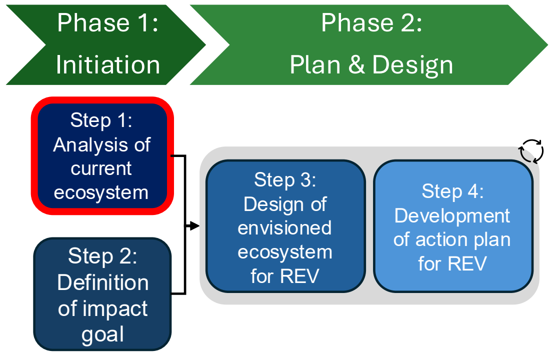
3. STEP 1: CURRENT ECOSYSTEM IN FLAGSHIP VALLEY

In line with Step 1 of the Holistic Approach, this chapter outlines the assessment of the current ecosystem in the Flagship Valley. As indicated, this assessment helps to understand the current characteristics of the area in terms of existing ecosystems, energy infrastructure, stakeholder needs and challenges and its link towards socio-economic and environmental impact currently created. The assessment lays the foundation for the development for the following steps.



This chapter starts with a quick re-iteration of the FV area build-up and known regional policies, commercial plans and electricity grid expansion plans of the DSO (Liander). Subsequently, the results from the energy system design analysis and stakeholder analysis are presented, followed by a simplification of the geographical representation of the FV for REVT5. Finally, the three remaining areas are investigated in more detail to complete the ecosystem analysis.

The Flagship Valley

Figure 6 presents an overview of the FV Alkmaar. One can see that five areas can be differentiated, namely:

1. Boekelermeer, a larger business park featuring over 300 companies
2. Overdie, a residential district of mixed high-rise and low-rise buildings
3. Heiloo – Plan Oost, featuring home owners in ground-level homes
4. Heiloo – Oude Werf, a smaller business park featuring some 50 companies
5. Zuidschermer, rural area which can feature the deployment of RES

Figure 6: The five areas within the Flagship Valley

Using this subdivision, the following sections will present the results of the Energy Analysis and Stakeholder Analysis to describe the current characteristics and challenges faced for the ecosystems in the FV.

3.1. Existing policies and plans for the FV

To understand the current ecosystem in the FV also an analysis of existing regional policies and plans was performed of the Province of North-Holland and several policies from the municipality of Alkmaar. This was already partly performed during the proposal phase of the project and as such alignment between the FV objectives and regional policies is ensured. A detailed analysis is provided in Annex 2.

Relevant known commercial plans in the FV

HVC and municipality of Alkmaar have plans to extend the heating grid in Overdie East and connect most of the social housing high-rise flats to the heating grid. This will reduce the natural gas consumption for Overdie.

NXT Mobility (partner in project) aims to open a commercial charging square with first 18 spots in Q1 2026 on Boekelermeer to support the electrification of heavy duty trucks. [4] This will reduce the fossil fuel consumption of mobility in the Boekelermeer and increase the electricity consumption in the area.

The ENGIE digester (previously owned by Sustenso) produces ~47 GWh/y of biomethane and feeds this into the local natural gas grid. Significant expansion of production is envisioned when congestion issues are solved. [5]

Known developments in Electricity Infrastructure until 2035

Since the electrical infrastructure has to deal with congestion, grid reinforcement is foreseen. Most of the Boekelermeer industrial area is connected to the local substation Boekelermeer, which is connected to the higher-level substation of Oudorp which is in turn connected to the main high voltage substation Oterleek. The Heiloo area is connected to the substation Heiloo, which is directly connected to main level substation Oterleek (part of transmission grid). The Overdie area is connected to the substation at Oudorp.

Because of the extra capacity demand in time, the electrical infrastructure will be restructured to provide enough capacity to the Boekelermeer area. Plans are still to be finalized, yet it is most likely an additional main level substation will be constructed in the vicinity of Boekelermeer. This would become part of the transmission grid. This new main level substation can then feed multiple substations in the distribution grid, e.g. Heiloo and Oudorp. Both timeframes are shown in Figure 7. In the figure the blue lines are the transmission grid and the yellow lines are the main connections in the distribution grid. In right part of the figure (after 2035) the big yellow box represents the planned new main level

[4] Nederland Elektrisch - Alkmaar krijgt laadplein met 36 plekken voor elektrische trucks
[5] Engie buys two Dutch biogas sites, hunts for more | Reuters

substation of Boekelermeer, connected via a blue line (transmission system) to the main level substation of Oterleek, which will also be extended.

	
Current situation anno 2025	Expected layout after 2035

Figure 7: Electricity grid topology in the area of the FV, now (left) and after reinforcements (right)

3.2. Energy system analysis of FV

The Energy System Designer toolbox has been applied to the FV and provides insights in the energy consumption and production of the different areas.

Assessment of FV - Energy Consumption (Stationary)

In line with the original project proposal, the primary analysis focuses on stationary energy consumption to establish a clear baseline. Excluding mobility fuels, the total energy consumption across Areas 1–5 amounts to 139 GWh in 2023, as illustrated in Figure 8 (for details, see Annex 3). In this scope, natural gas is the dominant energy carrier, accounting for 66% (92 GWh) of the demand, followed by grid-imported electricity at 28% (39 GWh) and district heating at 6% (8 GWh).

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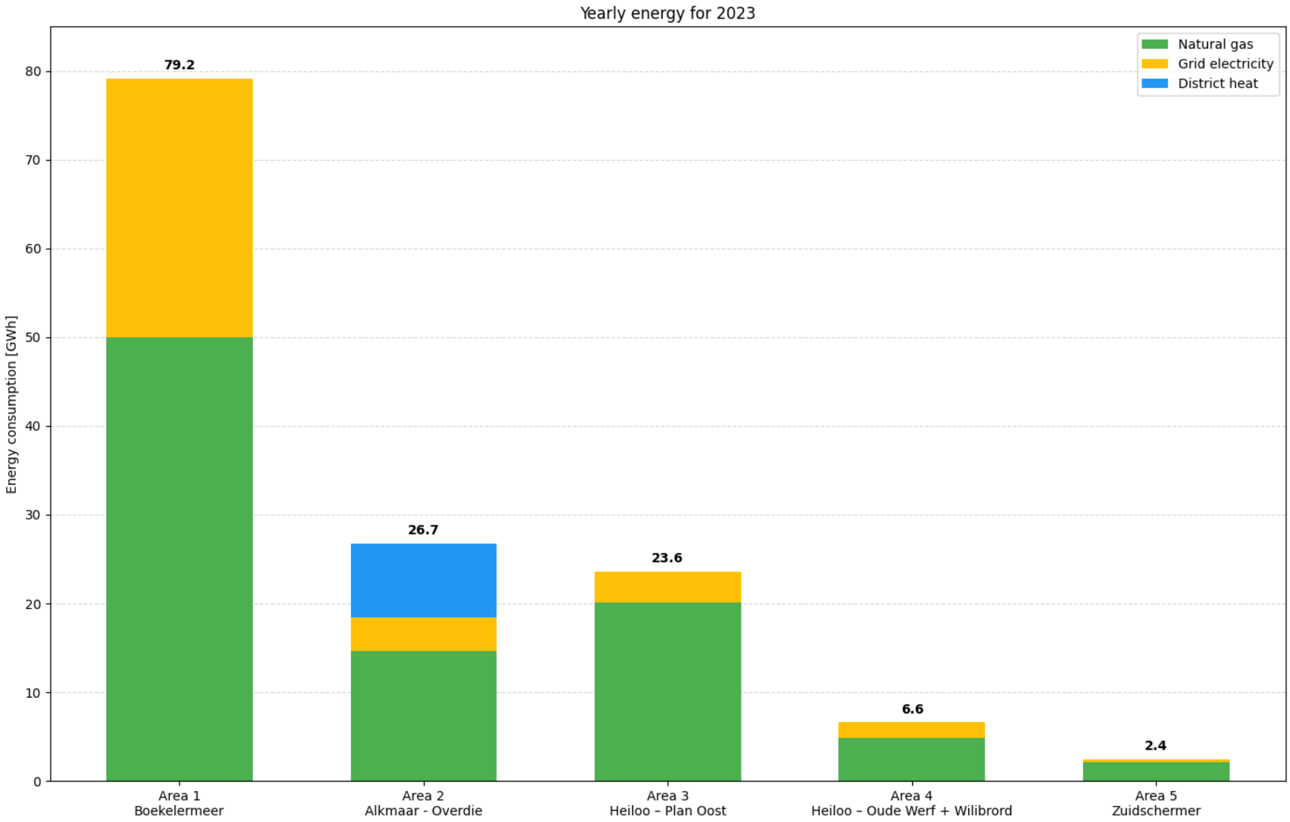

Figure 8: Breakdown of the Annual Energy Consumption in the Flagship Valley in 2023 per area and carrier excluding mobility

Area 1 (Boekelermeer) is the undisputed largest energy consumer, accounting for 57% of the total stationary demand (79 GWh). This dominance is driven by its industrial profile, accounting for the majority of the region's electricity consumption (29 GWh). Area 2 (Overdie) maintains a unique profile as the only zone utilising district heating, consuming 8 GWh of heat. Areas 3, 4, and 5 play a comparatively smaller role, collectively accounting for approximately 13% of the total regional demand. Area 3 is the largest contributor (35 GWh), primarily driven by natural gas consumption for residential heating.

Impact of Mobility

When mobility data is included in the reference scenario, the energy landscape shifts radically. The total consumption rises to 358 GWh, with mobility fossil fuels becoming the dominant carrier at 61% (220 GWh), overtaking natural gas (26%) and electricity (11%) as shown in Figure 9 (for details see Annex 3). This dominance is largely attributed to Area 1's role as a logistics hub; heavy freight traffic and a high density of registered vehicles result in mobility fuel consumption of 193 GWh in this area alone.

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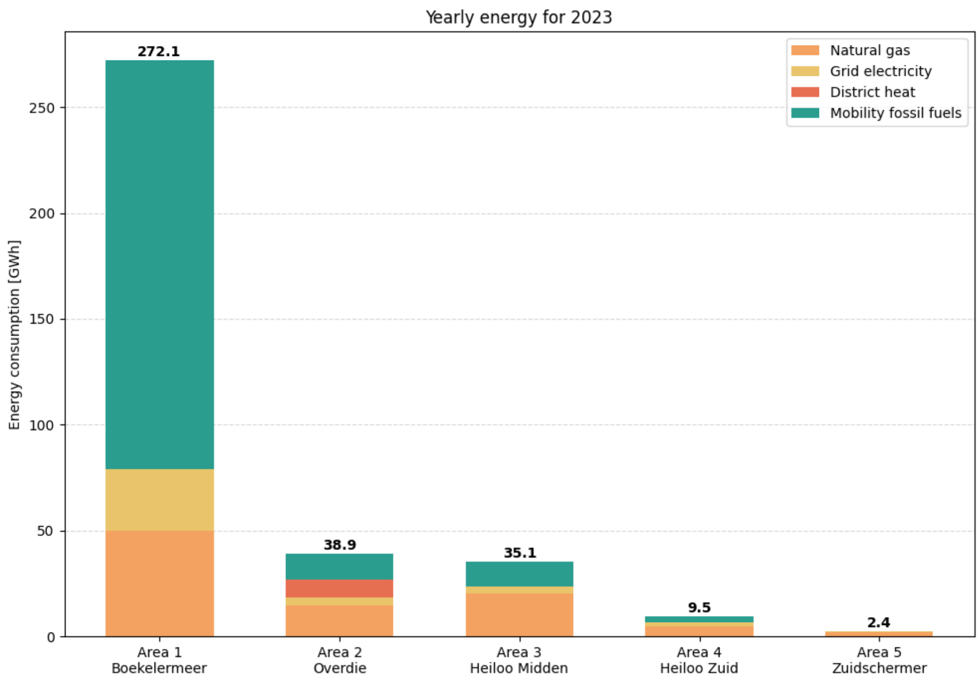

Figure 9: Breakdown of the Annual Energy Consumption in the Flagship Valley in 2023 per area and carrier including mobility

Crucially, this figure must be interpreted with caution. The energetic calculations are based on vehicle *registrations* within the FV. Attributing the massive consumption of fossil fuels by rolling stock solely to the FV distorts the picture, as the model assumes all vehicles are fossil-based using average yearly mileage. This approach artificially inflates local demand by assigning fuel energy expended across a much wider region to the local nodes. Consequently, the actual CO2 emissions and refueling infrastructure are likely located outside the valley. Worse, this "on-paper" fossil dominance drowns out the local energy demands, effectively repressing the significance of actual local consumption needs and preventing a direct comparison with the original proposal.

However, despite these data limitations, the future electrification of this logistics fleet will undeniably have a strong impact on the grid, significantly increasing peak loads. This shift also brings opportunities; the electrified fleet could serve as a flexibility asset, aiding in balancing renewable overproduction through smart charging and V2G applications.

Assessment of FV – Renewable electricity production

The Flagship Valley's 2023 renewable energy infrastructure comprises 13 MWp of solar PV capacity and four wind turbines (9 MW total), generating 13 GWh and 22 GWh annually, respectively, totalling 35 GWh of renewable production (see Annex 3). Area 1 (Boekelermeer) dominates renewable generation, accounting for nearly two-thirds of solar capacity (65%) and three-quarters of wind capacity (74%), concentrated primarily to the industrial medium voltage feeders serving the Boekelermeer industrial zone. Area 4 (Heiloo – Oude Werf + Wilibrord) contributes significantly with 18% of solar capacity. Residential solar adoption is most prominent in Area 3 (Heiloo – Plan Oost) at 13% of total capacity, while Area 2 (Alkmaar – Overdie) shows modest penetration at 4%. Area 5 (Zuidschermer) has no renewable installations. A detailed breakdown of renewable assets per area is provided in Annex 3.

Conclusion

The 2023 reference scenario defines the FV's baseline energy profile with a total consumption of 358 GWh, dominated by mobility fossil fuels (61%) and natural gas (26%). While Area 1 accounts for 76% of this demand, the allocation of mobility fuels based on registration rather than location inflates local figures and masks true stationary consumption needs.

3.3. Stakeholder analysis of FV

At the start of the project, and as a start of Step 2 and 3 of the Holistic Approach, an initial general stakeholder mapping and frontrunner selection were carried out for the whole FV area, based on the tools and methodologies part of the Stakeholder Engagement and Socio-Economic Impact Assessment Toolbox, as presented in D6.4. The initial FV wide stakeholder mapping results are included in Annex 4 for the interested reader.

Simplification of FV into three areas for REVT5

Based on the insights generated through the Energy Analysis and Stakeholder Analysis, which demonstrated significant differences between areas and the stakeholders they represent, it was decided to simplify the FV accordingly: For the purpose of REVT5 and this deliverable, the decision was made to combine the original areas 1 and 5 and areas 3 and 4. Accordingly, three areas remain, as presented in Figure 10:

1. Boekelermeer + Zuidschermer
2. Heiloo (Plan Oost and Oude Werf)
3. Overdie

Area 1 will be referred to as "Boekelermeer" from here on. Area 2 will be referred to as "Heiloo" and Area 3 will be referred to as "Overdie" for simplicity. These three areas will be analysed in more detail in the following sections.

Scope impact: REVT5 will simplify the FV to three areas and develop separate approaches for each region

Figure 10: The three areas of the Flagship Valley as adopted for REVT5

3.4. Boekelermeer

Stakeholder mapping and frontrunner selection

The detailed stakeholder mapping for the Boekelermeer is depicted in Figure 11. The mapping provides the basis for developing more detailed engagement plans for the area and highlights the varying roles that certain actors play across the different area. Again, the stakeholders positioned as ‘high interest – high influence’ are considered as the most promising stakeholders to involve to develop solutions and collaborations towards addressing (renewable) energy challenges.

Given the business orientation of the Boekelermeer area, significant emphasis was placed on onboarding the companies as part of renewable energy initiatives. Based on data from the DSO relevant companies were identified. Also through a series of initial contact efforts and surveys with companies present in the Boekelermeer area, a set of companies were targeted which were 1) willing to participate as part of (local) renewable energy initiatives, as current energy needs or challenges were faced, and 2) which would have a substantial impact on working towards the goals set for the REV (i.e., targeting those companies that, through exploring energy solutions and new collaborations, could yield significant impact for the REV).

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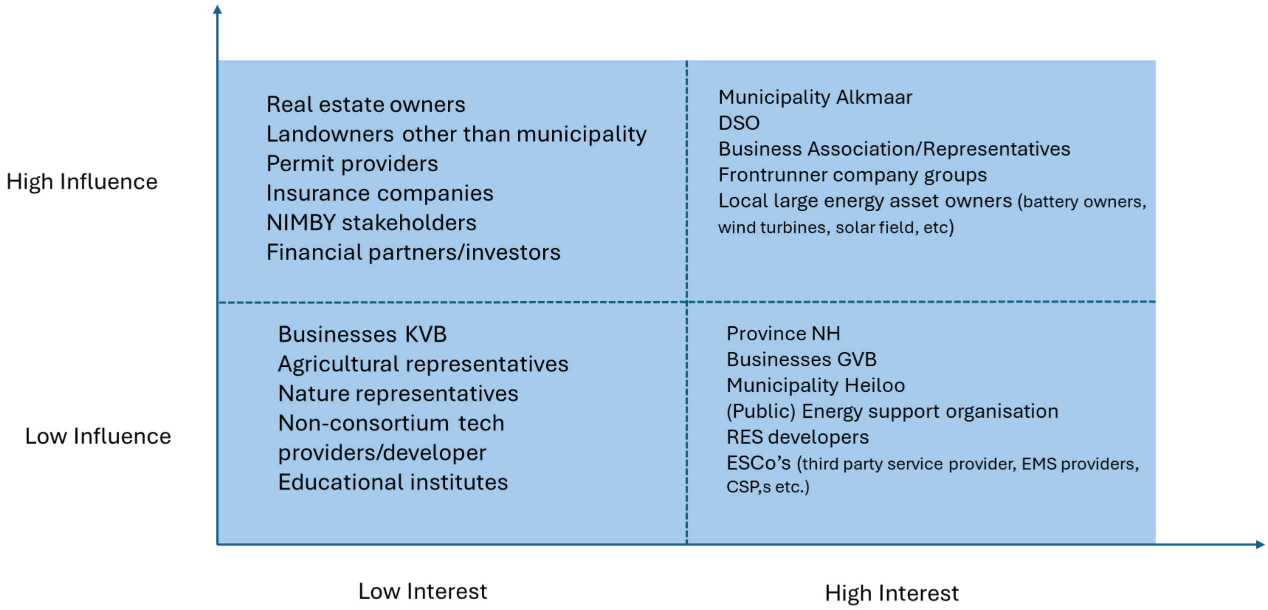

Figure 11: Business Area Boekelermeer Influence vs. Interest Grid

Following this analysis, 12 large companies were identified with a potential to become an essential part of a frontrunner group, based on a first general assessment of their energy consumption and production profile. These companies were interviewed on their operation, motivations and needs in 2024. The full results of the survey / interviews are indicated in Annex 4 of this deliverable. The **following key insights** emerged from these interviews and frontrunner group selection:

- **Grid congestion** is a major concern, and most companies have already explored individual solutions.
- There is strong willingness to collaborate, share data, and participate in the REFORMERS project.
- Expectations for REFORMERS project are high, particularly regarding its ability to address congestion challenges.
- Technical and regulatory constraints drove the frontrunner selection, which consequently limited the size of the group.
- Companies that were not selected expressed disappointment, which could have been avoided through clearer communication about the criteria and a more grid-oriented selection rationale
- The frontrunner group expressed the need for concrete next steps and a clear timeline moving forward.

