



# POCITYF

Transition Track #2

Activities for Alkmaar- Version 1

D7.7

WP7, T7.4

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# Technical references

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|---------------------|---------------------------------------------------|
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|                              |                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------|
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\* PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)



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# Executive Summary

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The following deliverable falls under WP 7 - Alkmaar Lighthouse City demonstration activities, T7.4 - Demonstration ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility. This deliverable is the first version of D7.7 - Transition Track#2 Activities in Alkmaar, providing a status update of the implementation of Integrated Solutions (IS) and Innovative Elements (IE) up to M39 of the POCITYF project. The two Integrated Solutions for Energy Transition Track (ETT) #2: P2P Energy Management and Storage Solutions for Grid Flexibility that will be covered are IS2.1 Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions and IS2.2 Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions.

With the provided overview this deliverable aims to provide a detailed analysis of the ongoing implementation efforts of all ETT#2 related activities that will be carried out at the POCITYF Lighthouse City of Alkmaar. The focus will be on the Innovative Elements associated with Integrated Solutions 2.1 (*Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions*) and 2.2 (*Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions*)

The focus of this deliverable is the implementation of the Integrated Solutions, therefore the document is structured to first provide a high-level overview of the POCITYF Lighthouse City of Alkmaar and then a short overview of the demonstration locations, followed by an overview per Innovative Element. Since other deliverables within the POCITYF project already cover the background and the demonstration locations extensively, a short description has been deemed sufficient.

Due to delays for some IEs, the deliverable will provide an overview of all developments at the current state and leading up to this deliverable. The final developments and updates will be included in the second version, which is due at the end of the project.



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## Abbreviations and acronyms

| Abbreviation       | Definition                                          |
|--------------------|-----------------------------------------------------|
| AC                 | Alternating Current                                 |
| ATES               | Aquifer Thermal Energy Storage                      |
| BEMS/HEMS/CEMS/EMS | Building/Home/City Energy Management System         |
| BESS               | Battery Energy Storage System                       |
| BIPV               | Building Integrated PV                              |
| DC                 | Direct Current                                      |
| dEF-Pi             | Distributed Energy Flexibility Platform & Interface |
| DSM                | Demand Side Management                              |
| DSO                | Distribution System Operator                        |
| ESS                | Energy Storage Systems                              |
| ETT                | Energy Transition Track                             |
| EV                 | Electric Vehicle                                    |
| HVAC               | Heating, Ventilation and Air-conditioning           |
| H2PS               | Hydrogen Powered Solutions                          |
| HPU                | Hydrogen Power Unit <sup>1</sup>                    |
| ICT                | Information and Communications Technology           |
| IE                 | Innovative Element                                  |
| IS                 | Integrated Solution                                 |
| KPI                | Key Performance Indicator                           |
| kWh                | Kilowatt hours                                      |
| LED                | Light Emitting Diode                                |
| LH                 | LightHouse                                          |
| LIB                | Li-ion Battery                                      |
| LiNMC              | Lithium Nickel Manganese Cobalt Oxide               |
| MWh                | Megawatt-hour                                       |
| P2P                | Peer-to-Peer                                        |
| PEB                | Positive Energy Building                            |
| PED                | Positive Energy District                            |
| PV                 | PhotoVoltaic                                        |
| PVT                | Photovoltaic Thermal                                |
| RES                | Renewable Energy Source                             |
| SCS                | Storage Control Systems                             |



| Abbreviation | Definition          |
|--------------|---------------------|
| SoC          | State of Charge     |
| ToC          | Table of Contents   |
| V2G          | Vehicle to Grid     |
| VPP          | Virtual Power Plant |
| WP           | Work Package        |



# 1 Introduction

This deliverable represents the first version of D7.7 - Transition Track #2 Activities for Alkmaar, which is to provide an overview of the developments of the Innovative Elements that are being implemented in Alkmaar Lighthouse City within the scope of the POCITYF project.