A survey similar to the one conducted for the Boekelermeer potential frontrunner companies was carried out with other stakeholders, more specifically with various public authorities from the 'high interest' categories.

The following **key insights** emerged from the survey results:

- Grid stability is the most critical requirement, with the highest average importance and multiple essential selections.
- Other objectives marked as essential include influence sustainability policy, security, energy independence, increased local sustainability, and economic growth.
- Objectives such as better energy efficiency, local added value, direct user participation, and emissions reduction scored high on average but were not marked essential, indicating they are expected benefits rather than decisive factors.
- Lower energy bill has relatively low importance and was not marked essential by any participant.
- Barriers are minimal: most respondents indicated no current doubts. Regulatory complexity, legal uncertainty, and lack of knowledge were each indicated as concerns by one participant.

All-in-all, these actions helped to define current gaps, challenges, and needs for the current ecosystem in Boekelermeer, setting the scene for follow-up actions as part of Step 3 (‘Developing the envisioned ecosystem’) and Step 4 (‘Develop the action plan’), namely to:

- Start with company-only models, then gradually introduce mixed collaborations with households once trust and clarity are established through targeted engagement initiatives.
- Emphasize autonomy and sustainability: Position energy independence and emissions reduction as core benefits
- Highlight opportunities for active involvement: Offer governance models that allow direct participation.
- Communicate technical reliability and security: Stress grid stability and data protection to build confidence.
- Frame economic benefits clearly: Showcase cost savings and operational convenience without overpromising ROI.
- Present social and policy goals as complementary: Avoid positioning them as primary drivers but highlight added value.
- Leverage reputational and environmental incentives: Promote green image and sustainability alignment.
- Provide clear legal and regulatory guidance and simplify administrative processes to reduce perceived complexity.
- Offer targeted knowledge-building activities (workshops, info sessions, targeted awareness campaigns) to close gaps and address uncertainty.

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3.5. Heiloo

Composition of Area 3 Heiloo

Heiloo is a village located west of Boekelermeer, formally five neighbourhoods are part of the Flagship Valley. The most northern part (Blockhovepark) however barely consists of any buildings and the most southern part is a business park (Oude Werf). As such three neighbourhoods remain: Plan Oost, Ter Coulster and Willibrord. These areas differ significantly from each other socially, even though they are adjacent, as depicted in Figure 12 and Table 1.

In Ter Coulster only a very limited number of houses can be found and Willibrord mostly consists of a care facility. As such the focus of the Heiloo area is Plan Oost, together with the Oude Werf. Ter Coulster formerly was a castle and the neighbourhood still includes a privately owned estate which explains the inflated average property value and potentially the high average electricity consumption as well. However, almost 70% of the houses in Ter Coulster was built after 2005, the same holds for Willibrord. The largest share of houses in Plan Oost was built between 1945 and 1965, approximately 45%.

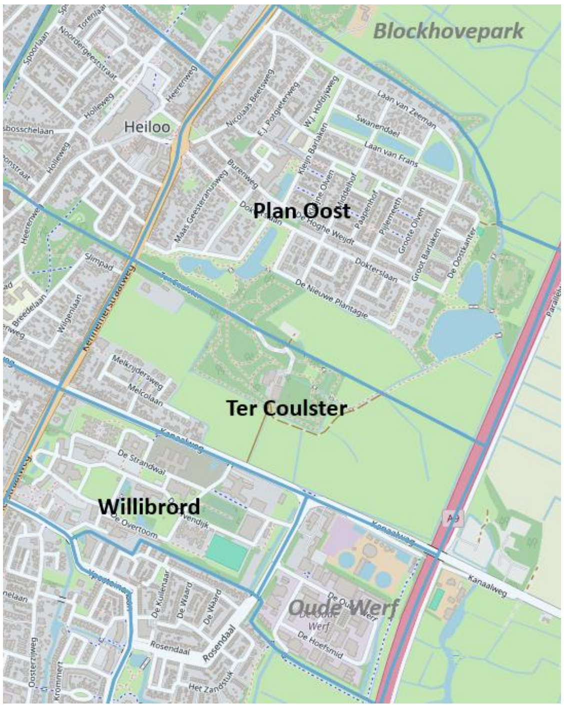

Figure 12: Composition of Heiloo area of official neighborhoods

Table 1: Characteristics of Heiloo, data of 2022

	Plan Oost	Ter Coulster	Willibrord	Netherlands
Number of households	1.005	120	240	*8,1 million*
Average income per resident	€34.400	€36.700	€22.000	*€30.800*
Average property value	€410.000	€517.000	€167.000	*€317.000*
Share of owner-occupied homes (%)	75%	61%	36%	*57%*
Share of housing corporation homes (%)	11%	0%	0%	*29%*
Average gas consumption per home	1.230 m³/year	1.150 m³/year	700 m³/year	*970 m³/year*
Average electricity consumption	2.610 kWh/year	3.330 kWh/year	1.410 kWh/year	*2.630 kWh/year*
Percentage of houses connected to heating grid	0%	0%	0%	*~6,5%*
Main construction period of homes	Largest share of homes built is in 1945 – 1965, ~45%	Largest share of homes built is after 2005, ~69%	Largest share of homes built is after 2005, ~77%	*Largest share of homes built is in 1965 – 1985, ~30%*

Stakeholder mapping

For Heiloo, a stakeholder mapping was conducted, aiming to understand the needs, challenges and perceptions of stakeholders in the area. The stakeholder mapping illustrated in Figure 13 was created based on the stakeholder groups identified. Importantly, the residents in Heiloo were considered as the key stakeholders to involve. Duurzaam Heiloo, as one of the partners in the project, is depicted as the local energy initiative/NGO, it’s legal structure being a foundation.

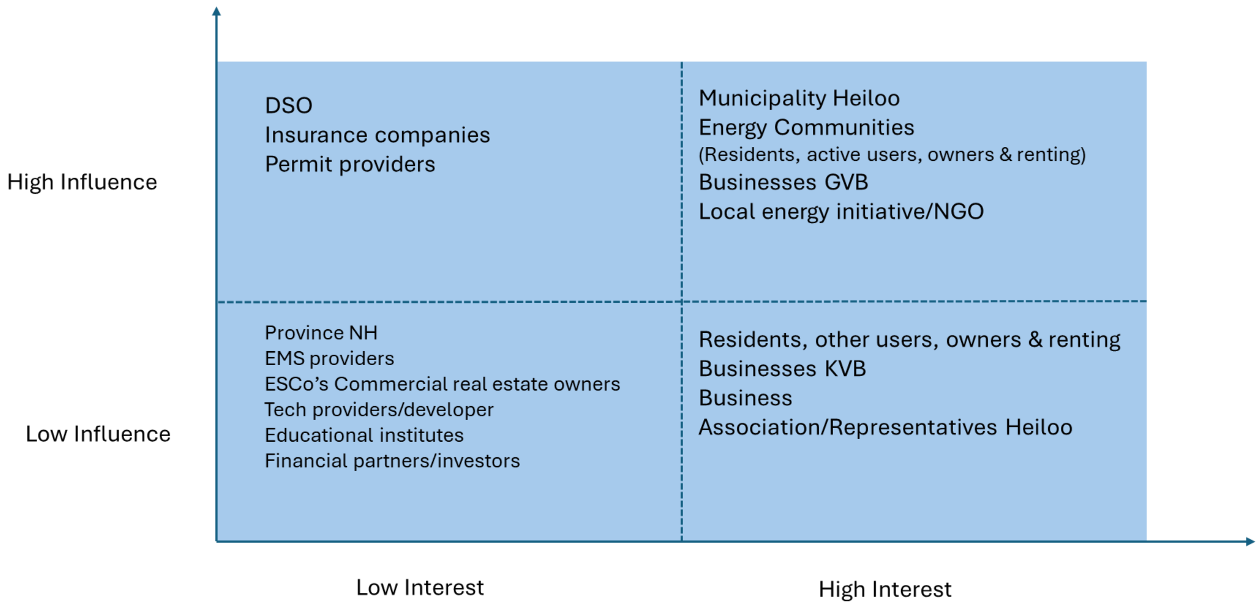

Figure 13: Residential and Business Area Heiloo Influence vs. Interest Grid

A survey on objectives and barriers for collective energy initiatives was also distributed among Heiloo residents, of which 16 filled it out. The detailed results of this analysis can be found in Annex 4. The following **implications for the future engagement approach** were defined:

- Emphasize cost savings, sustainability, and knowledge-building in communication and outreach.
- Highlight the innovative and autonomous nature of Renewable Energy Valleys to appeal to residents' desire for independence.
- Offer learning opportunities and light involvement options for those interested in participation, while recognizing not all will seek active roles.
- Address barriers by:
    - Developing clear, accessible communication materials to improve understanding.
    - Providing transparent financial models and tangible benefit examples to reduce cost concerns.
    - Simplifying regulatory messaging and offering low-barrier entry points for inexperienced participants.
- Create diverse participation pathways, from financial contributions to occasional involvement in meetings or projects.
- Use informative, low-effort communication channels as the primary engagement method, complemented by optional opportunities for deeper involvement.

3.6. Overdie

Composition of Area 3 Overdie

Overdie is a district on the southern side of Alkmaar, located just north of Boekelermeer. It consists of two official neighbourhoods as shown in Figure 14: Overdie East and Overdie West. These areas differ significantly from each other socially, even though they are adjacent, as depicted in Table 2. This makes them an interesting case within the project.

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Figure 14: Composition of Overdie of official neighbourhoods

In Overdie East a high proportion of social housing exists: 88% of the homes are owned by housing corporations. The average income is lower than the national average, and there is a relatively high share of practically or ‘lowly’ educated residents. The neighbourhood includes several large residential blocks and four-story apartment blocks. Most of these buildings are to be connected to the heating grid of HVC, in 2022 14% of the houses was connected to it already according to the formal statistical data.

In Overdie West, few homes are owned by housing corporations: 20% compared to 29% nationally. The share of owner-occupied homes is much higher than in Overdie East: 60%, which aligns with the national average. Compared to Overdie East, the neighbourhood also has a relatively high share of theoretically educated residents. Here, most homes are single-family houses. In the multi-story buildings in this neighbourhood, homeowners’ associations (HOAs) (Vereniging van Eigenaren; VvE) are also present.

The neighbourhoods also share similarities. Property values in both areas are below the national average, although the average property value in Overdie East is still significantly lower than in Overdie West. Energy consumption and the electrification of the vehicle fleet are also lower than in the Netherlands overall. Both neighbourhoods were built in the 1960s.

Table 2: Characteristics of Overdie, data of 2022

	Overdie West	Overdie East	Netherlands
Number of households	645	1.355	*8,1 million*
Average income per resident	€29.700	€18.500	*€30.800*
Average property value	€234.000	€181.000	*€317.000*
Share of owner-occupied homes (%)	60%	9%	*57%*
Share of housing corporation homes (%)	20%	88%	*29%*
Average natural gas consumption per home	870 m³/year	710 m³/year	*970 m³/year*
Average electricity consumption per home	2.170 kWh/year	1.850 kWh/year	*2.630 kWh/year*

Percentage of houses connected to heating grid	0%	~14%	*~6,5%*
Main construction period of homes	Largest share of homes built is in 1945 – 1965, ~63%	Largest share of homes built is in 1945 – 1965, ~77%	*Largest share of homes built is in 1965 – 1985, ~30%*

Stakeholder mapping

For Overdie, a stakeholder mapping was conducted, aiming to understand the needs, challenges and perceptions of stakeholders in the area. The stakeholder mapping illustrated in Figure 15 was created based on the stakeholder groups identified. Importantly, the municipality of Alkmaar, the housing corporations and home owners associations were identified as key stakeholders.

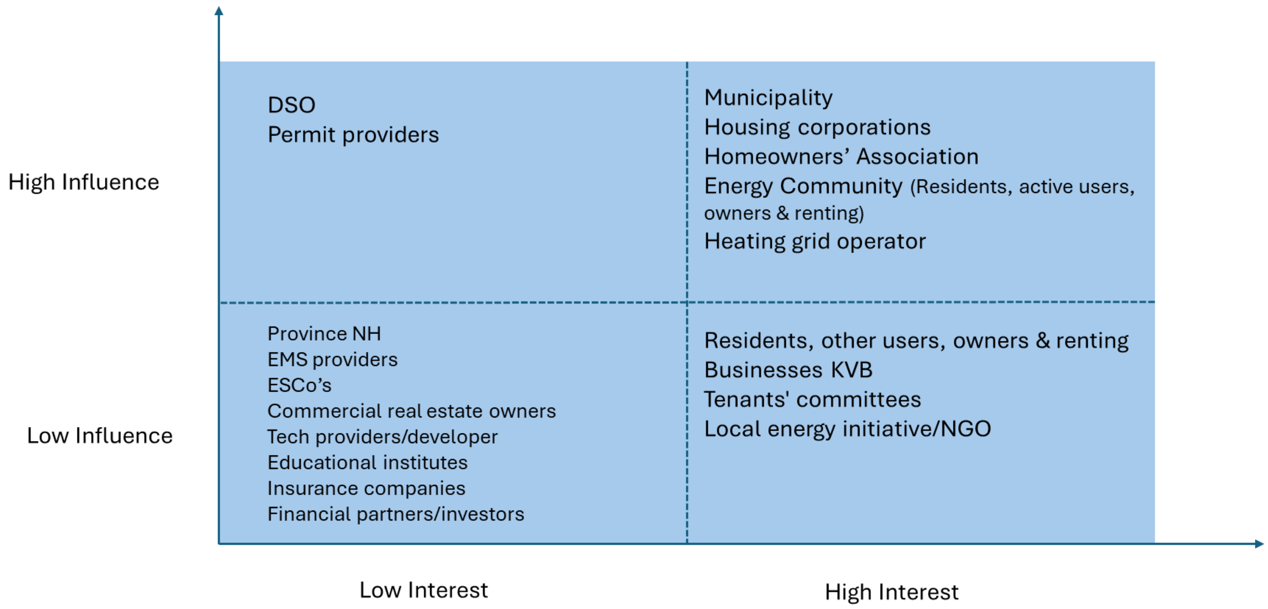
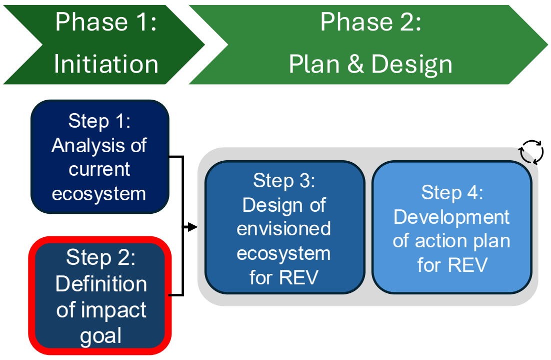


Figure 15: Residential Area Overdie Influence vs. Interest Grid

At the time of writing, an analysis of the motivations and barriers of the Overdie stakeholders has not yet been conducted. In the coming months, interviews will be scheduled with the housing corporations and the municipality to gain insight into the local context and to identify the most suitable instruments for engaging other local actors and understanding their challenges.

An initial meeting with one of the housing corporations has led to the current plan to focus the REVT5 efforts on the privately owned ground-level houses in the area as most of the high-rise buildings owned by the corporations is envisioned to be connected to the heating grid of HVC.

4. STEP 2: DEFINITION OF IMPACT GOAL



This chapter describes the impact goals for the Flagship Valley. Generically it would build on the ecosystem analysis performed in Step 1 and additional activities to define and align stakeholders on one or several objectives for the REV.

For the FV, however, several objectives were already defined in the Grant Agreement. In that process, the objectives were already very closely aligned with regional policies as was presented in the previous chapter and in more detail in Annex 2. Furthermore several relevant stakeholders were included in the definition of these objectives.

This chapter re-iterates the objectives in the Grant Agreement and updates these were relevant. Furthermore, the Energy System Designer Toolbox provides additional energetic modelling results for the FV to investigate the solution space.

Given the technical developments in REVT 1-3, this chapter mostly provides the basis for the scoping of REVT4 and REVT5 activities in close alignment with each other, specifically for the Boekelermeer area.

4.1. Objectives for the Flagship Valley

The Grant Agreement of the project provides several Specific Objectives (SO), this section summarizes these and provides additional insights were relevant.

Environmental and Energetic Objectives for the Flagship Valley

All objectives in the Grant Agreement (excluding mobility) for the end of the project (2028):

- 75% CO_2 reduction: Save 15 kton CO_2 annually (SO1)
- Energy Positivity: Produce 100% of all its energy locally and renewably (SO1)
- Fossil fuel fade out: Have fully replaced natural gas consumption (SO1)
- Self-sufficiency of 75% of all energy on annual basis (SO1)
- Diversification of natural gas supply (SO1)

In the Grant Agreement of the project one can also find the energetic expectations/ambitions that were written down (excluding mobility), here included in Table 3. The main insights can be summarized as follows:

- On the consumption side the main ambition was to fully replace natural gas by biomethane, with decreasing consumption rates from 2022 towards 2030 due to the shift of heating demand to electricity and the extension of the heat grid.
- On the production side:

- Extensive biomethane production, from ~0 GWh/y in 2022 to ~**147 GWh/y in 2028** and further uptake after the project towards 230 GWh/y in 2030
- Extensive hydrogen production, from ~0 GWh/y in 2022 to **~9 GWh/y in 2028** and further update after the project towards 109 GWh/y in 2030
- Solar PV increase from ~13 GWh/y in 2022 to **~26 GWh/y in 2028** and continued further uptake after the project
- Wind increase after the project from 23 GWh/y in 2022 to 47 GWh/y in 2030

The main challenge to reach these ambitions was identified to be the current congestion issues as posed by the electricity system until the grid is extended (see previous chapter).

Table 3: Energetic expectations as included in the Grant Agreement of REFORMERS for the FV (excluding mobility)

FV energy consumption (MWh/y)	Year	Total
Electricity	2022	91,754
	2028	97,928
	2030	101,753
Natural gas	2022	77,174
	2028	-
	2030	-
Biomethane	2022	-
	2028	59,676
	2030	44,085
Hydrogen	2022	-
	2028	253
	2030	385
Heat	2022	13,127
	2028	15,190
	2030	18,846
Total	2022	182,055
	2028	173,047
	2030	165,069

RES per source (MWh/y)	Year	Solar PV	Wind	Bioenergy	Other	Total
Electricity	2022	12,930	23,200	168,000	-	204,130
	2028	25,846	23,200	168,000	-	217,046
	2030	42,720	47,200	168,000	-	257,920
Biomethane	2022	-	-	-	-	-
	2028	-	-	-	147,000	147,000
	2030	-	-	-	230,300	230,300
Hydrogen	2022	-	-	-	-	-
	2028	-	-	-	8,620	8,620
	2030	-	-	-	108,610	108,610
Heat	2022			125,000	-	125,000
	2028	-	-	125,000	-	125,000
	2030	-	-	125,000	-	125,000
Total	2022	12,930	23,200	293,000	-	329,130
	2028	25,846	23,200	293,000	155,620	497,666
	2030	42,720	47,200	293,000	338,289	721,830

Social and Methodological Objectives for the Flagship Valley:

- Co-develop new arrangements for business and governance with quadruple helix ecosystems to help create energy valleys. (SO3)
- Involve SMEs in the design and build phases while working on renewable energy supply chains. (SO4)
- Understanding user behavior in a changing energy system. (SO5)
- Achieve at least 90% user acceptance by developing social networks and technical design platforms that integrate multi-stakeholder engagement and informed decision-making tools. (SO5)

The social objectives for the Flagship Valley focus on deep stakeholder engagement, high user acceptance, inclusive participation, capacity building, and the development of new governance and community models. These are essential for the successful transition to a fully renewable, self-sufficient energy system and for ensuring that the project's benefits are widely shared and accepted.

4.2. Energetic scenarios for the Flagship Valley in 2030

Using the Energy System Designer Toolbox (developed in WP6 of the project) four distinct 2030 scenarios have been systematically developed for the Flagship Valley. They have helped to investigate and further understand the solution space to reach the energetic objectives for the FV.

Scope and limitations

It is however important to note that these scenarios focus exclusively on the stationary electrical energy system. In the analysis the following have been **excluded**:

- Heat demand and mobility-related energy consumption are excluded from these results
- The bio-energy plant of HVC was excluded, this unfortunately makes comparison with Table 3 difficult and such numerical results were omitted here to not cause confusion.
- Electrical energy storage has not been included in this area-specific analysis. Consequently, the self-consumption rates reflect a system without battery buffering, highlighting the direct temporal mismatch between generation and consumption.
- Impact of behaviourial change or impact of new contracts and other incentives.

The modelling complexity was already significant when only handling the electrical grid and already provides valuable insights. For a detailed description of the scenario definitions and results, please refer to Annex 3. Potentially a more elaborate analysis will be performed at a later stage in the project.

High level insights of the four scenarios for 2030

The scenarios reveal critical considerations for balancing renewable generation capacity expansion with self-consumption optimisation.

- Wind-focused: This scenario achieves 49% self-sufficiency while maintaining the highest self-consumption (62%), demonstrating efficient utilisation of generated energy even without storage.
- PV-focused: Despite high generation potential, this scenario shows the lowest self-consumption (54%). This reflects the temporal mismatch between daytime solar peaks and evening consumption, a gap that would typically require battery storage to bridge.
- Combined RES: This delivers the highest self-sufficiency (63%) but requires managing significant grid injection peaks.

Compared with the baseline, all three expansion strategies show substantial improvements in self-sufficiency (from 30% to 47-63%), but this comes at the cost of increased grid injection requirements. The corrected energy balance calculations confirm that all scenarios remain physically consistent, providing a reliable foundation for these strategic decisions.

The analysis confirms distinct roles for the different areas. Area 1 (Boekelermeer) consistently emerges as the primary hub for renewable generation due to its industrial capacity, while Areas 2 and 3 drive residential solar adoption. A detailed strategic breakdown of each area's role and constraints is provided in Annex 3.

4.3. Scoping of REVT4 and REVT5 objectives

Based on the original objectives for the FV, as included in the Grant Agreement, and the insights from the energetic modelling it was decided to focus REVT5 activities primarily on the electricity system for all three areas (Boekelermeer, Heiloo and Overdie). The electricity system is posing the main barrier for:

- Increased production of biomethane from current levels
- Production of hydrogen in the FV
- Additional solar PV installations at large consumers
- Electrification of fossil energy demand
- Larger companies to extend their activities in the region

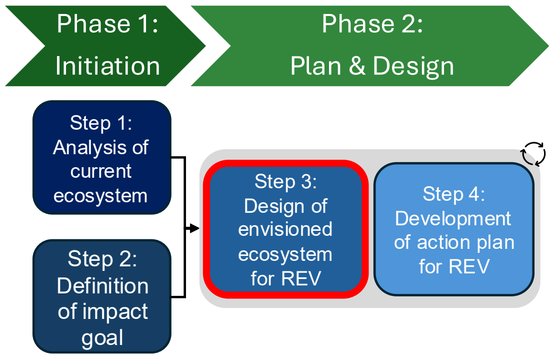
In time, extension of the electricity grid is foreseen, as explained in the previous chapter, however in the Netherlands more and more options become available for regions and stakeholders to improve the utilization of the existing electricity infrastructure. As the local DSO is one the partners in the project, it provides a great opportunity to experiment with different approaches in the FV.

Scope impact: REVT4 and 5 will primarily focus its efforts on the electricity system in the FV, specifically

1) to enable companies and citizens to perform their desired activities in the FV,
2) to enable electrification of fossil energy demand in the FV,
3) to enable additional renewable production to be connected in the FV,
4) to improve self-sufficiency of demand with renewable production in the FV,
5) to improve utilization of the local electricity grid in the FV,
6) to enable the project Energy Innovations developed in REVT1-3 to be deployed in the FV.

5. STEP 3: ENVISIONED ECOSYSTEMS IN FLAGSHIP VALLEY

This chapter introduces Step 3 of the Holistic Approach, the definition of the envisioned ecosystems in the FV. Step 1 resulted in a division of the FV into **three main areas**, namely Boekelermeer, Heiloo, and Overdie, with different energy characteristics, stakeholders and potential plans and developments. Step 2 presented the objectives for the FV and combined with the current status drove the decision for REVT4 and REVT5 to primarily **focus the efforts on the electricity system.**



In line with the back casting principle of the Theory of Change, based on the FV objectives, the envisioned ecosystems are an intermediate step towards the action plan. In line with the Orchestrating Innovation[6] principles, the envisioned ecosystems provide a clear picture of a desired and realistic value chain that can be orchestrated which will contribute to reaching the REV impact goal. To orchestrate such an ecosystem requires a detailed understanding of several areas of expertise such as Legal & Policy, Business Models, Stakeholder Engagement and Governance. These are combined in the Orchestrating Innovation approach.

For both REVT4 and REVT5, **a remaining key decision is the selection of what type of electricity coordination mechanism is selected**, this remains an open decision and will affect the further approach. This topic is introduced in the first section of this chapter. Independent of the specific mechanism, all three areas have their distinct envisioned ecosystem, which all contribute towards realising the overall FV objectives as presented in Step 2. As such, the remainder of this chapter is structured per area (Boekelermeer, Heiloo, Overdie) and describes the envisioned outcomes of the approach foreseen in terms of ecosystem development.

As the phase 2 project efforts in the FV are still in development at the time of writing some things are still impact to change and external decision making, as such this chapter provides the status overview at the time of writing but some details will need to be further elaborated upon.

5.1. Electricity coordination mechanism and regulatory developments

The regulatory domain is moving, both on EU level (e.g. Demand Response Network Code is expected soon) and Dutch national level with new contract options being tested (e.g. the group Transport Agreement, gTO as Dutch abbreviation). For the highly congested grids in the Netherlands, the new regulatory solutions are expected to help

[6] Orchestrating Innovation: engaging in innovation together - TNO Vector

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deal with the congestion. The envisioned ecosystems in the FV are build on these insights, as such this chapter starts with some regulatory developments.

In the Dutch regulatory domain of electricity **a relevant distinction is made** between entities that have a:

- large connection, i.e. bigger than 3x80 Amps and
- small connection, i.e. up to and including 3x80 Amps.

This is relevant as, for now, **only entities with a large connection can partake in several activities and contracts with the DSO**. Based on the data from the DSO the REVT5 team was able to analyse which large consumers are connected in the FV and as such identify viable groups for collaboration.

In collaboration with the REVT4 team the ecosystems in this chapter have been drafted, however these are still impact to change. It also became apparent potentially new activities need to be deployed to coordinate electricity flows in alignment with real-time data of the DSO substation. In Annex 5, some options for new activities for the Flagship Valley (FV) are presented. These activities are defined in terms of stakeholder activities within the FV for this coordination.

During the remaining three years of the project, it needs to be determined which building blocks are feasible and contribute to achieving the FV's objectives. This section explains the key uncertainties that need to be investigated and introduce the related research questions.

To identify which activities listed in Annex 5 should be included in the FV, it is required to answer the research questions formulated in Deliverable D4.3. These questions address which aspects of information exchange are critical for FV functionality and which are technically feasible. In addition, uncertainties related to regulatory developments must be considered, as well as organizational structures and business models and relate these to the findings of the questions addressed in Deliverable D4.3.

A key open decision concerns the organization of grid constraint management at the substation level. While stakeholders share an interest in optimizing operations to meet system-level goals such as to create capacity for additional grid connections, there are multiple ways to organize this coordination. Five potential approaches were identified, derived from the taxonomy of grid-edge coordination proposed by Charbonnier et al. (2022), see Figure 16. The taxonomy categorizes choices based on agency (independent control of resources or not), information (how individual data is shared), and game type (competition or cooperation). The selected five applicable approaches for the FV are:

1. Mediated Competition: Flexibility is offered to the DSO by market participants, and the DSO procures flexibility through market-based mechanisms. This represents the business-as-usual approach, but given the complex dynamics within the FV, it is unclear how well market-based procurement will fit.
2. Direct Control: Flexible resources are operated under predefined agreements with the DSO. These agreements must align with other arrangements involving flexibility

resources and comply with regulatory frameworks that prioritize market-based local service provision under certain conditions.
3. Mediated Cooperation: The DSO, market participants, and/or consumers/producers jointly optimize operations by sharing data and control options with a mediator (which could be the DSO or an independent party) who runs a cooperative optimization algorithm or rule-scheme. Multi-stakeholder optimization is challenging because it requires detailed prioritization agreements in advance and raises questions about compatibility with EU competition regulations.
4. Implicit Cooperation: The DSO shares grid state and forecast data with market participants, who then adapt their planning and local service offerings accordingly. This approach introduces potential gaming opportunities that require further study.
5. Bilateral Coordination: Consumers/producers coordinate directly or via market participants. This option serves as an alternative when mediated cooperation is not feasible. Bilateral coordination can involve competition and/or partial cooperation but introduces risks such as price-fixing.

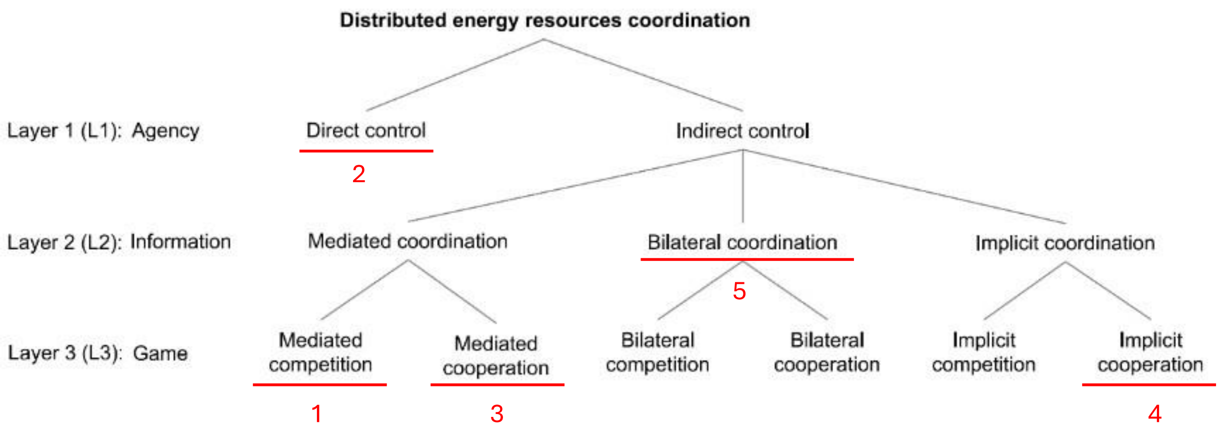

Figure 16: Taxonomy of distributed energy resource coordination (Charbonnier et al. (2022))

These five approaches of coordinating operations on a substation level can be combined. To support the selection and combination of these coordination paradigms, Annex 5 defines a set of activities that reflect these paradigms while allowing for integration. The following research questions were formulated to explore which combinations of activities best support FV development:

1. How do FV-level objectives translate into stakeholder goals? What interests and incentives drive stakeholders to cooperate or compete in aligning their operations with grid constraints?
2. Which activities in Annex 5 align well with stakeholder goals within the FV, and which do not?
3. Based on the results on the research questions defined in D4.3, which activities or combinations of activities lead to a successful FV? Are these combinations feasible

within the current organizational and regulatory context? If not, is adapting this context achievable with the timelines of the FV development plan?

5.2. Boekelermeer

For the Boekelermeer area the focus of REVT4 and REVT5 is with setting up a coordination mechanism for electricity flows amongst companies connected to the substation Boekelermeer. Most of the companies in the area are connected to this substation and in close collaboration with the DSO (Liander) research has shown that it is not the main bottleneck in the area. The main bottleneck is the (higher) substation Oudorp (see Chapter 3 for the grid layout in the area).

The draft of the envisioned ecosystem for the Boekelermeer in 2030 is shown in Figure 17. The grid is expected to be expanded and strengthened after 2035, yet companies in the Boekelermeer are already required and willing to combat challenges of grid congestion, collective action is needed. The current organisation of energy generation, distribution and consumption can be further optimised to free up capacity at companies which are at times in low demand for energy, which can help other companies deal with instances of peak or over consumption. In addition, organisations can make collective investments in energy infrastructure such as batteries or windmills to increase the local generation of energy whilst allowing the costs of such infrastructure to be shared across participants.

Often individual solution directions (i.e. optimizing individual energy connection and setup) are more appealing to businesses, however these might not always be able to provide solutions. Accordingly, the intention for 2030 is to mobilise organisations to form energy cooperatives or collectives around collaborative energy solutions. Such solutions may be based upon transport capacity sharing contracts (which are currently being rolled-out in the Netherlands), may revolve around shared investments in energy assets (batteries, windmills) for collective use to manage and increase energy capacity or a combination of solutions. Ideally, these cooperatives help address the urgent needs of many companies in the Boekelermeer to acquire extra or better manage their current contracted electrical capacity - it is of course to be expected that for some companies, these solutions will not be feasible or satisfactory.

Subsequently, the energy collectives and cooperatives can be further integrated as part of the envisioned substation approach to improve utilization of the substation for the area. This may offer further advantages in terms of freeing up additional capacity or reusing (or even reselling) leftover capacity for use at other collectives. It may also lead to integration efforts between energy cooperatives. All-in-all, this should enable the DSO to further optimize the grid performance and work with local collectives and cooperatives to finetune the utilization rate of the substation. It is the expectation that this transition can contribute towards dealing with the current grid congestion challenges posed and to improve the sustainability (economical, ecological) of the energy system.

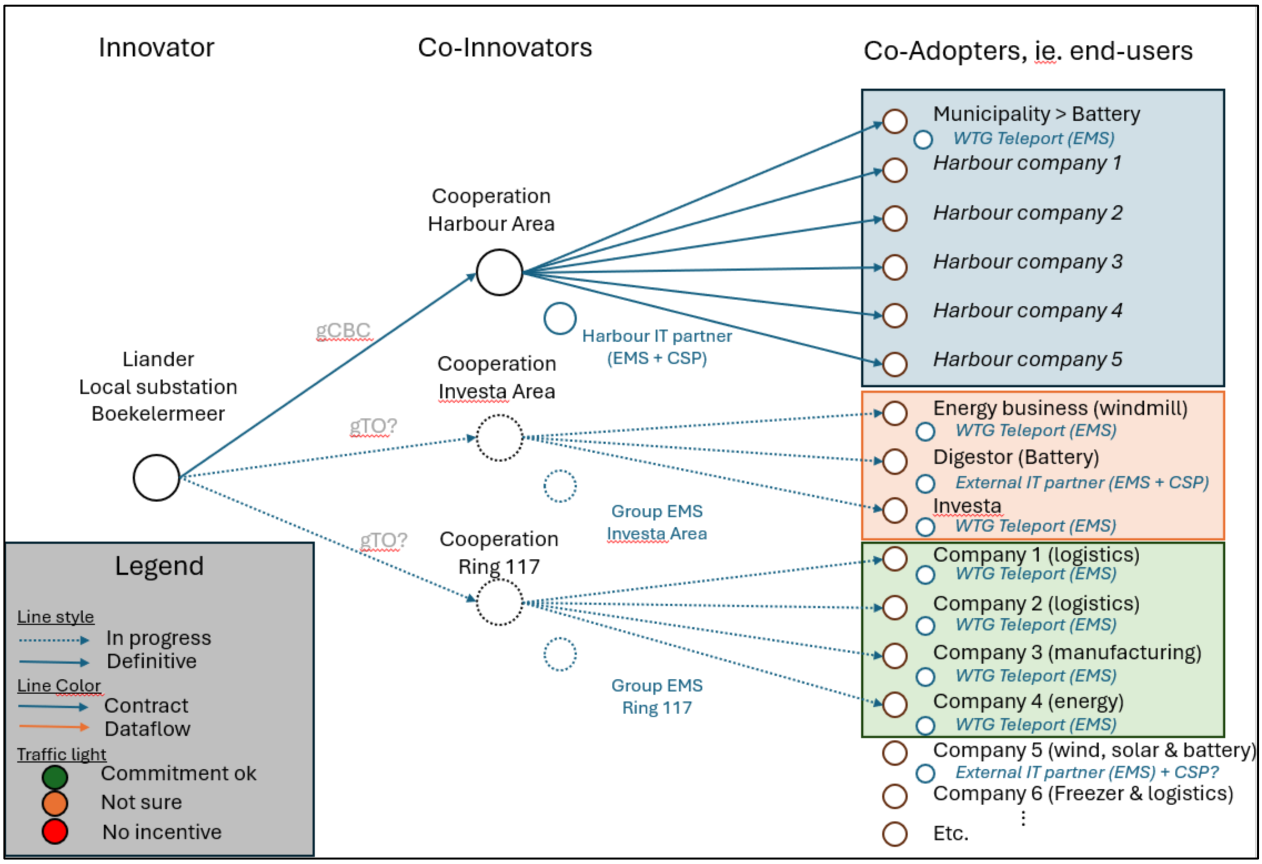

Figure 17: Envisioned ecosystem for the Boekelermeer area (work in progress)

Figure 17 is a work in progress schematic, conversations with several stakeholders are still ongoing. Dataflows have not been drawn yet, nor the indication of the willingness to cooperate (traffic light). However, as tool in the approach the authors decided it could be beneficial to include the entire template to indicate the line of thinking.

5.3. Heiloo

Two tracks within Heiloo: The individual assets track and the collective battery

Current state and challenges

Duurzaam Heiloo is the organization implementing two initiatives in two subareas of Heiloo. The first initiative is located in the residential neighbourhood Plan Oost, where electric home batteries and heat storage devices are adopted. The second initiative is in De Oude Werf, where a community battery will be installed behind the meter of a company. The collective envisioned ecosystem is illustrated in Figure 18. In the following, this ecosystem is described in more detail for both Plan Oost and de Oude Werf separately, given their differences in terms of the solution direction elected.

Implemented technologies

<u>Plan Oost</u>

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In Plan Oost, ten electric batteries of 10 kWh are installed in homes with at least seven solar panels and five thermal batteries will be installed. All systems will be equipped with a Teleport Home system, which allows monitoring of energy consumption, generation, and storage. A party is being sought to control the batteries and devices via a home energy management system (HEMS). The combination of solar panels, home batteries, and energy management systems offers homeowners several possible benefits. First, they can store self-generated solar energy for later use, reducing reliance on the grid. Second, they can trade energy on markets, using part of their battery capacity for day-ahead transactions. Finally, collectively, homeowners can offer battery capacity to grid operators as a buffer during peak demand.