The deliverable will provide a short description of the how the input for the deliverable has been collected and the aim of Energy Transition Track #2. Much of the background and information of ETT#2 was covered in the proposal and extensively in other previously submitted deliverables, e.g. D1.8 City Vision and Master Plan for ETT#2 Solutions - version 1 and 2. Therefore, the information within this deliverable aims to provide a condensed overview.

For ETT#2 the focus lies on increasing the share of Renewable Energy Sources (RES) over time, which is based on the decentralization of energy generation. This decentralization can be on local household or block/district level, operating on the level of micro-grids. Taking into consideration that RES are subject to more fluctuation in the times of energy production, this can lead to stress on the grid calling for flexibility in the energy system to reduce energy curtailment. Here ETT#2 explores different innovative storage solutions or grid flexibility.

These innovative solutions on how to accommodate the periodical energy production through RES will be demonstrated in different areas in the Lighthouse City of Alkmaar that represent a Positive Energy District (PED) or Positive Energy Building (PEB). ETT#2 includes two Innovative Solutions under which the Innovative Elements are grouped. The first of the Innovative Solution is IS 2.1 - Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions, the second is IS 2.2 - Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions. Under each of the IS the IEs are grouped to provide an overview of the current state and the progress achieved until the time of the deliverable.

Some IEs are being implemented by different partners at different locations, therefore a separation of these overviews was made to give a clear picture of the status. For each IE the respective partners were asked to complete a template containing a set of questions that cover several aspects, namely: the goal and description of the IE, involved partners, faced barriers and lessons learned as well as the next steps and connections to other IEs or ETTs. This also gives an indication of what progress is to be made by the end of the project.

The conclusion gives a brief summary as well as a view on the ambitions for the second version of the deliverable.

## 1.1 Scope and objectives of the deliverable

The POCITYF project aims to embrace the Energy Transition Strategy by deploying four Energy Transition Tracks, namely; ETT#1, ETT#2, ETT#3 and ETT#4. In interplay, the ETTs provide a comprehensive, but tailored approach to ensure that common and varied challenges and conditions of the Lighthouse Cities and Fellow Cities are addressed. Within these ETTs 10 Integrated Solutions (IS) were identified to support the demonstration, replication, and acceleration of mature and innovative technologies, two of the IS; Integrated Solutions (IS) - 2.1 - Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions and IS 2.2. Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions, belonging to ETT#2.

This document represents the first version of deliverable *D7.7 - Transition Track #2 Activities for Alkmaar* due in M39. The second version of this deliverable will be made available in M60. The deliverable is part of T7.4 which encompasses all implementation activities planned under ETT#2. This report is to be submitted to describe the current status of all the demonstration activities, and provides information regarding the achieved progress envisioned within the implementation plan. For Innovative Elements that, at the moment



of writing, are still in the process of being finalized in their implementation, the document will provide an overview of their current achieved status.

## 1.2 Relation to other tasks and deliverables

Due to the nature that this deliverable discusses, POCITYF Lighthouse City of Alkmaar relations to the other WPs are relevant. This deliverable and the IEs included in this deliverable have several overlapping elements with other WPs within POCITYF. This includes WP1 - POCITYF Smart City Framework Towards Integrated Deployment, WP2 - Setting Up, Planning and Execution of Performance Monitoring Activities, WP3 - Evaluation Activities, Socio-economic Impact Assessment and Recommendation, WP4 - Citizens Engagement and Open Innovation Activities, WP5 - Business Models across Circular & Sharing Economy Pathways, WP6 - Evora Lighthouse City demonstration activities, WP8 - Replication Plans and 2050 Vision for Fellow Cities.

## 1.3 Structure of the deliverable

This deliverable is composed of seven sections according to the following structure:

- Chapter 1 - Introduction;
- Chapter 2 - Methodological Approach;
- Chapter 3 - Alkmaar Demonstration Area Description ETT#2;
- Chapter 4 - Demonstrating ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility;
- Chapter 4.1 - IS 2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions;
- Chapter 4.2 - IS 2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions;
- Chapter 5 - Conclusions;
- Annexes;
- References.