De Oude Werf

When considering actors and roles, the challenge towards 2030 is to develop a governance structure around management of the batteries together with the involved actors in both areas. In addition to Duurzaam Heiloo as an initiator of innovation in both Plan Oost and De Oude Werf, an innovative company, and the participating households, other stakeholders are and will be involved. Stakeholders that yet need to be involved include the company that will install and maintain the energy management systems, the company responsible for installing and maintaining the batteries and heat buffers, the municipality (which oversees, for example, the development of district implementation plans), and DSO (Liander), which manages the local electricity grid.

Future pathways

The current aim is to create an energy community that is suitable for the parties involved. Through iterative action research, Duurzaam Heiloo aims to let the needs of the involved stakeholders guide the development of an appropriate form of collaboration. This form will differ between Plan Oost and De Oude Werf, since Plan Oost focuses on individual energy batteries and optimization, while Oude Werf involves a collective battery. Additionally, the propositions for using these innovations must be developed and defined for all stakeholders that can be used in business modelling. This will be done iteratively over the coming years and in close cooperation with all the actors mentioned.

Plan Oost

Concrete pathways in Plan Oost, are thus (1) to identify a EMS system that affords the possibility to efficiently monitor and share electricity. (2) To identify realistic value propositions for stakeholders, such as a viable proposition for residents that delineates how PV, an electric battery and EMS system help to increase local electricity generation, increase self-consumption of electricity and lower costs. And (4) to experiment and formulate with different governance arrangements for the collaboration between these stakeholders.

De Oude Werf

Pathways in De Oude Werf are similar. Also here a (1) technical partner that can implement, operate, and maintain the EMS system needs to be involved. (2) Relevant stakeholders such as the municipality need to be engaged (3) Realistic propositions for stakeholders need to be described. And (4) governance arrangements for the collaboration between these stakeholders need to be outlined. Especially this fourth point needs special attention. Since a company hosts the battery for communal and public use by residents, De Oude Werf offers an excellent place to explore a suitable governance form, for example with an energy community.

Impact 2030

By 2030, the project has the potential to demonstrate that batteries can make a valuable contribution to more efficient local energy use by individual households in Plan Oost. The neighbourhood battery offers an excellent opportunity to show that electricity exchange can be a solution for peak production and peak demand among companies and residents in De Oude Werf. Together with the participating residents and stakeholders, new technical solutions for energy management in EMS systems, new value propositions and new governance arrangements will be developed that provide valuable insights and can be used for future initiatives.

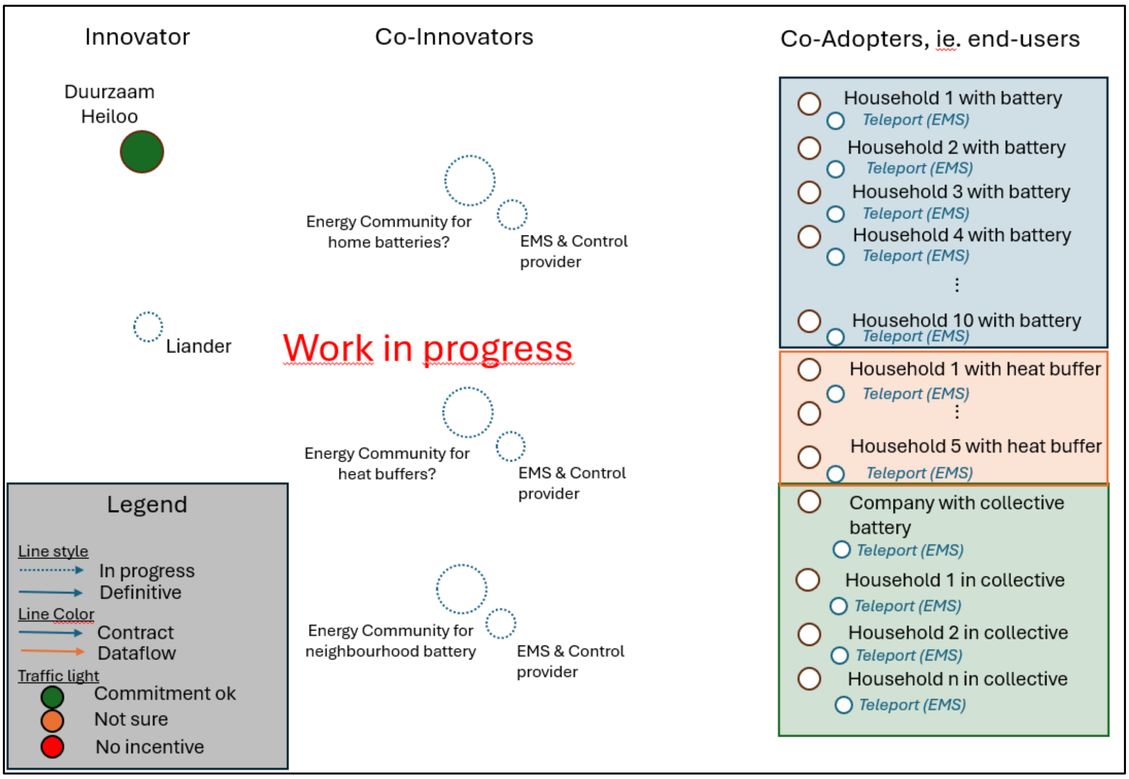

Figure 18: Envisioned ecosystem for Heiloo (work in progress)

Figure 18 is a work in progress schematic, conversations with several stakeholders are still ongoing. Dataflows have not been drawn yet, nor the indication of the willingness to cooperate (traffic light). However, as tool in the approach the authors decided it could be beneficial to include the entire template to indicate the line of thinking.

5.4. Overdie

Vision for 2030

Actors and roles

At the time of writing, New Energy Coalition, TNO, and Woonwaard are exploring what role the REV can play within the ecosystem of Overdie East and West. Other key actors include HVC, the municipality of Alkmaar, Liander, tenants, and private homeowners in Overdie East and West. Innovators enabling energy storage and exchange through, for example, batteries and EMS will also be part of the network. This ecosystem is still being developed, and therefore the roles will crystallize in the future.

Future pathways

Because the HT heating network is being installed, Overdie East and West offer two excellent cases to analyse how a REV functions in this context. It is relevant to examine the role of electricity generation, storage, and sharing. The area will also be used to explore how electricity and heat can be integrated.

Overdie, with its completely different ownership structures, offers an excellent opportunity to set up different governance models and investigate business cases. One question could be how a housing corporation can best provide an HT heating network and electricity supply to tenants and homeowners. Another aspect to explore is how the benefits and costs of these services can be distributed fairly yet feasibly among the actors, tenants, and homeowners.

Impact 2030

By 2030, the project has the potential to demonstrate how a REV operates when an HT network is the heat source. It can show how such a REV can be organized for both housing corporations and private homeowners. By demonstrating the REV for both target groups in a highly comparable setting, it will be possible to analyse which governance models and business structures work best for housing corporations, their tenants, and homeowners. A preliminary version of the envisioned ecosystem is illustrated in Figure 19.

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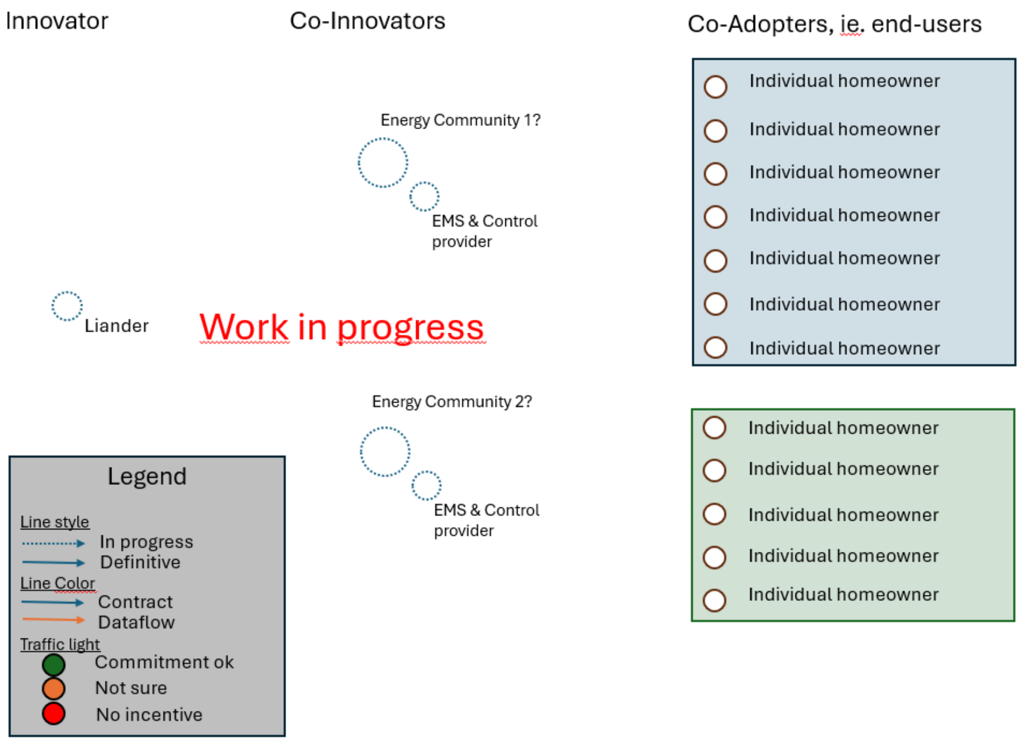
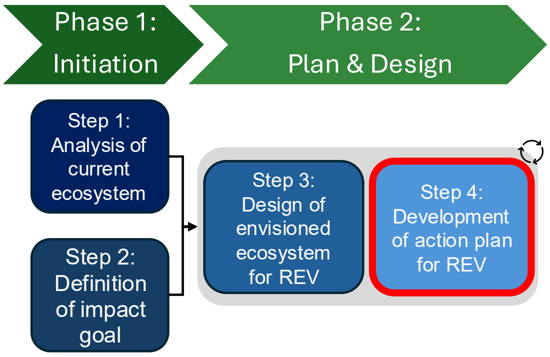


Figure 19: Envisioned ecosystem for Overdie (work in progress)

Figure 19 is a work in progress schematic, conversations with several stakeholders are still ongoing. Dataflows have not been drawn yet, nor the indication of the willingness to cooperate (traffic light). However, as tool in the approach the authors decided it could be beneficial to include the entire template to indicate the line of thinking.

6. STEP 4: REVT5 PLAN FOR THE NEXT THREE YEARS



This chapter describes the next steps in the Implementation and Operation Plan of REVT5 to reach the 2030 envisioned ecosystems for Boekelermeer, Heiloo and Overdie as described in the previous chapter. The technical backbone needed for enabling this vision is developed as part of REVT4. In order to develop the envisioned ecosystem per area, this chapter describes the actions for the next three years to be taken in terms of stakeholder engagement, governance and business modelling.

REVT4 and REVT5 will collaboratively work towards the envisioned ecosystems for Boekelermeer, Heiloo and Overdie in close alignment with the DSO and local frontrunner groups and their service companies and IT partners.

As the phase 2 project efforts in the FV are still in development at the time of writing some things are still impact to change and external decision making, as such this chapter provides the status overview at the time of writing but some details will need to be further elaborated upon.

6.1. Boekelermeer

Stakeholder Engagement

Based on the stakeholder mapping for the area, as well as the insights gained from the stakeholder analysis performed as part of Step 1, the following stakeholder engagement objectives and general approach are identified for the coming years:

The engagement strategy for Boekelermeer will take the following into account:

- Starting with company clusters: Supporting the formation of cooperatives around capacity sharing contracts and asset investments (batteries, windmills).
- Emphasizing autonomy and sustainability: Positioning energy independence and emissions reduction as core benefits.
- Providing legal and technical clarity: Offering workshops and info sessions to address regulatory and knowledge gaps.
- Leveraging reputational incentives: Highlighting green image and local sustainability contributions.
- Iterative scaling: Using early successes to onboard additional companies and later explore integration with residential actors.

The following concrete general activities will be pursued:

- Conduct targeted workshops on legal frameworks and innovative contract forms.
- Facilitate co-creation sessions for governance and business model development.
- Launch awareness campaigns focusing on sustainability and operational benefits.
- Establish feedback loops with frontrunner groups to refine engagement strategies.

The more specific implementation and timing will be defined in the coming months. The overview of potential engagement activities for the various stakeholder categories, as presented in Section 2.5 of Deliverable D6.4, will serve as a basis for identifying concrete initiatives for the different identified Boekelermeer stakeholders.

Governance

The energy transition of an energy valley means investing in installations, operating them, and investing in expansion and innovation. These installations generate energy, store it, convert one form of energy into another, use energy, and help manage the entire system of the valley. This entire system integrates generation, storage, conversion, and use, so development and management can only be done with an overview of the system. This is an important argument for collaboration, for example within an energy community, but not every entrepreneur in the valley is always willing to do so. The result is that a legal entity is needed that is suitable for joint investment and management, but also for cooperation with entrepreneurs who want to remain outside the community.

The legal entity for joint investment and management can be the legal entity of an energy community of the valley (see the EU Renewable Energy Directive[7]). Such a community has, based on the Dutch Energy Act, the right to carry out almost all activities within the energy sector. For most companies in an energy valley, participation is allowed, and this also applies to governments and citizens. The community is free to choose any form of legal entity, and here the CV-BV will serve as a prototype. Prototype means the model that will be tested, with the aim of developing a better model from it. Non Dutch readers can find an EU repository in the footnote.[8]

CV stands for *commanditaire vennootschap* (limited partnership). To begin with, this is also a BV (private limited company) and it has shareholders. These can be entrepreneurs, governments, and citizens. They take shares in developing and managing an integrated energy system because they want to organize their daily concern for their energy supply. However, they are not energy entrepreneurs; they have daily concerns for other activities, for example because they run a business that does something entirely different than providing energy. In other words, the members of the CV want to wisely manage their concerns for a good energy supply.

With a CV, the shareholders choose to be owners of the company that meets their energy needs. They do not choose to outsource their concerns to a company over which they have

[7] Consolidated TEXT: 32018L2001 — EN — 16.07.2024
[8] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities/energy-communities-repository-products_en

no control, but they do hire such a company through the other BV, the BV in the CV-BV structure. This BV is also known as an SPV (*Special Purpose Vehicle*), a company tailored to the special needs—the special purposes—of the participants in the CV: their energy needs. The CV can simply hire another BV to act as the SPV, but that makes no difference from outsourcing all concerns to that BV, and then the CV makes little sense. It only makes sense if the CV is the owner or co-owner of the BV.

To be clear, there are two BVs: the CV and the SPV, and both have shareholders. Since the CV establishes the SPV, the participants in the CV are initially full shareholders of the SPV. However, they can transfer shares to another party or parties, creating a joint venture. This structure is particularly suitable for larger investments, where the CV seeks a strong partner, think of a wind turbine or a heating network. Collaborating with a strong partner is the essence of a CV because the members of the CV themselves have no expertise in energy and cannot finance all investments on their own. Through the SPV, they can collaborate with a party that brings this expertise and financing. At the same time, the CV gives participants the chance to retain control.

Two main advantages of the CV-BV are that the CV not only hires expertise but also a party that is, for example, certified. The other advantage is that the CV can cooperate with the government by making it a member and shareholder. This gives the government opportunities to fulfil its role in the energy transition, especially now that municipalities in the Netherlands are expected to actively participate in energy provision. To realize projects, a government will often need to tender. The CV-BV structure is designed for this because partnership in the SPV can be tendered. With these and other issues, the CV-BV structure—the prototype—can be tested, and issues such as government participation and tendering obligations are part of the test. Below are some other issues:

Collaboration

As mentioned, there are likely entrepreneurs who want to remain outside the common energy system. It makes sense that they collaborate with the energy community behind this system through contracts, for example for the supply of electricity and heat. The SPV seems the better contractual partner than the CV.

Energy Act

Does the Energy Act impose restrictions on the energy community to establish a CV-BV? So far, it does not seem so, but it is good to check this again. It is also good to look at replicability. The energy community exists in all EU member states, but the CV-BV as a Dutch phenomenon does not. However, the CV-BV is both a classic private law figure and a modern phenomenon with the SPV, which is applied in many countries. There is therefore a chance that the CV-BV will also be understood in other member states as a way to answer the question of which legal entity an energy community should choose.

CBC, capacity-limiting contract

There is still a lot of pressure on companies to conclude a GTO, Group Electricity Transmission Agreement, but in the last six months, CBC feed-in contracts have also been concluded. A lot is happening, and one question is whether there will also be a group CBC, which seems suitable for an energy community.

Decision-making

Within energy communities, various decisions are made according to the one-man-one-vote system. Within companies, voting often depends on the number of shares. How can this be aligned when an energy community chooses a CV-BV? Do the largest shareholders then have the most say, or is control organized differently?

Cooperative

Many energy communities choose the cooperative. Can you choose a cooperative instead of a CV and let this cooperative have a BV as SPV? What are the advantages and disadvantages? Are there, for example, tax differences? What is most convenient for the government, given that experience shows it is reluctant to join cooperatives and has experience joining CVs?

More communities

The situation in Boekelermeer shows that there are more communities that together form a larger community. Is it useful to establish a CV-BV per community or to have a joint CV-BV as communities? How can they make more strategic decisions together?

Development and operation

The CV-BV seems suitable for both developing and operating projects. The question is what is best after development. One option is to establish an SPV per project and convert the BV of this SPV into an operating company after development. The CV holds shares in that company, as does the partner previously brought into the SPV. Do they continue together or transfer shares? Another option is to have the SPV handle multiple projects; if those projects are similar, this is conceivable, but otherwise probably not.

If the CV-BV prototype does not pass the test on the above and other issues, a better prototype will follow. For now, the CV-BV is the best interpretation of the prototype.

Business Models

At the time of writing this deliverable, business modelling workshops have taken place for a cluster of companies in Boekelermeer, exploring how supply and demand for energy capacity can be distributed more effectively and efficiently to support the long-term growth ambitions of these companies. This has led to the identification of a solution strategy (a joint energy contract), the formation of an energy cooperative, as well as initial decisions on the financial and investment structure to support this cooperative. This cluster represents just a fraction of the companies active in Boekelermeer. As next steps, REFORMERS intends to support other clusters of companies as well in terms of their business modelling efforts, growing the energy communities and cooperatives that result from this. The lessons learned from working with the initial cluster of companies can help to speed up and scale these efforts to other clusters as well. Moreso, this initial cluster focused on a scenario in which no available or additional renewable energy infrastructure was foreseen (and hence the solution relied on aligning and optimizing supply and demand). In the harbour area of Boekelermeer, investments in energy infrastructure are taking or have taken place (e.g., installation of a battery or the availability of a windmill), which allows us to explore different kinds of business models. All-in-all, in the upcoming three years, this should lead to the formation of local energy cooperatives or communities, supporting the needs of different companies in the Boekelermeer area. Once multiple cooperatives / communities are available, business modelling efforts will also be dedicated towards understanding how these collaborations can be interconnected, identifying potential synergies between different cooperatives and communities.

6.2. Heiloo

Stakeholder engagement

The strategy for stakeholder engagement in Heiloo will focus on three target groups: citizens, government, and technical experts, particularly those responsible for installing a well-functioning EMS.

Plan Oost

Citizens in Plan Oost will be involved in two phases. The first phase consists of research among early adopters — those who first install and/or use the ten home batteries, thermal batteries, and Teleport Home systems. In the second implementation phase, early users may also adopt these technologies and will then be included as a study population. Throughout the project, relevant government actors will first be carefully identified, for example, if policy support is needed. In addition, the coming year will involve actively seeking a party capable of installing and maintaining an energy management system. This system must be able to intelligently store, deliver, trade, and share energy.

The approach for stakeholder engagement is rooted in action research. Within action research, empirical investigation is not only carried out, but improvements in practice are also pursued. Stakeholders are actively involved in the research to identify needs, evaluate solutions, and develop them further. Methods used include semi-structured in-depth interviews, questionnaires, and informal information sessions. Over three years, others will gradually be engaged through a public campaign and via the network of study participants.

De Oude Werf

In De Oude Werf, a comparable approach to citizen engagement will be applied. The use of the battery at the company involved will serve as a demonstration site in the first implementation phase. In the second phase, other companies and users might adopt new batteries. An extra feature that will be installed are electronic vehicle charging stations. Here, residents in Heiloo can charge their electronic vehicles. Therefore, a party will need to be involved in De Oude Werf to realize the charging infrastructure.

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Stakeholders are involved in a similar way as in Plan Oost: through action research, they actively contribute to the technical and social design of the Neighbourhood Battery, the EMS system, and the technical functionalities of these systems.

Governance

Plan Oost

An appropriate governance structure will be developed iteratively and via participation in Heiloo. Residents and stakeholders will be asked which form of collaboration suits them best, in order to create a shared vision on a desired governance arrangement. In Plan Oost, governance mainly concerns individual home batteries and EMS systems. Here, it must be clarified how these systems can and may operate on the market.

De Oude Werf

Since De Oude Werf involves a neighbourhood battery, forming a collective governance model with citizens and a company for the battery is also relevant. Based on stakeholder needs, the coming years will explore which governance model is most appropriate, such as an energy community.

Business models

Plan Oost

In Plan Oost an ecosystem analysis will form the basis for subsequent business model calculations. In the coming years, a comprehensive overview will be created of stakeholders (residents, businesses, municipalities, knowledge institutions), their activities, interconnections, and value propositions. It will also be explored how these value propositions can be linked to achieve shared stakeholder goals. REFORMERS will support the development of this ecosystem analysis so that it can be used in business model calculations. The business models are developed in various workshops with relevant stakeholders.

De Oude Werf

A similar approach is used in De Oude Werf. However, relatively much attention will be given to developing a solid business case for companies, citizens, and possibly the charging infrastructure of electric vehicles.

6.3. Overdie

Stakeholder engagement

In Overdie East and West, REFORMERS will invest in engaging relevant stakeholders in the upcoming year. At the time of writing, New Energy Coalition and TNO are initiating the approach in Overdie East and West. Discussions about a close collaboration are ongoing with Woonwaard, the housing corporation that is connecting its portfolio to the district heating network of heating company HVC. Woonwaard provides an important gateway to other relevant stakeholders. Through the network of parties involved in REFORMERS, such as New Energy Coalition, other relevant stakeholders will also be engaged. Examples of these, in addition to HVC, include the municipality of Alkmaar, Liander, tenants, and private homeowners in Overdie East and West. Innovators enabling energy storage and exchange through, for example, batteries and EMS are also included as stakeholders.

The selection of relevant stakeholders will be achieved through discussions with these parties and a stakeholder analysis. Mapping the stakeholder ecosystem will help to clearly identify which stakeholders are present and what for example their influence, interests, and impact are.

Governance

Based on stakeholder needs, the coming years will explore what appropriate governance arrangements could look like in Overdie East and West. Several possible governance arrangements can be developed for:

- The integration of heat and electricity.
- Electricity generation, storage, and exchange between the housing corporation, residents, businesses, and other relevant stakeholders in Overdie East.
- Electricity generation, storage, and exchange between owner-occupiers, home owners associations (*Vereniging van eigenaren*), businesses, and other relevant stakeholders in Overdie West, for example in the form of energy communities.

Business models

REFORMERS will support the mentioned stakeholders in their business modelling efforts. Since lessons have already been learned in Boekelermeer about business modelling for a REV, a reasonably validated business modelling approach can be applied. This will then be adapted to also be relevant for residents.

7. LESSONS LEARNED FOR THE HOLISTIC APPROACH

This chapter presents the lessons learned while developing the holistic approach and setting up the FV. These insights are split into lessons with respect to the approach and lessons with respect to upscaling of REVs.

7.1. Lessons with respect to the approach

- **Reduce the complexity.** Due to scope, size and characteristics of an area, the development of setting up a REV can become highly complex, with energy grids being intertwined, stakeholders being interrelated and the realization of the strategic objectives being reliant on seemingly concurrent decision making (for example to take collective action or to make investments towards the deployment of renewable energy infrastructure). However, due to the risk of making investments, such decision making may potentially be delayed, with stakeholders 'waiting' on other stakeholders to take action. To reduce the complexity, it is advocated to *simplify the area into coherent subareas* (with similar geographical characteristics, supporting similar business functions or featuring similar stakeholders). Subsequently, these subareas can become the focus of assessment, design and development, enabling these subareas to already explore solution directions without being dependent on decisions made elsewhere. Accordingly, this can help to accelerate REV development by partitioning the area into more 'digestible' local initiatives (whilst simultaneously keeping in mind the grand vision for the REV). This is further illustrated in Figure 20.
- By aligning the approach with a proper methodological basis various tools and methods become directly available for the process of setting up REVs. By aligning with the four phases of MOOI EIGEN various tools and aids can potentially be adopted for application to setting up REVs.
- The energetic modelling and monitoring for the FV have proven challenging due to challenges with system boundary definitions and data availability of import/export streams. The energetic modelling of mobility for the FV illustrates this issue.
- The Holistic Approach is now linked to the REFORMERS toolboxes, however this should be made more generic as there are many available tools and toolboxes.
- As the approach was developed alongside the operational activities in the FV some decisions in the FV were made in isolation. This however also illustrates the complexity and will often happen in larger REVs.
- Proper understanding of the regulatory frameworks, current and future changes, local stakeholder needs and capabilities and proper support schemes is key to developing feasible ecosystems.
- This is not an extensive list and the holistic approach will be further developed as part of REFORMERS and an update is planned to be developed as part of D6.3 due at the end of 2026.

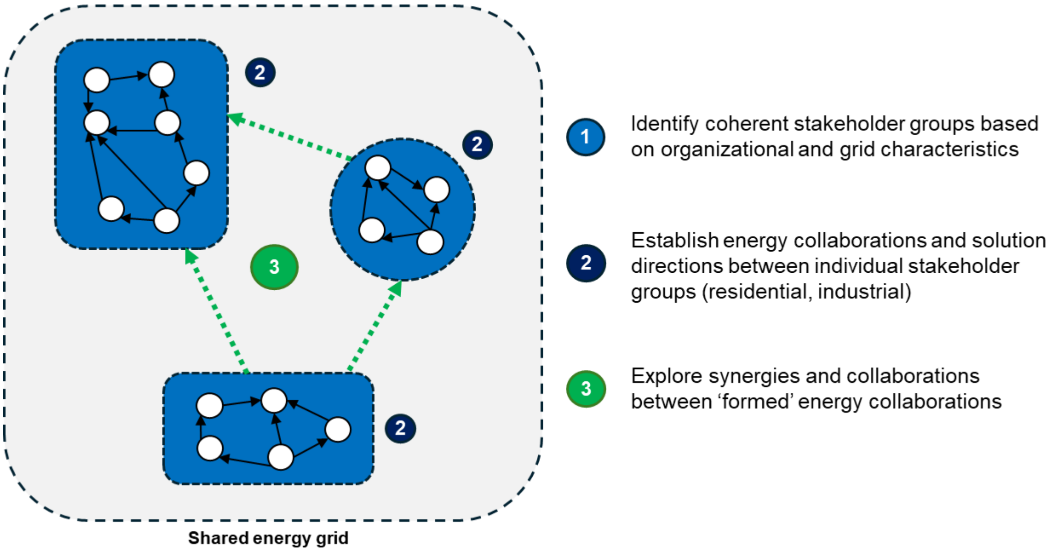

Figure 20: Identification of subareas to support REV development

7.2. Lessons with respect to upscaling of REVs

Based on experiences in the Netherlands several lessons learned can be shared with respect to upscaling of REVs. In the Netherlands a new domain and profession if you will is developing, setting up regional energetic collaborations.

A good process coordinator is key:

- In various areas in the Netherlands communities of practice have been set up for process coordinators to exchange lessons learned. [9]
- Various training programs have been developed to train more people to become a process coordinator.[10,11]

Some key enablers to set up a REV are:

- **Standardization of the approach** helps to build a common understanding which is crucial for national and regional support schemes to be formulated. In the Netherlands MOOI EIGEN was a crucial project contributing to building this common understanding with respect to Energy Hubs.
- **Clear support on national and regional level** is a tremendous enabler. In the Netherlands several support schemes have been set up to facilitate setting up energy hubs, i.e. collaborations between companies. The urgency of grid congestion played a big role in this.[12, 13]
- **DSO involvement is a key enabler**. For the FV, the close collaboration with the DSO (Liander) has been pivotal in gaining insight in the current status of the electricity grid,

[9] Community of Practice in de Provincie van Zuid-Holland — Sustainable Scale-Up Foundation (in Dutch)
[10] Masterclass Smart Energy Hubs (in Dutch)
[11] Three day course for energy hub development (in Dutch)
[12] Handreiking Stimuleringsprogramma Energiehubs 2024 (in Dutch)
[13] Stimulering energiehubs Noord-Holland, subsidie (in Dutch)

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future expansions and building towards a future ecosystem. DSOs are adapting to a new paradigm and in the Netherlands are developing standardized approaches to share data[14] and to formulate new collaborative contracts.[15]

For European context:

- **Regional context is expected to have a great influence** in the development of REVs. European frameworks and legislation are developing, but regional variations in available renewable energy sources is expected to have a big impact on the type of REV that is most suitable for a region.

[14] Roadmap data sharing for the energy transition | Netbeheer Nederland (in Dutch)
[15] Improved utilization of the electricity grid | Partners in Energie (in Dutch)

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ANNEX 1 - METHODOLOGICAL BASIS FOR THE HOLISTIC APPROACH

This annex elaborates on the methodological basis for the Holistic Approach. The main structure of four phases is adopted from a successful approach in The Netherlands (and broadly used in project development), the initial four steps are based on the Theory of Change and the integration of expertise areas builds on the insights of Orchestrating Innovation as developed and taught by TNO.

Four phases

The structure of four phases is inspired by the decision-making approach which resulted from the Dutch innovation project MOOI EIGEN (https://www.eigen-energyhubs.nl/). The MOOI EIGEN project focused on the development of a holistic approach to set up (sustainable) energy hubs and several tools and toolboxes to aid in the process. The results were turned into a national knowledge platform (Kennisplatform Energiehubs) and are now widely adopted by all levels of Dutch government, grid operators and representatives from industry.

In addition, the approach loosely follows the regular development cycle of setting up innovation and collaborative ecosystems[16,17], with REVs supporting the collaboration between diverse energy stakeholders (private, public) and enabling joint innovation on new energy solutions.

First four steps based on Theory of Change

The Theory of Change is particularly useful for any initiative that aims to create complex social, economic, or environmental change. It helps stakeholders understand and communicate the causal links between activities, outputs, and desired outcomes, ensuring a strategic approach to planning, implementation, and evaluation. **The Theory of Change uses backwards mapping**, requiring planners to think in backwards steps from the long-term goal to the intermediate and then early-term changes that would be required to cause the desired change. This creates a set of connected outcomes known as impact pathways.[18] The steps of the Theory of Change are shown in Figure 21.

[16] https://www.tno.nl/en/about-tno/organisation/units/strategic-analyses-policy/orchestrating-innovation/
[17] https://www.weforum.org/publications/innovation-ecosystems-a-toolkit-of-principles-and-best-practice/
[18] Impact academy - Overview of Theory of Change

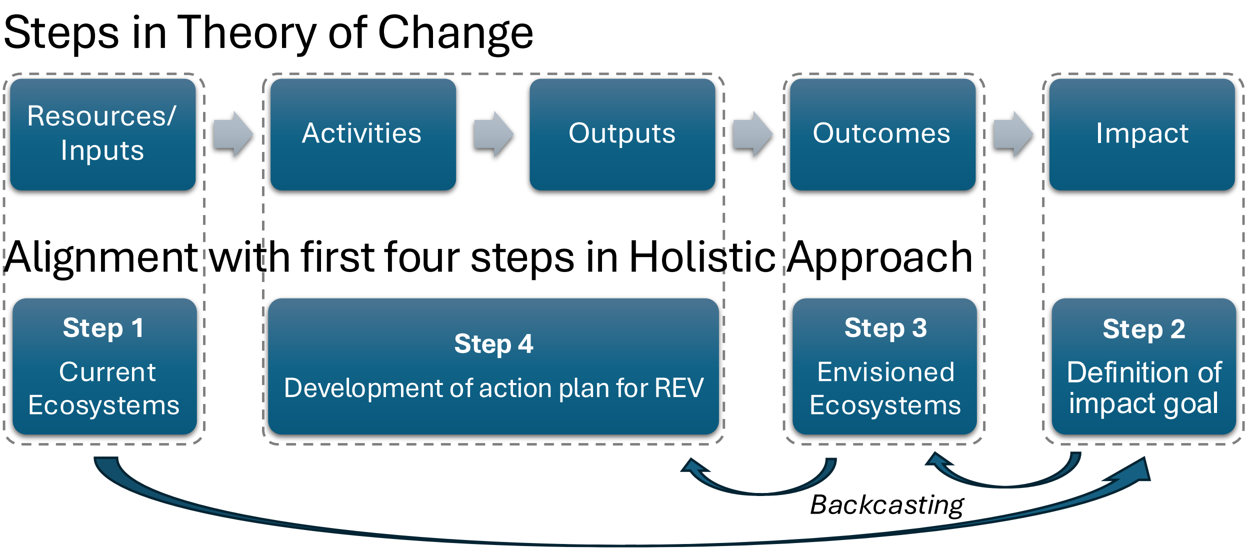

Figure 21: Steps in the Theory of Change and relation to the first four steps in the Holistic Approach

Developing Ecosystems via Orchestrating Innovation

Developing an innovation ecosystem requires expertise. Without expertise there is no direction. TNO refers to this as 'Orchestrating Innovation'. The main goal is to adopt an efficient and effective action-oriented approach to every innovation, achieving more impact with less effort. The most important condition for developing a successful innovation ecosystem is feasibility. Orchestrating Innovation makes complex innovations manageable by setting common goals that are feasible in practice – actions that stakeholders are willing to take together, continuously looking for common ground at every stage. That is how Orchestrating Innovation brings the interests of all stakeholders together.

Over the past decade TNO has developed the method of Orchestrating Innovation.[19] It aims to build public private ecosystems that contribute to societal impact goals.[20] It is closely aligned with the Theory of Change and as such goes well together with the steps as presented in the Holistic Approach.

[19] Orchestrating Innovation: engaging in innovation together - TNO Vector
[20] Developing an innovation ecosystem - TNO Vector

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ANNEX 2 – REGIONAL POLICY ANALYSIS

This annex provides a summary of relevant regional energy policy affecting the FV and shows the alignment of the FV objectives with these regional policies. The national policies are omitted here.

Energy Vision for 2050 by the province of North-Holland

In January 2025, the province of Noord-Holland, within which the Flagship Valley is situated, published their Energy Vision ('Energievisie 2.0'[21]) for 2050. This vision sets five core principles that form the base for decision making towards a sustainable and reliable energy system.

1. Energy saving as spearhead for energy policy
2. Demand, supply and storage of renewable energy will be bundled in order to efficiently utilize existing and new energy-infrastructures
3. Smart utilization of energy and infrastructures: strive towards and optimal regional energy mix
4. Developing energy infrastructures with attention to environmental quality and a healthy living environment
5. Focus on robust energy junctions ('energieknooppunten')

Within these robust energy junctions, energy-intensive activities are clustered, and local energy systems (demand, supply and storage) come together. Boekelermeer, the central business park of the FV, is one of the six identified energy junctions. Boekelermeer is recorded as potential green molecule hub and mobility hub (due to conjunction of high- and waterways) where energy infrastructure creates potential for economic development. Lastly, the area is marked for the reinforcement of the power grid and for the reallocation of businesses to accommodate for housing construction in the city centre.

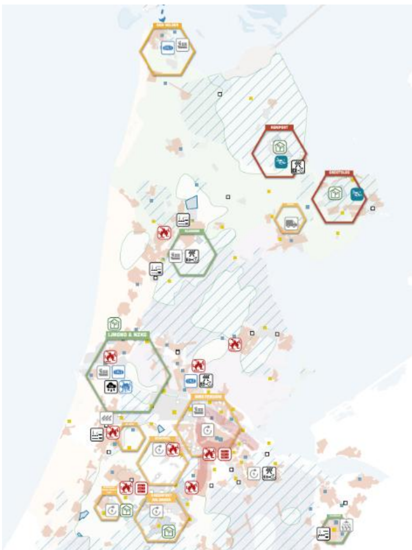

Figure 22: Energy junctions Noord-Holland

Aside from the energy junction, the following development pathways are being mapped in for the region Alkmaar in the Energy Vision:

- The extension of the regional heat grid operated by HVC in which the waste-to-energy plant can potentially be replaced by geothermal sources to feed the heat grid.
- The additional reinforcement of the power grid post 2035 (further delineated in Section 3.2).
- The future connection to the national hydrogen backbone

[21] https://www.noord-holland.nl/bestanden/pdf/Klimaat_Energie/Energievisie.pdf

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Agenda Sustainable Alkmaar

Next to the Energy Vision of the province, the municipality of Alkmaar created their 'Agenda Duurzaam Alkmaar (ADA)[22]' (Agenda Sustainable Alkmaar), to frame and prioritize projects and programs in the municipality's ambition to be climate neutral, climate resilient and circular by 2050. The energy- and heat transition is one of the four themes with the following corresponding subgoals:

- Substitute natural gas usage at 1,600 households per year
- Increase Renewable energy production in the Alkmaar region to 0.62 TWh in 2030
- Achieve 55% CO_2 reduction by 2030 at properties owned by the municipality
- All offices owned by the municipality should have energy label C

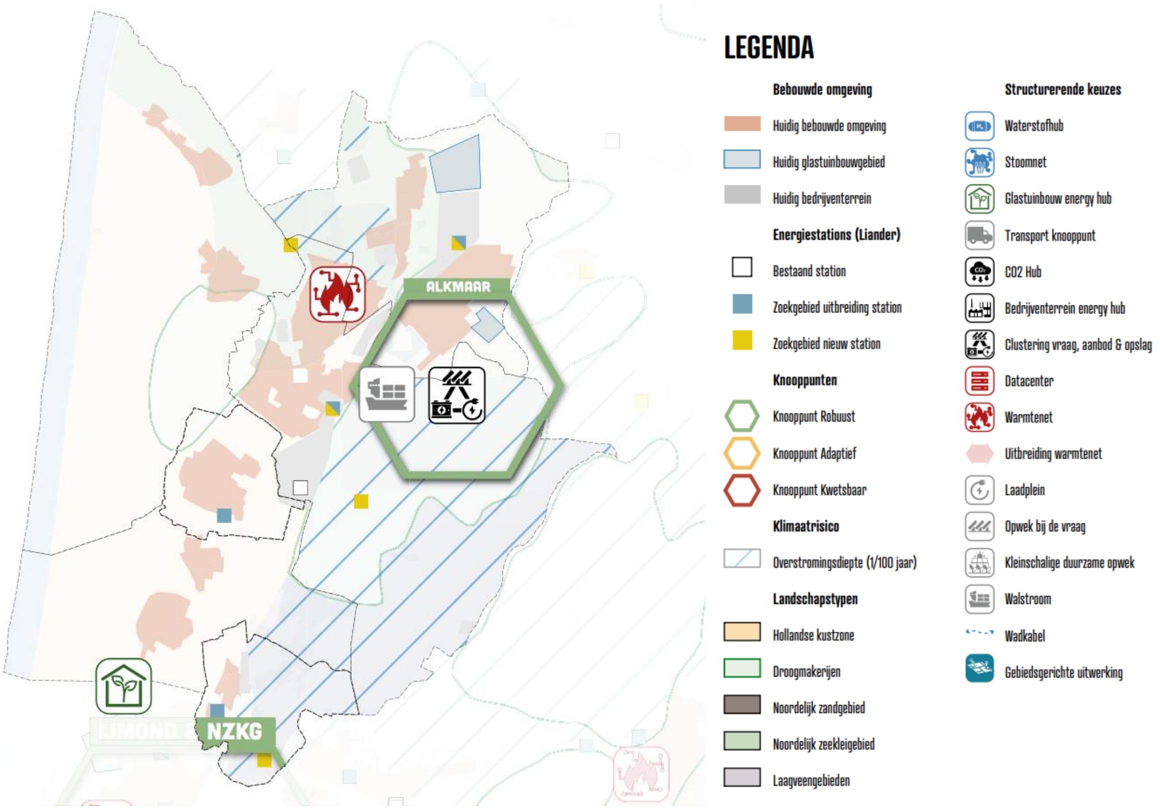

Figure 23: Agenda Sustainable Alkmaar by the municipality

[22] https://alkmaar.bestuurlijkeinformatie.nl/Agenda/Document/f60a2b3c-f1b0-4d7d-90ce-40cc5e0482fc?documentId=cf9f5dbe-9cf8-411c-a1d0-cb53d51d800d&agendaItemId=37e3d1eb-bb9f-4ac3-a973-ad66a6ffae07

Regional Energy Strategy North-Holland North

For the shorter term, a recalibration of the Regional Energy Strategy Noord-Holland North was established by the provincial council on the 30th of June 2025[23]. The target of 'energy region' Noord-Holland North is to annually produce 3.63 TWh renewable energy by 2030 across the regions of 'Kop van Noord-Holland', 'Westfriesland' and 'Regio Alkmaar'. According to this recalibration document, the existing RES accumulate for 2.34 TWh, meaning that another 1.29 TWh of RES should be installed by 2030.