## 2 Methodological approach

This is not a technical deliverable; therefore, the methodological approach focuses on the collection of the input from partners involved. To have a structured approach and to collect the necessary information from involved partners, the ETT-leaders (ETT#1, ETT#2, ETT#3 and ETT#4) have decided on a shared approach. This benefits the involved partners to have a consistent and standardized approach from all ETT-leaders. In collaboration, questionnaires were developed to determine what information is necessary and relevant for the deliverable. In addition, a template questionnaire was completed to provide guidance for the partners, when completing information.

For each partner and for each IE one template was created and stored on the project's file repository, including a folder to upload the completed questionnaires. In the case that multiple partners work on the same IE, each partner received a questionnaire, which was then consolidated by the respective ETT-leader.

An overview was created that helps partners clearly see which IE-questionnaire is to be completed by whom and where to upload the completed templates. All information was shared and presented to partners during a physical Alkmaar meeting in September 2022 and followed up by email with summarized instructions and links to the templates and the folders on where to upload completed information.

Partners had 1.5 months to complete the questionnaires to allow sufficient time within regular workload to complete the information, gather necessary materials and return the completed templates. Contributing partners, who are responsible for the implementation of an IE, were asked to complete the template with the information and progress achieved so far. A copy of this template can be found in Annex A.

With the input provided by the partners, the ETT leaders were able to consolidate the information and follow-up with partners should any additional information be missing. This being the first version of the deliverable, information that is not known yet, will be included in the second and updated version due at the end of the project.

Table 1: Timeline for this deliverable

| Activity                                                         | Timeline       | Involved                                       |
|------------------------------------------------------------------|----------------|------------------------------------------------|
| First discussion on Table of Contents (ToC) for deliverable      | February 2022  | ETT-leaders                                    |
| Coordination with Project Coordinator and finalization of ToC    | March 2022     | ETT-leaders and Project Coordinator            |
| ETT-leaders drafting and finalization of template questionnaires | August 2022    | ETT-leaders                                    |
| Presentation of work and input request to Alkmaar partners       | September 2022 | ETT-leaders                                    |
| Input collection                                                 | September 2022 | POCITYF Alkmaar partners                       |
| Consolidation of provided information, follow-ups, etc.          | November 2022  | ETT-leaders                                    |
| Final review and submission                                      | December 2022  | ETT-leader, Reviewers, and Project Coordinator |



## 3 Alkmaar Demonstration Area Description - ETT#2

Energy Transition Track #2 focuses on the increasing share of RES in the coming period. A key aspect of increasing the use and generation RES is also the shift of energy generation towards a decentralized generation and for local households and blocks/district operating on the level of micro-grids. The periodical nature of RES also creates additional stress on the grid, which requires more flexibility in the energy system reducing the need for energy curtailment. To achieve this goal, the different technologies will support linking resource efficiency and flexibility in energy supply and demand with innovative, inclusive and efficient services for citizens and businesses. Under ETT#2 innovative storage solutions and grid flexibility solutions will help with effective energy management of interdependent energy sub-networks and sub-systems of sustainable district/city smart grid environments.

**ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility focuses on 3 solutions:**

1. maximizing self-consumption;
2. reducing grid stress and avoid load and generation curtailment; and
3. increasing the financial value through flexibility services to the grid.

**The innovative solutions are grouped together under 7 key topics:**

1. low temperature waste heat,
2. innovative short and long-term seasonal storage solutions,
3. DC to work in parallel with AC grids,
4. smart ICT to interconnect EMS on a home/building/district level,
5. DSM platforms for optimization of energy flows,
6. thermal grid controllers, and
7. market-oriented building flexibility services.