Zooming in on the region where the REFORMERS FV is situated, 'Regio Alkmaar', the existing RES capacity of 267 GWh is aimed to reach 661 GWh by 2030. To achieve this ambition, renewable energy search areas are defined for solar and wind. The following map depicts 'Regio Alkmaar' and its searching areas (numbers) for additional renewable energy capacity.

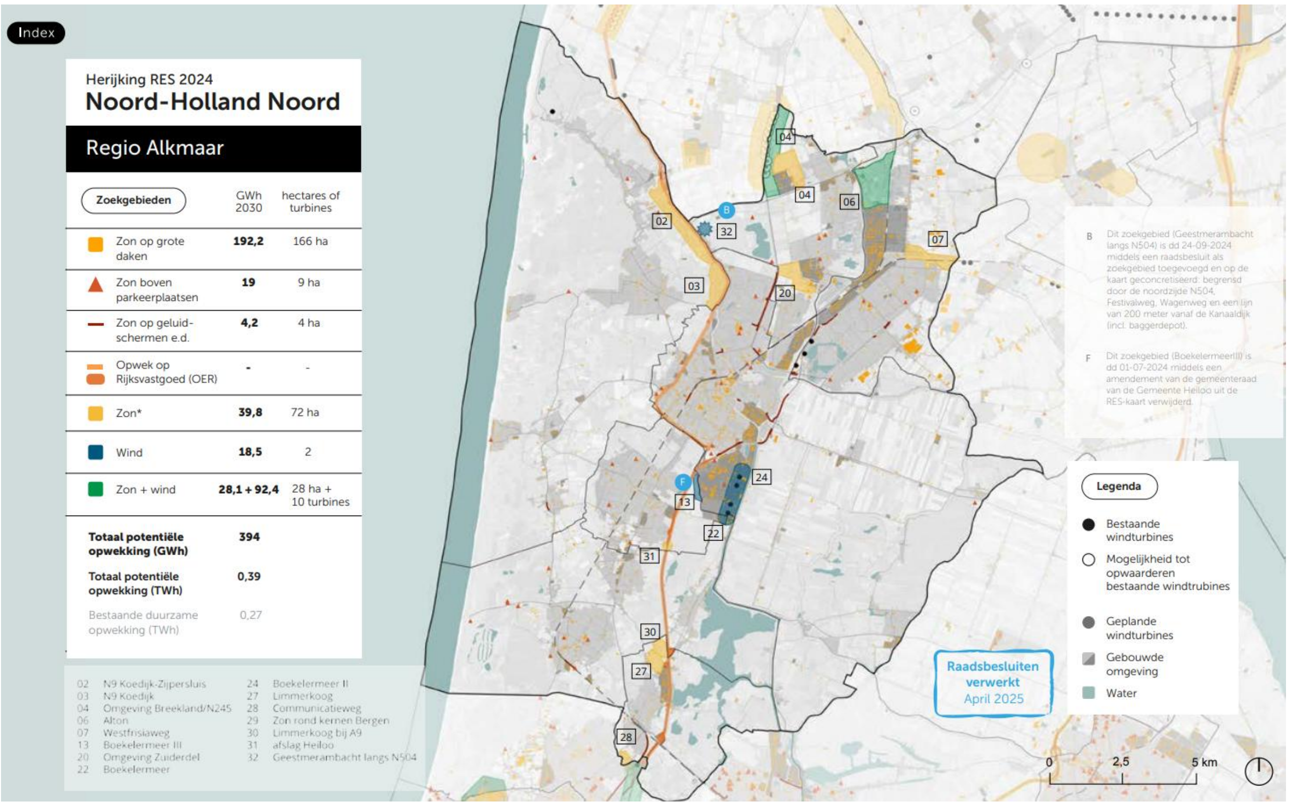

Figure 24: Renewable Energy Strategy regio Alkmaar

[23] https://energieregionh.nl/media/pages/medialibrary/fc637e6dd3-1752139335/herijking-res-2024-nhn_def-v4b.pdf

Zooming in on the FV – next to the potential of PV on roofs, parking lots and noise barriers – two (large-scale) searching areas are identified (22 and 24) for the instalment of 2 or 3 additional wind turbines next to the 4 existing ones. It should be noted that search area 13 has recently been removed.

All of the aforementioned Boekelermeer ambitions from the energy vision, Agenda Duurzaam Alkmaar and Regional Energy Strategy are perfectly reflected in the current REFORMERS FV activities and future ambitions. Table 4 showcases how REFORMERS' FV contributes to achieving ambitions.

Heat vision of municipality Alkmaar

In 2025 the municipality Alkmaar renewed it's heat vision[24], Overdie East is still on the list as one of the first neighbourhoods in the municipality to be connected to the heat grid of HVC. During the project duration many of the high-rise buildings of Woonwaard in Overdie East will be connected to the HVC heat grid. The same goes for the high-rise buildings of other corporations in Overdie East.

[24] Alkmaarse warmtevisie 2025

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Table 4: Contributions of REFORMERS FV to regional ambitions

1. Energy vision		REFORMERS contribution
1.1 Energy Junction	Green molecule hub	REFORMERS supports this ambition through the support of InVesta's centre of expertise where SMEs will produce and integrate biogas, syngas and biofuels. HYNOCA will produce 30 - 60 kg/h hydrogen per hour and Stoff 2 will demonstrate a 1MW hybrid electrolyser.
	Mobility hub	REFORMERS' partner NXT Mobility is creating a charging hub in addition to their existing sustainable fuel station. Also, the virtual local energy system enables companies to (re)locate at the newly built transshipment harbour.
	Matching demand and supply and integrating storage	REFORMERS matches local demand and supply within the FV (e.g. at the harbour, InVesta and frontrunner companies). 12 MWh of additional battery storage capacity has been installed by December 2025, and storage installations for other renewable energy carriers will be implemented in 2026 onwards.
1.2 Development pathway	The extension of the regional heat grid	REFORMERS enables HVC to expand their regional heat grid to Overdie. By 2028, the regional heat grid will be fed by a geothermal source instead of the waste-too-energy plant.
	Reinforcement of the power grid	See chapter 4.1
	Future connection to the hydrogen backbone	REFORMERS creates an initial decentral hydrogen ecosystem that will be equipped to be connected to the hydrogen backbone post 2030.
2. Agenda Duurzaam Alkmaar		**REFORMERS contribution**
2.1 Energy- and heat transition goals	Natural gas substitution at 1,600 households annually	REFORMERS is currently connecting a high rise building with >100 households owned by housing corporation Woonwaard to the extended regional heat grid. 6 more buildings will follow this example.
	Increase RES to 0.66 TWh/y in 2030	Within the FV, REFORMERS will increase the RE production to 26 GWh (solar) by 2028, and 42GWh/y (solar) and 47 GWh/y (wind) by 2030.
	Achieve 55% CO_2 reduction at the properties of the municipality	REFORMERS will decrease the CO_2 in the flagship valley from 20 kton in 2022 to 5 kton by 2028 (75% decrease).
	All municipal offices should have energy label C	No municipal offices are located in the FV

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3. Regional Energy Strategy		REFORMERS contribution
3.1 RES capacity	Increase RES in Regio Alkmaar from 267 GWh to 661 GWh	REFORMERS aims to enable the further integration of solar power on roofs at business and households. The identified searching areas for additional wind capacity match the ambition within the FV to install two additional wind turbines post 2028.

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ANNEX 3 – ENERGY SYSTEM ANALYSIS

This annex provides a comprehensive breakdown of the energy system analysis for the Flagship Valley. The first section presents the 2023 reference year, highlighting specific node-level consumption patterns and providing essential methodological context regarding mobility data. The second section details the 2030 scenario results, providing a granular geographical breakdown of the distribution of renewable capacity across the five distinct areas for each of the four modelled pathways.

In the analysis below one of the wind turbines was included in the Area 4 results, this is because at the time the data was collected it was probably connected via the substation of Heiloo. Physically all four wind turbines are located in Area 1.

Energy System Analysis of FV in 2023

Detailed Area Analysis

Within the Flagship Valley, consumption is heavily concentrated in Area 1 (Boekelermeer), When mobility figures are included, this node alone accounts for 272 GWh/y, reflecting high gas use in industrial processes and a substantial mobility footprint. Conversely, Areas 4 and 5 represent the smallest consumers. Area 5 (Zuidschermer) is the only zone with no attributed mobility energy, relying solely on electricity and gas.

Methodological Note on Mobility Data

As highlighted in the main text, the energetic calculations for mobility fossil fuels are based on vehicle registrations in the FV. Attributing the massive consumption of fossil fuels by rolling stock solely to the FV distorts the picture, particularly since the model assumes all vehicles are fossil-based using average yearly mileage and consumption. This approach artificially inflates local demand by using fuel energy expended across a much wider region.

Consequently, the actual CO2 emissions and refuelling infrastructure are likely to be located outside the valley. Worse, this fossil dominance completely drowns out the local energy demands, effectively repressing the significance of actual local consumption needs. This ultimately prevents a direct comparison with the original proposal. Lastly, since a portion of the fleet is already electrified, fossil fuel demand would be lower, offset by an additional, albeit smaller, electricity demand.

Detailed Renewable Breakdown

Renewable generation is not evenly distributed across the valley. While Area 1 dominates, Area 4 (Heiloo – Oude Werf + Wilibrord) contributes significantly with 17.9% of solar capacity and one 2.3 MW wind turbine. Residential solar adoption is most prominent in Area 3 (Heiloo – Plan Oost) at 12.9% of total capacity, while Area 2 (Alkmaar – Overdie) shows modest penetration at 4.3%. Area 5 (Zuidschermer) currently has no renewable installations.

Data Tables

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Table 5: Breakdown of the Annual Energy Consumption (including mobility fuels)

Area	Area Name	Natural gas (GWh/y)	Grid – imported Electricity (GWh/y)	District heat (GWh/y)	Mobility fossil fuels (GWh/y)	Total energy (GWh/y)	Share of total (%)
Area 1	Boekelermeer	49,99	29,2	0	192,88	272,07	**76,00%**
Area 2	Alkmaar - Overdie	14,63	3,79	8,32	12,17	38,91	**10,90%**
Area 3	Heiloo – Plan Oost	20,1	3,49	0	11,55	35,14	**9,80%**
Area 4	Heiloo – Oude Werf + Wilibrord	4,83	1,76	0	2,9	9,49	**2,70%**
Area 5	Zuidschermer	2,07	0,37	0	0	2,44	**0,70%**
TOTAL	All Areas (1-5)	91,63	38,6	8,32	219,5	358,05	**100,00%**

Table 6: Breakdown of the Annual Energy Consumption (excluding mobility fuels)

Area	Area Name	Natural Gas (GWh/y)	Electricity (GWh/y)	District Heat (GWh/y)	Total Energy (GWh/y)	Share of Total (%)
Area 1	Boekelermeer	49,99	29,2	0	79,19	**57,16%**
Area 2	Alkmaar - Overdie	14,63	3,79	8,32	26,74	**19,30%**
Area 3	Heiloo – Plan Oost	20,1	3,49	0	23,59	**17,03%**
Area 4	Heiloo – Oude Werf + Wilibrord	4,83	1,76	0	6,59	**4,76%**
Area 5	Zuidschermer	2,07	0,37	0	2,44	**1,76%**
TOTAL	All Areas (1-5)	91,63	38,6	8,32	138,55	**100,00%**

Table 7: Renewable electricity production per area

Area	Area Name	Solar (MWp)	Wind Turbines	Wind (MW)	Solar Prod (GWh/y)	Wind Prod (GWh/y)	Solar %	Wind %
Area 1	**Boekelermeer**	**8,36**	**3**	**6,6**	**8,60**	**16,43**	**64,90%**	**74,20%**
Area 2	**Alkmaar - Overdie**	**0,55**	**0**	**0,0**	**0,57**	**0,00**	**4,30%**	**0,00%**
Area 3	**Heiloo – Plan Oost**	**1,67**	**0**	**0,0**	**1,71**	**0,00**	**12,90%**	**0,00%**
Area 4	**Heiloo – Oude Werf + Wilibrord**	**2,31**	***1***	***2,3***	**2,38**	***5,72***	**17,90%**	***25,80%***
Area 5	**Zuidschermer**	**0,00**	**0**	**0,0**	**0,00**	**0,00**	**0,00%**	**0,00%**
TOTAL	**All Areas (1-5)**	**12,88**	**4**	**8,9**	**13,27**	**22,15**	**100,00%**	**100,00%**

Energy Scenario descriptions of FV for 2030

Overall system performance comparison

Table 8 presents the system performance across the four scenarios. All scenarios assume a projected demand growth to 77 GWh/y by 2030.

Table 8: Overview of Energetic Scenario Results

Metric	Baseline 2030	Wind focus 2030	PV focus 2030	Combined RES 2030
Total demand (GWh/y)	77	77	77	77
Total production (GWh/y)	39	62	68	90
Total solar+wind production (GWh/y)	*Error*	26	32	54
Grid injection (GWh/y)	15	23	32	43
Grid offtake (GWh/y)	54	39	41	29
Self-sufficiency	30%	49%	47%	63%
Self-consumption	60%	62%	54%	56%

Baseline Scenario 2030

The baseline scenario 2030 represents a future with minimal renewable energy expansion beyond current levels, maintaining modest deployment distributed across the flagship valley. Area 1 - Boekelermeer serves as the primary renewable energy hub, with approximately 8,357 kWp of solar and three wind turbines in the industrial zone. Residential areas show varied adoption levels, with Area 3 - Heiloo – Plan Oost leading at 1,665 kWp, followed by Area 2 - Overdie at 552 kWp. Area 4 - Heiloo – Oude Werf demonstrates its mixed character with approximately 2,308 kWp across residential and industrial nodes, plus one wind turbine. Notably, Area 5 - Zuidschermer remains entirely undeveloped despite its designation as rural for RES deployment. With only limited renewable production against 77 GWh/y total demand, this scenario achieves just 30.2% self-sufficiency, highlighting the significant gap that would persist without substantial renewable energy intervention by 2030.

Wind Turbine Focus Scenario 2030

This wind-focused strategy dramatically increases RES production to 25.56 GWh/y by concentrating wind expansion in Area 1 - Boekelermeer, which adds four wind turbines to reach seven total units (with an additional wind turbine remaining in Area 4, bringing the valley-wide total to eight wind turbines) while maintaining baseline solar capacity. All residential areas (Areas 2 and 3) and the mixed-use Area 4 maintain their baseline configurations without additional wind deployment, respecting residential character and community acceptance constraints. Area 5 - Zuidschermer remains undeveloped as the strategy prioritises industrial concentration over distributed rural deployment. The scenario achieves 49.4% self-sufficiency with a balanced 61.9% self-consumption rate, demonstrating that wind deployment in industrial zones can effectively support local energy demand while maintaining reasonable alignment between generation and consumption patterns. Total production reaches 62 GWh/y ,with grid offtake reduced by 27.6% relative to the baseline (from 54 to 39 GWh/y), thereby significantly reducing dependence on external electricity sources.

Photovoltaic Focus Scenario 2030

This solar-focused pathway significantly increases photovoltaic capacity across all five areas, achieving 47.3% self-sufficiency while maintaining a strong 53.6% self-consumption by better aligning solar generation and consumption. Area 1 - Boekelermeer experiences the most dramatic transformation, with a nearly fourfold increase to approximately 32,007 kWp, making it a central solar generation hub. Residential areas show substantial growth, with Area 2 - Overdie quadrupling to 2,379 kWp and Area 3 - Heiloo – Plan Oost increasing by 47% to 2,440 kWp, including the newly developed Blockhovepark. Area 4 - Heiloo – Oude Werf more than doubles to approximately 5,495 kWp, effectively balancing its mixed industrial-residential character. Area 5 - Zuidschermer begins contributing with 231 kWp, representing initial utilisation of rural land, though still modest relative to theoretical capacity.

Combined RES Scenario 2030

This most ambitious pathway integrates substantial solar and wind resources to achieve the highest self-sufficiency of 62.7% with 54.10 GWh/y RES production, representing a twentyfold increase over the baseline**.** Area 1 - Boekelermeer becomes a fully integrated renewable energy powerhouse with approximately 32,959 kWp of solar and seven wind turbines (with an additional wind turbine in Area 4, bringing the valley-wide total to eight), demonstrating optimised hybrid deployment that provides complementary baseload wind and peak solar generation. Residential areas reach their full potential with Area 2 - Overdie at 2,635 kWp, representing comprehensive rooftop utilisation across all housing types, and Area 3 - Heiloo – Plan Oost at 2,669 kWp, maximising deployment while respecting architectural constraints. Area 4 - Heiloo – Oude Werf achieves its highest deployment level at approximately 6,005 kWp, creating an integrated system serving both industrial operations and residential end-users. Area 5 - Zuidschermer increases to 284 kWp but remains conservatively developed, suggesting opportunities for further expansion in subsequent planning phases. Total production reaches 90 GWh/y, with self-consumption of 56.4%, demonstrating that hybrid renewable deployment can balance generation capacity expansion with reasonable alignment of local consumption. Grid offtake is reduced by 46.5% compared to baseline (from 54 to 29 GWh/y), representing the most significant reduction in grid dependence across all scenarios, though requiring substantial grid injection capacity (43 GWh/y) to export surplus generation.

ANNEX 4 – STAKEHOLDER ANALYSIS

This annex provides the results of the stakeholder analysis performed for FV. The results from the initial analysis for the entire FV are shown and the detailed survey results for Boekelermeer and Heiloo later on in the project. At the time of writing a similar detailed analysis has not yet been performed for Overdie as the approach for that area started recently. Besides these survey results other stakeholder engagement activities were performed as well, these are not included in this annex.

Results of initial stakeholder mapping

The stakeholder identification process for the Flagship Valley began with compiling a comprehensive general overview of all relevant actor groups. This mapping included public authorities, businesses, residents, and other local entities with potential influence or interest in the energy transition. To structure the analysis, each group was positioned within an **Influence vs. Interest Grid**, allowing the project team to assess their strategic relevance and tailor engagement strategies accordingly. This exercise was carried out collaboratively by the teams responsible for Tasks 4.4 and 6.4, and was refined during a consortium-wide workshop held on-site on February 26th, 2024. To capture the evolving dynamics over time, this mapping was re-evaluated in May 2025. The resulting grid provided a framework for prioritizing stakeholder engagement initiatives and is presented in **Error! Reference source not found.**. Simultaneously, representatives for each stakeholder group were identified, and their contact details were collected.

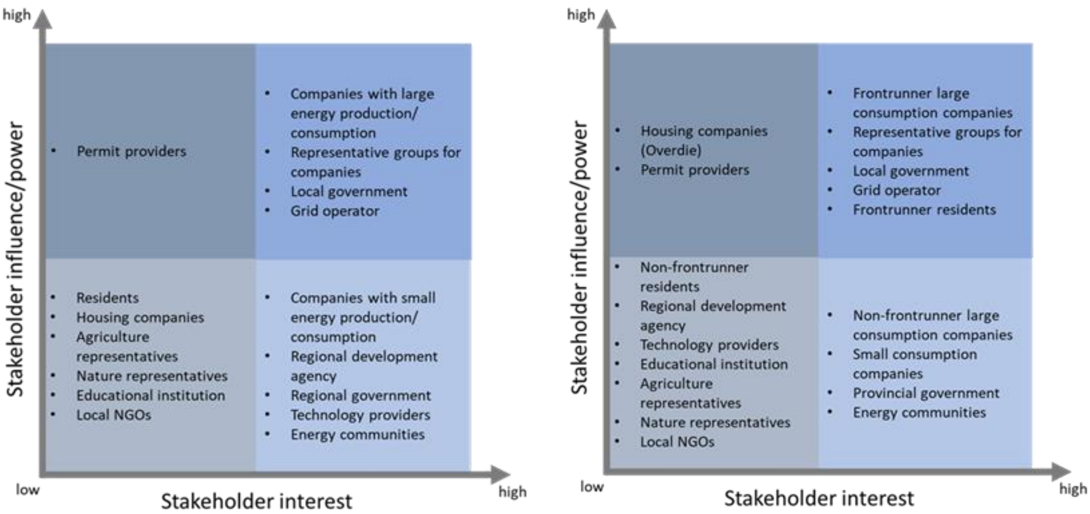

Figure 25: FV Influence vs. Interest Grid – Initial (2024, left) versus final (2025, right) mapping

Particular attention was given to actors falling into the high influence–high interest quadrant, as these are considered key to initiating the co-creation process. The involved stakeholders from the start of the project often are from this quadrant and are denoted as 'Frontrunners', as these stakeholders are 1) more willing or able to explore energy solutions and act as early adopters and 2) can act as ambassadors of the value of the new solutions realized to other stakeholders. This represents the shift in terminology between the initial (2024) and final (2025) mapping.

Through the mapping, it is observed that different types of stakeholders with high influence-high interest were identified, each with different needs and motivations and each active in different areas of the FV (for example, *Residents* being relevant to the Heiloo and Overdie related areas, whereas *Companies with large energy production / consumption* were largely relevant for Boekelermeer). For the group '*Companies with large energy production/consumption*', a technical analysis was conducted to identify potential frontrunner companies suited for establishing a meaningful small-scale energy collaboration. This helped to ideate solution directions to address the needs of the companies and to spark further engagement.

Results of survey boekelermeer

A survey was performed with 12 potential frontrunner companies on their objectives and barriers for joining a collective energy initiative in the Boekelermeer area. The following key insights emerged from the survey results, touching upon the preferences, motivators and barriers for organizations to engage in energy collaborations:

- Collaboration preferences (see Figure 26):
    - Most companies prefer collaboration only with other businesses, not mixed with households.
    - Willingness to cooperate with residents is generally low, with most companies professing a neutral stance towards setting up an energy partnership with residential actors, suggesting uncertainty or hesitation. Only one company is fully willing.

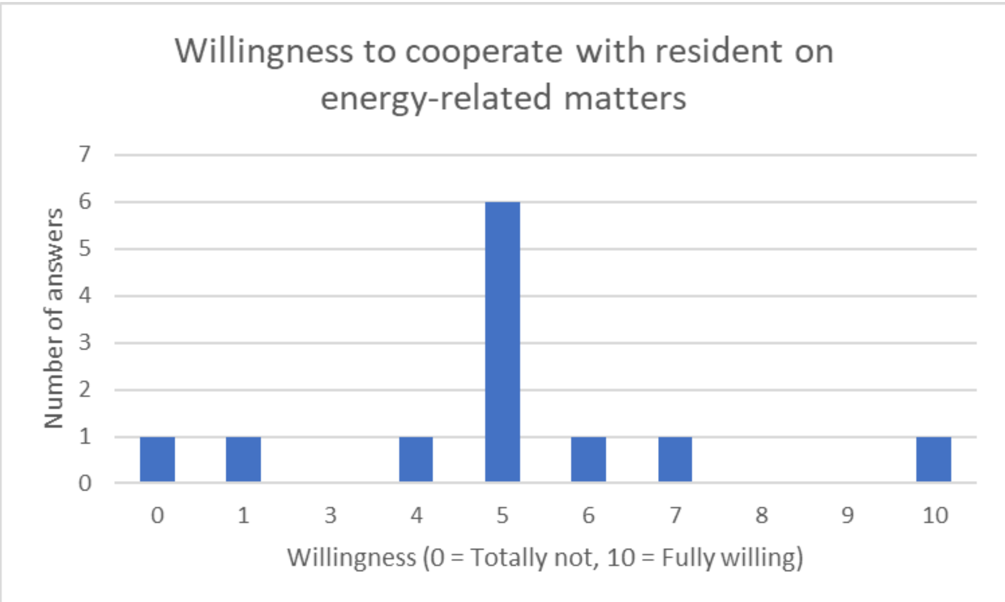

Figure 26: Survey results on collaboration willingness with residential actors

- Top motivators for participation (see Figure 27):

- Energy independence, direct user participation, and emissions reduction are the strongest drivers.
- Increased local sustainability and (green) image also rank high.
- Technical reliability (grid stability, security) and privacy protection are important secondary factors, together with economic drivers, although they are often not regarded as the most essential ones.
- Grid stability, lower energy bills, and operational ease (unburdening) matter but are not decisive.

- Companies value autonomy, sustainability, and active involvement more than purely financial aspects.

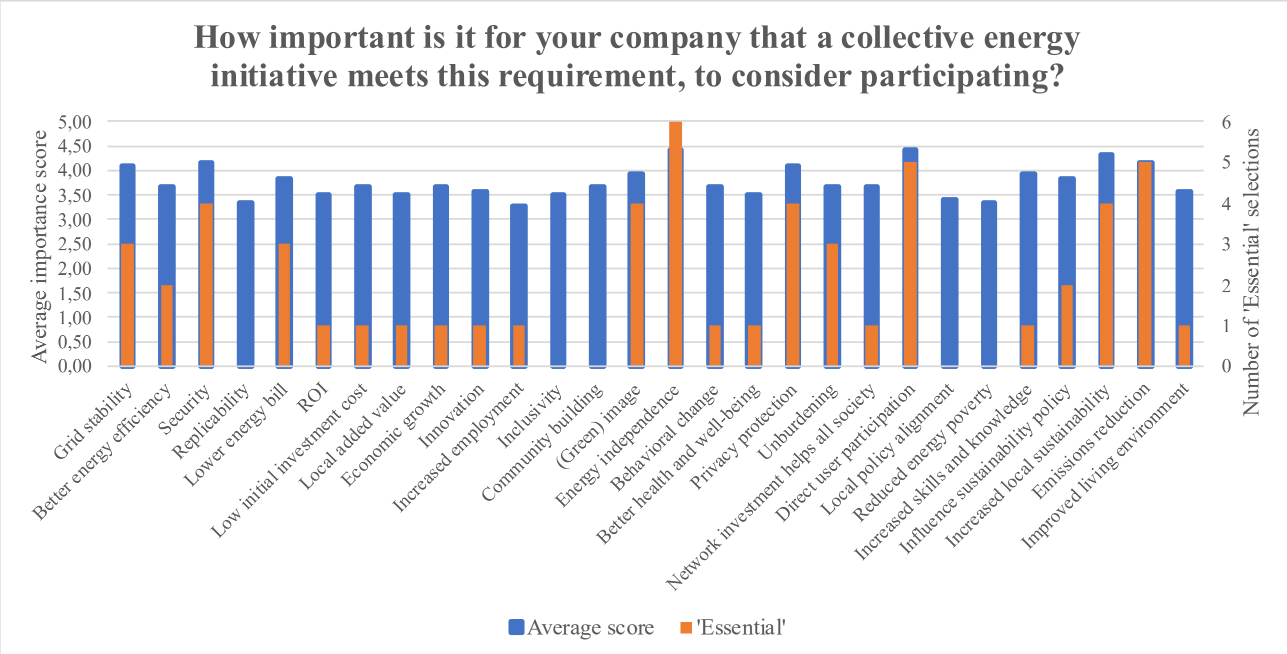

Figure 27: Survey results on motivations for energy collaboration

- Main barriers (see Figure 28):
  - Regulatory complexity, legal uncertainty, and lack of knowledge are the most cited obstacles, which are indicated as a barrier by at least half of the participating companies
  - Technical concerns, such as incompatible infrastructure, along with worries about administrative and time burdens, are relevant but not considered major obstacles by most.
  - More socially oriented challenges, such as distrust of collaboration partners, doubts about their level of commitment, or lack of experience in energy cooperation, are generally not considered relevant concerns.

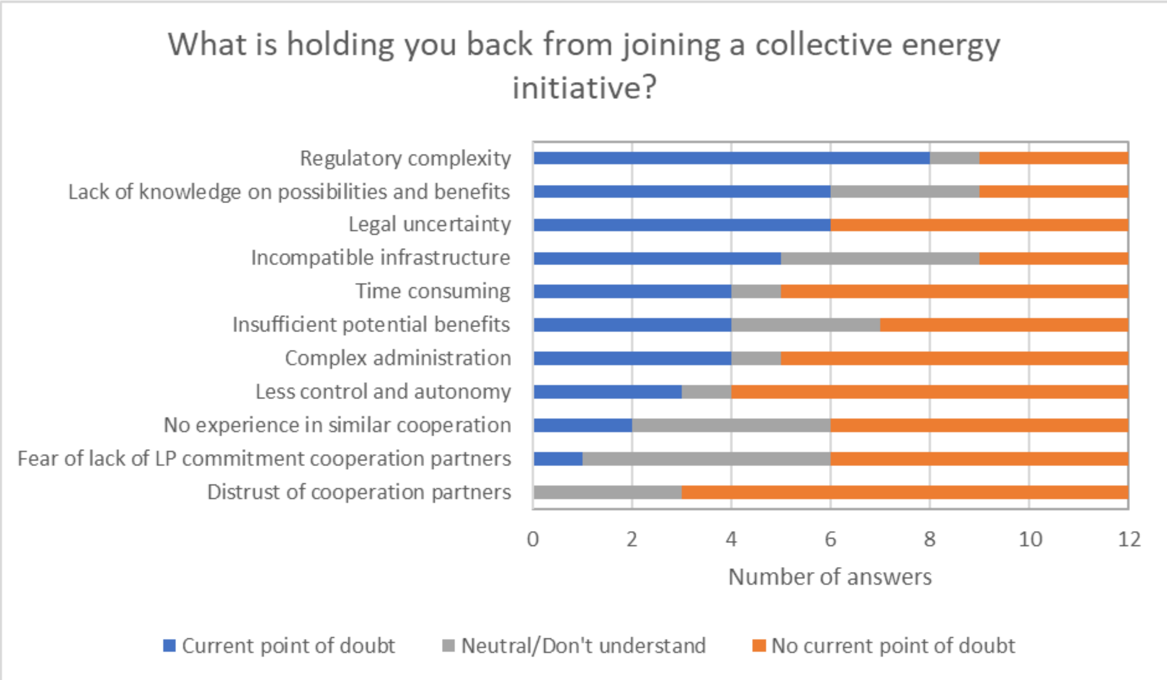

Figure 28: Survey results on perceived barriers for energy collaboration

Results of survey Heiloo

A survey was performed with residents in the Heiloo area on their preferences and willingness to participate in energy initiatives. The following key insights emerged from the survey results, touching upon preferences, motivators and barriers for participation.

- **Collaboration preferences** (see Figure 29):
    - There is a **large openness to collaborate** with other actors on local energy initiatives
    - Willingness to collaborate with residential stakeholders is just as strong as with non-residential stakeholders

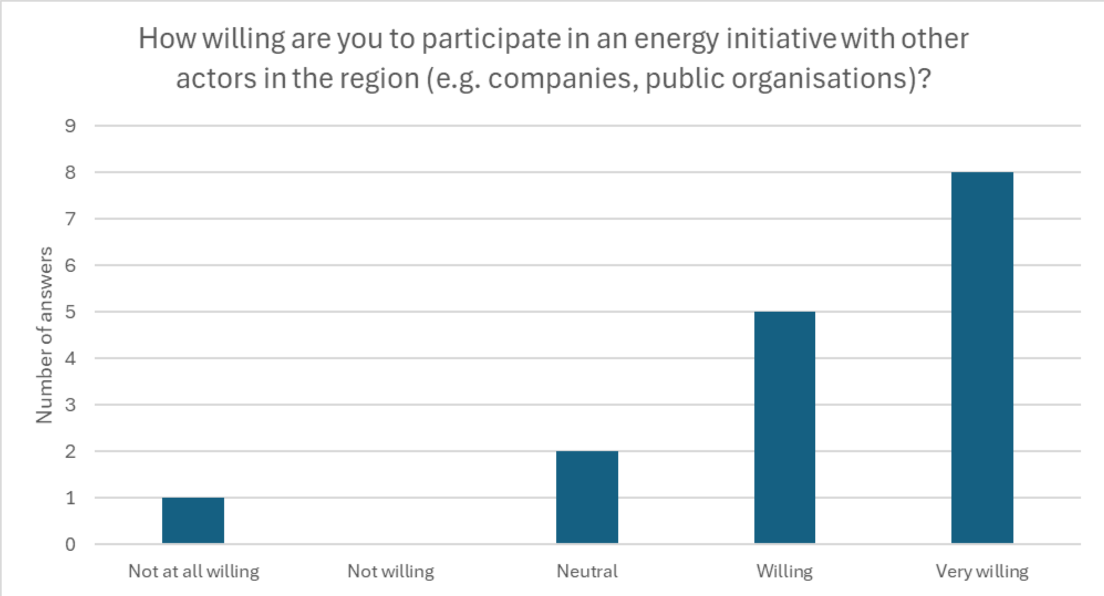

Figure 29: Survey results on collaboration willingness with non-residential actors

- **Top motivators for participation** (see Figure 30):
    - Cost savings are the most compelling motivator for residents, followed by sustainability/emissions reduction and the opportunity to increase energy knowledge.
    - Innovation, technical reliability, and less dependence on large suppliers also rank high, showing interest in autonomy and modern solutions.
    - Social benefits like community building, local job creation, and green image enhancement are less influential. Direct decision-making power has minimal appeal.
    - No respondents indicated that nothing can convince them, indicating overall openness to participation.

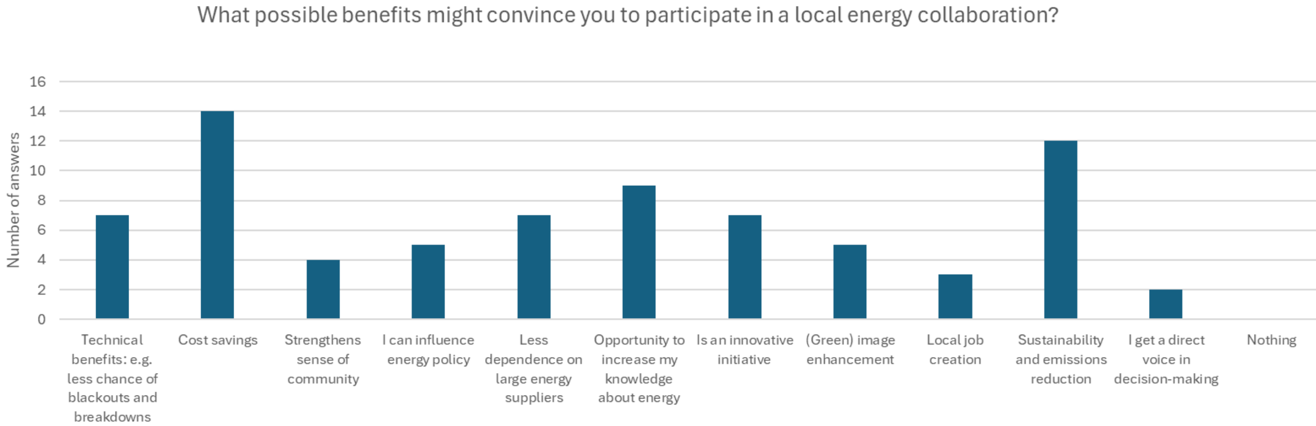

Figure 30: Survey results on potential motivators for energy collaboration

- **Main barriers** (see Figure 31):

- Limited knowledge is the most cited obstacle.
- Fear of investment costs and unclear benefits are major deterrents.
- Complex regulations and lack of experience contribute to hesitation.
- A small group (3) reported no barriers, showing potential for immediate engagement.