More details can be found in D1.8 -City Vision and Mater Plan for ETT#2 - version 2. This chapter will provide a high-level overview of the different demonstration locations in the POCITYF Lighthouse City of Alkmaar. The reason for providing a high-level overview in this deliverable is that the demonstration areas have been reported on in great detail in previous deliverables. Furthermore, this deliverable focuses on the achievements of the Innovative Elements and the current status. For more background on the POCITYF Lighthouse City of Alkmaar, please see D1.8 - City Vision and Master Plan for ETT#2 Solutions - version 2.

An initial overview is provided in Table 2 and Table 3 of the IEs, including which partners are involved and at which locations they will be/are implemented.

For ease of readability a short overview will however be given in this deliverable regarding the Lighthouse City of Alkmaar as well as the respective PED/PEBs. Figure 1 depicts the general conceptual mapping of the Integrated Solutions (IS) that will be implemented in Alkmaar Lighthouse City, with Figure 2 describing the ISs belonging to ETT#1, ETT#2, ETT#3 or ETT#4.



Table 2: Overview of IS 1

| IS 1 - Flexible and sustainable Electricity Grid Networks with Innovative Storage Solutions |                                         |                                                            |
|---------------------------------------------------------------------------------------------|-----------------------------------------|------------------------------------------------------------|
| IE 2.1.5 - P2P Energy Trading Platform                                                      | Gemeente Alkmaar                        | PEB 1.3 - Bloemwijk                                        |
| IE 2.1.6 - CEMS                                                                             | NEROA                                   | PED Westrand                                               |
| IE 2.1.7 - ReFlex (prev. PowerMachter)                                                      | TNO                                     | PEB 1.1 - De Meent, PEB 1.3 - Bloemwijk, PEB 1.4 - InVesta |
| IE 2.1.8 - Stationary Batteries                                                             | Van Alckmaer, Gemeente Alkmaar, InVesta | PEB 1.1 - De Meent, PEB 1.2 - Woonward, PEB 1.4 - InVesta  |
| IE 2.1.9 - VPP                                                                              | TNO                                     | PEB 1.1 - De Meent, PEB 1.3 - Bloemwijk                    |
| IE 2.1.11 - DC Grid                                                                         | Gemeente Alkmaar, InVesta               | PED - Westrand                                             |
| IE 2.1.12 - Fuel Cell                                                                       | InVesta                                 | PEB 1.4 - InVesta                                          |

Table 3: Overview of IS 2

| IS 2 - Flexible and Sustainable District Heating/Cooling with Innovative Storage Solutions |                  |                      |
|--------------------------------------------------------------------------------------------|------------------|----------------------|
| IE 2.2.3 - Low Temperature Heat (smart) grid                                               | Gemeente Alkmaar | PEB 1.1 - De Meent   |
| IE 2.2.4 - Indirect Delivery Sets                                                          | HVC              | PEB 1.5 - Dillenburg |
| IE 2.2.5 - Low temperature Waste Heat                                                      | Gemeente Alkmaar | PEB 1.1 - De Meent,  |
| IE 2.2.7 - Thermal Network Design Toolkit (alt. HeatMatcher)                               | TNO              | PED - Westrand       |
| IE 2.2.8 - Heat Island Concept                                                             | InVesta          | PEB 1.4 - InVesta    |