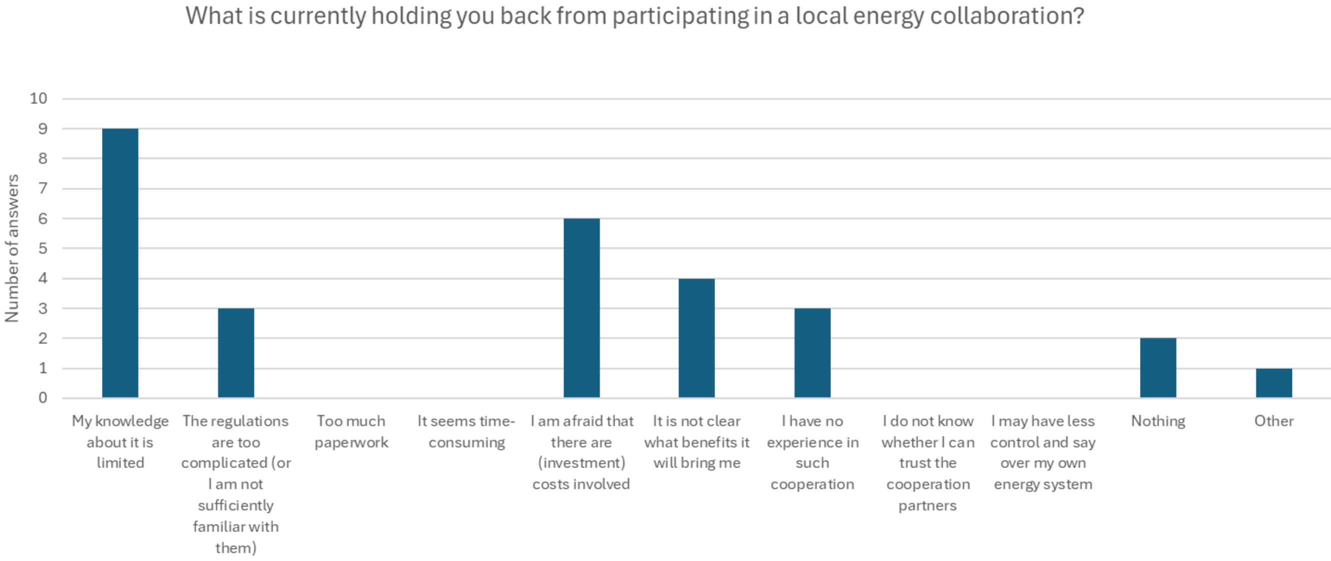

Figure 31: Survey results on perceived barriers for energy collaboration

- **Preferred collaboration forms** (see Figure 32):
  - Financial investment is most preferred.
  - Many residents are also open to active involvement (decision-making, volunteering, awareness-raising).

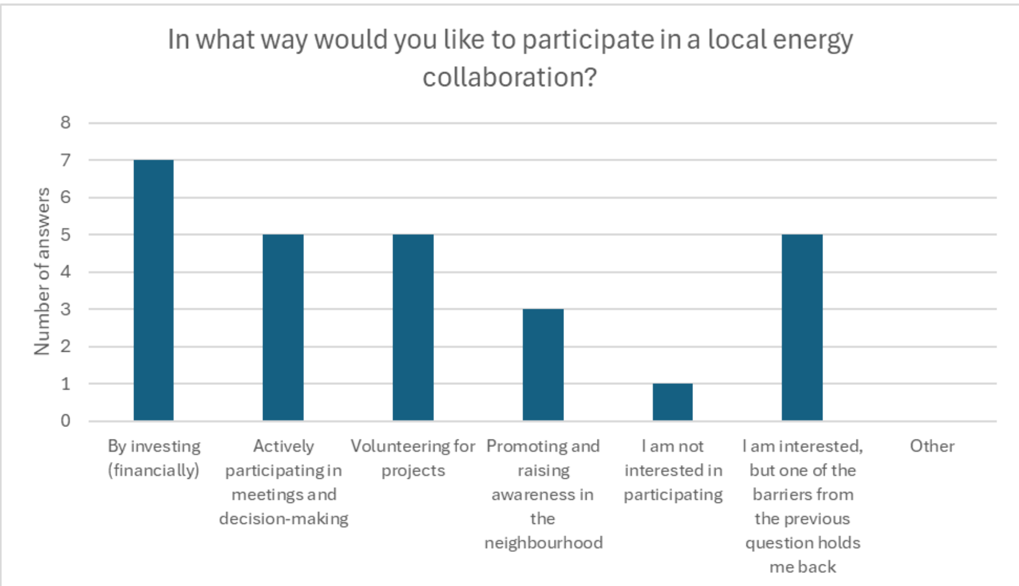

Figure 32: Survey results on preferred collaboration forms

ANNEX 5 – REGULATORY CONTEXT AND ACTIVITIES IN FV

This Annex presents several activities that can be initiated as part of the FV approach, it includes various perspectives and stakeholders. To contribute to the envisioned ecosystem several relevant activities for stakeholders in the FV were identified and this annex presents how these activities can be organized. The relevant European and Dutch regulatory frameworks are briefly discussed around each activity as well as the options in terms of governance to manage these activities.

Relation REVT4 and the parallel Deliverable D4.3

The activities presented in this annex originate from the technical design presented in the parallel Deliverable 4.3 of the project. Deliverable 4.3 describes the digital building blocks: tools such as local and collective Energy Management Systems and the data exchange between these tools. Here, these activities of specific stakeholders are presented within a certain institutional context.

Not all activities introduced here may be needed. As indicated in Deliverable 4.3, there are still two key uncertainties that influence what activities are critical for the functioning of the FV:

- Tasks that take place in the application *Substation-EMS* can be implemented by different type of Parties including the DSO, Flexibility Service Provider and Resource Aggregator. The governance of the Substation-EMS functionality beyond the pilot phase is not clear yet.
- Certain data exchange process are defined for the pilot phase, but there are still many unknowns about the usefulness and feasibility of sharing specific type of information. During the pilot phase of the FV it will be explored what information is critical for effective functioning of the FV.

Regulatory context

The developments around the FV take place in the context of the European internal market. As such Regulation (EU) 2019/943 is highly relevant. This regulation provides rules on the short-term coordination through market-based dispatch and redispatch, but also regulates how member states should drive long-term efficiency of the market through tariff design. The basis provided by Regulation (EU) 2019/943 will be extended by regulation of local service provision in the upcoming Grid Code on Demand Response. Below this regulatory context is briefly explained.

Redispatch and local grid services

Dispatch of generation and demand response must follow transparent, market-based rules (Article 12). Priority dispatch for renewables is only allowed under strict conditions and is being phased out. When congestion occurs, operators follow an implicit "escalation ladder" (Article 13): first, resolve issues via market-based redispatch using commercial offers; only if that fails, apply non-market-based redispatch as a last resort. Generators curtailed through non-market-based actions must receive full compensation.

The upcoming Demand Response Network Code (version ACER, March 2025) changes how congestion is managed in European grids. It introduces more situations where congestion can occur and even allows operators to accept it deliberately in certain areas. This is because the code emphasizes local flexibility as a first response. DSOs and TSOs are required to forecast and manage congestion within defined zones, often using demand response and other flexibility services through local market-based procurement. Instead of immediately removing congestion, operators may tolerate it temporarily if it can be controlled with contracted flexibility or flexible connection agreements. This approach integrates congestion into normal operations rather than treating it as an exception.

These changes fit within the escalation ladder defined by Regulation (EU) 2019/943. The new code adds localized market-based actions before system-wide redispatch. If local flexibility cannot resolve the issue, operators escalate to traditional redispatch steps. In short, the code shifts congestion management closer to the grid edge, making it a managed condition rather than something to avoid at all costs, while preserving the market-first principle of the regulation.

Grid tariffs

Grid tariffs (Article 18) serve a different purpose. They are not tools for real-time coordination at the grid edge but influence investment and connection decisions over time. Tariffs must be cost-reflective, transparent, and non-discriminatory, avoiding policy costs or distortions. They should provide efficient price signals for network use and support innovation. These principles reinforced by ACER's guidance (2025 report), which calls for tariff structures that incentivize flexibility, storage, and demand response while promoting overall system efficiency. Member States must define tariffs within these principles, ensuring they shape long-term behavior that can co-exists with operational mechanisms like redispatch.

Grid tariffs are not included in the discussion of the activities but they are an important context factor. The selection of the activities of the FV should therefore be checked against developments in this direction in the Netherlands.

Relevant formalized roles in the electricity system

The activities are identified per role. Parties in the FV can adopt multiple roles in principle, however there are regulatory limitations for combining certain roles. The key limitations that apply will be discussed per activity.

Stakeholder	Definition	Governance
Distribution System Operator (DSO)	A Distribution System Operator (DSO) is the legal person responsible for operating, ensuring the maintenance of and, if necessary, developing	The DSO is a regulated role. Grid operators have depending on the Member State also other roles such as a responsibility for metering or providing grid access. In some

	the distribution system in each area and, where applicable, its interconnections with other systems and, for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity, as defined by the Electricity Directive (EU) 2019/994 [25].	activities new tasks for the DSO are explored which are not clearly regulated in European nor Dutch regulatory frameworks.
Flexibility Service Provider (FSP)	A party that offers flexibility services based on acquired (aggregated) Resources[26]. This term includes the 'service providers' as defined in the EU grid code on Demand Response: Service Provider means a market participant with service providing units or service providing groups able to provide system operator services in a balancing or local market;	A Flexibility Service Provider needs always an official license to operate e.g. as Balance Responsible Party or Balance Service Provider. In this work the Congestion Service Provider role as defined in the Dutch regulatory framework is the most relevant 'license' but for some newly defined activities it is not yet clear whether the CSP role as currently defined fits. In the domain of the EU grid code on Demand Response the role of (Local) Service Provider is mentioned which aligns partly with the CSP role in the Netherlands, however local service include also other services than 'congestion management' e.g. other grid constraint management or power quality support services.
Resource Aggregator (RA)	A party that aggregates Resources for usage by other market participants. A Resource is a market representation of an asset or a group of assets related to the energy industry.	There are different entities that can fulfil the role of a Resource Aggregator. For example an energy community manager can be a Resource Aggregator but also an a market participant such as an energy supplier. In this work the situation is also considered that FSPs act both as FSPs and as RA that offer flexibility to other FSPs.
Resource Provider (RP)	A role that manages a resource and provides production/ consumption schedules for it, if required.	This party is contracted by the owner of the asset or is the owner itself.

[25] EU DSO Entity - Who can become a member
[26] THE HARMONISED ELECTRICITY MARKET ROLE MODEL, Version 2025-01

Activities

For each defined activity the envisioned domain in the FV is mentioned, this does not mean activities cannot take place in other type of domains. It only means that the activity is (based on D4.3) only identified as relevant on that domain in the FV. Many activities imply that another party takes up another activity. For example, a DSO requesting local services needs FSPs to provide these services. These direct dependencies between activities are defined and categorized in Table 9.

Table 9: Activities linked to roles and domain

No.	Role	Domain in FV	Activity	Dep.
1	*DSO*	Substation-level	Day-ahead an intraday local service procurement	7
2	*DSO*	Substation-level	Real-time local services procurement	7
3	*DSO*	Substation-level Mid-level Connection-level	Capacity limitation agreements	11
4a/b	*DSO*	Substation-level Mid-level Connection-level	Capacity availability agreements a. Direct control by DSO b. Control via mandatory bidding	4b → 7
5	*DSO*	Substation-level	Local service orchestration	12
6	*DSO*	Substation-level	Grid state information sharing for market efficiency	8
7	FSP	Substation-level Mid-level Connection-level	Provide local services to DSO (with or without underlying capacity availability agreements)	1 or 2 and 10
8	FSP	Substation-level	Pre-coordination for local service provision based on DSO information	6
9	FSP	Substation-level	Pre-coordination for local service provision by sharing information with other FSPs	7
10	RA or RP	Mid-level Connection-level	Provide (aggregated) flexibility to an FSP	7
11	RA or RP	Mid-level Connection-level	Manage capacity limitation agreements (implicit flex)	3
12	FSP, RA or RP	Substation-level	Provide information to DSO for joint-goal optimization	5
13	RA	Mid-level	Joint energy trade optimization	NA
14	RA	Mid-level	Collective self-balancing	NA

1. Day-ahead and Intraday local services procurement

Role	*DSO*

Status	*Existing*
Governance	*Clear*

GOPACS is a platform where grid operators in the Netherlands can request for flexibility from the FSPs to assist in solving local congestion. GOPACS is a market-based procurement platform. This means all communication between market and DSO is in terms of 'transactive' values.

In terms of the draft Demand Response Grid Code, GOPACS can be seen as an example of a platform for the DSO to procure local services. On the platform both free bids as well as bids that origin from a mandatory bidding contract (activity: *Capacity availability agreements*) are placed. For placing bids it is required to be qualified as a Congestion Service Provider.

It is not clear to what extend GOPACS can and should be used in the FV. Market-based procurement should be chosen by the DSO if that is feasible according to the EU grid code on Demand Response. The alternatives, activities 3,4a, and 5 may have a better fit if there is not 'a local market' feasible. A combination is also possible.

2. Real-time local services procurement

Role	*DSO*
Status	*Concept*
Governance	*Clear*

Out of scope of GOPACS is real-time procurement of local services. In the design of D4.3 a request for flexibility during a 15-minute operational window is foreseen at the level of the Substation energy management system. This type of procurement is from a governance perspective not different from the procurement of flexibility services ahead (DA, ID) but given that this is an operational activity, this activity comes with operational challenges e.g. Balance Responsible Parties may be notified in real-time. Furthermore, there is not yet a mature platform or information exchange infrastructure in place for this activity.

3. Capacity limitation agreements

Role	*DSO*
Status	*Existing but in development*
Governance	*Clear but there are developments to overcome the barrier of large financial risks for individual consumers/producers.*

Non firm connection agreements and other static capacity limit agreements. This can be arranged via:

- A smaller (firm) capacity connection contracts

- Non-firm connection agreements or capacity limiting contracts based on time blocks , so the capacity is time-bound (TDRT contracts)
- Non-firm connection agreements or capacity limiting contracts where the grid operator can announce e.g. 20% of the hours in the year that the limitation is valid
- Group transport contract (GTO) and capacity limiting contracts (CBC).

4. Capacity availability agreements

Role	*DSO*
Status	*Existing but in development*
Governance	*Option via FSP is clear. Direct control option in development.*

Mandatory bidding and agreements for control on request of DSO / direct control. This includes in the Netherlands non-firm connection agreements as well as capacity limiting contracts (CBCs) with obligation to make flexibility available via a market or direct control signals.

5. Local service orchestration

Role	*DSO*
Status	*Concept*
Governance	*Unclear*

Customers and market participants share information that determines their local service provision ability. The DSO uses this information to determine the optimal market-based procurement at day-ahead or Intraday. What is optimal should be clearly defined as optimality from the perspective of the DSO and the market participants may be conflicting.

It is possible that the DSO asks a neutral party to provide this role. Many research questions apply to this activity. The freedom of choice of customers, how will that be taken into account in this orchestration. How does this activity align with competition law? What gaming opportunities arise?

6. Grid-state information sharing for market efficiency

Role	*DSO*
Status	*Concept*
Governance	*Unclear*

The DSO shares information about the state of the grid to the market participants (FSPs). This option is susceptible to gaming risks. If you share this information, everyone can see the remaining available capacity. One of the research possibilities: How can companies share sensitive data in such a way that allows for coordination without hurting their interests?

7. Provide local services to DSO

Role	*FSP*
Status	*Existing*
Governance	*Clear*

Flexibility Service Providers can act as Congestion Service Provider and deliver flexibility via different products, for example intraday congestion management via GOPACS. Challenge for the FSP is to deal with all underlying dynamics and contracts when he offers a local service. What data does he need from his customers?

8. Pre-coordination for local service provision based on DSO information

Role	*FSP*
Status	*Concept*
Governance	*Unclear*

When a DSO shares information that market participants can help to position themselves on a local service market or market-based redispatch or wholesale or balancing market the DSO should share this information publicly. When such information is shared FSPs can better position themselves by for example ensuring battery's are full at a certain point in time or by prioritizing local service provision positioning over wholesale market arbitrage. This may have as result that the liquidity of local markets at critical moments is higher than without pre-coordination.

9. Pre-coordination for local service provision by sharing information with other FSPs

Role	*FSP*
Status	*Concept*
Governance	*Unclear*

In this activity, market participants share information between each other about their ability to provide flexibility. The purpose of sharing information is to increase the ability to trade flexibility for local services as well as wholesale market and balancing market. This activity is challenging to implement in combination within a competition environment for example when there is also a market-based redispatch mechanism in place. Gaming and price fixing opportunities will arise.

10. Provide (aggregated) flexibility to an FSP

Role	*RA or RP*
Status	*Existing; aggregation facilitation is still in development*

Governance	*Clear however responsibilities of RA/RP are defined in commercial domain. These contracts are in development.*

Resource Aggregators can provide flexibility in an aggregated way to Flexibility Service Providers. When RAs use resources from customers with different BRPs a Transfer of Energy has to take place. That needs to be arranged in the commercial domain however there are obligation to provide data to the BRPs that are involved. The development of information exchange channels is ongoing.

11. Manage capacity limitation agreements (implicit flex)

Role	*RA*
Status	*Existing but in development*
Governance	*Clear but there are developments to overcome the barrier of large financial risks for individual consumers/producers.*

A resource aggregator can manage on behalf of the customers that limitations are guaranteed when customers take part in other activities for example market-based redispatch or market arbitrage.

12. Provide information to DSO for joint goal optimization

Role	*FSP, RA or RP*
Status	*Concept*
Governance	*Unclear*

Service providers and market roles can share information with the DSO such that a better planning can be made towards joint goals. It depends on the goal of the optimization and the type of information market participants get from being part of such arrangement. It is possible that the result of the optimization gives away competition sensitive information. Also the role of the DSO should be defined clearly. The DSO needs to act within the regulations that apply to this role and effects on the functioning of the market should be evaluated.

13. Joint energy trade optimization

Role	*RA*
Status	*Possible in commercial domain but in practice only existing when all consumers/producers have the same energy supplier. Cross-portfolio trade optimization depends on developments around P2P trading (DA, ID, RT).*
Governance	*Clear*

Resource aggregators can match demand and supply in their pool. In the Netherlands that happens within energy communities and hubs for example via the platform 'Entrnce'. Via arrangements with the energy supplier or via P2P transactions it is also possible to optimize when customers have different balance responsible parties.

14. Collective self-balancing

Role	*RA*
Status	*Possible in commercial domain but in practice only existing when all consumers/ producers have the same energy supplier.*
Governance	*Clear*

Shifting balance responsibility from individual suppliers to the group level creates opportunities for cost optimization and operational efficiency, in particular when other joint energy takes place in a community. In this activity, the group acts as a single entity for imbalance settlement, meaning that deviations from forecasted consumption or generation are aggregated and managed collectively. Each participant still maintains a contractual relationship with their own energy supplier or balance responsible party (BRP), but the key difference is that balancing costs are allocated at the group level rather than individually.

This approach is commercially feasible and can significantly reduce imbalance exposure by leveraging diversity within the group. However, in practice, implementation is limited when multiple BRPs or suppliers are involved, as current market structures and contractual frameworks do not easily support cross-party arrangements. Typically, only grid users sharing the same supplier can benefit from this setup. Tools such as Entrnce provide solutions for energy suppliers to enable group-level settlement.

The Electricity Market Regulation (EU) 2019/943 requires all market participants to be balance responsible, either directly or through contractual delegation to a Balance Responsible Party (BRP). Imbalance settlement and delegation are governed by Article 5 of this regulation and further detailed in the Electricity Balancing Guideline (EU) 2017/2195, which harmonizes procedures across Member States.

Aggregators or groups that manage flexibility must assume full imbalance responsibility, either by becoming a BRP or by contracting with one. While group-level arrangements are legally possible, they must comply with these regulations and national implementations of EU network codes. This means that pooling imbalances at the group level is permitted only if proper delegation agreements exist.

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