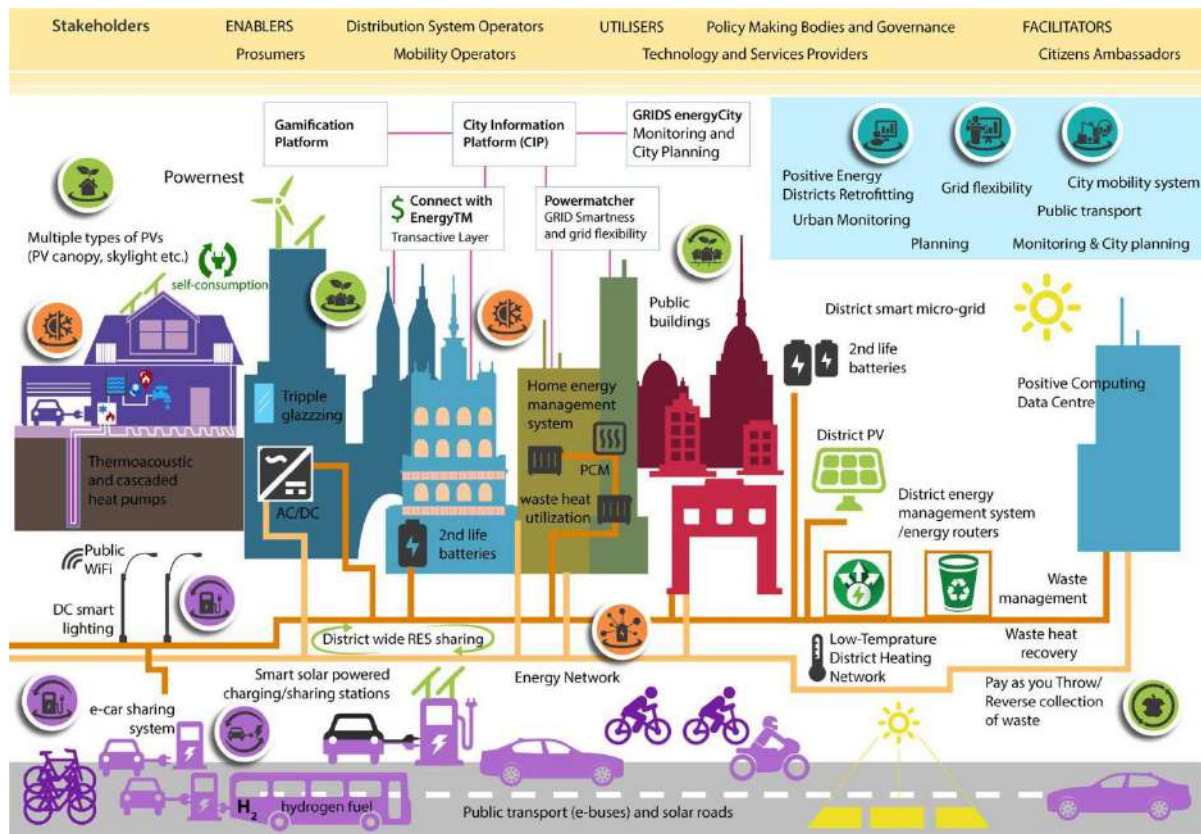


Figure 1: High-level conceptual mapping of POCITYF Integrated Solutions within the Lighthouse districts

|  |                                                                                  |  |                                                                                                  |
|--|----------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------|
|  | IS-1.1: Positive Energy (stand-alone) Buildings                                  |  | IS-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions     |
|  | IS-1.2: Positive Energy Districts Retrofitting                                   |  | IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions |
|  | IS-1.3: Feeding PEDs with Waste Streams Promoting Symbiosis and Circular Economy |  | IS-4.1: Social Innovation Mechanisms towards Citizen Engagement                                  |
|  | IS-3.1: Smart V2G EVs Charging                                                   |  | IS-4.2: Open Innovation for Policy Makers and Managers                                           |
|  | IS-3.2: e-Mobility Services for Citizens and Auxiliary EV Technologies           |  | IS-4.3: Interoperable, Modular and Interconnected City Ecosystem                                 |

Figure 2: Legend of Innovative Solutions

### 3.1 PED Westrand

The city of Alkmaar is one of two lighthouse cities in the POCITYF project. The city is located in the province North-Holland, a half hour by car and train from Amsterdam. The demonstration district for Alkmaar is the Westrand area. The Westrand demonstration district of Alkmaar is located in the west of Alkmaar. Over the years, the area has become densely populated and next to households additional kinds of space occupancy, such as catering, offices and shops have increased. The district itself is currently developing future desired qualities of the Westrand area up to 2030, laying the groundwork for transformations (retrofitting houses and buildings and in the public space), paving the road towards becoming an energy positive district.



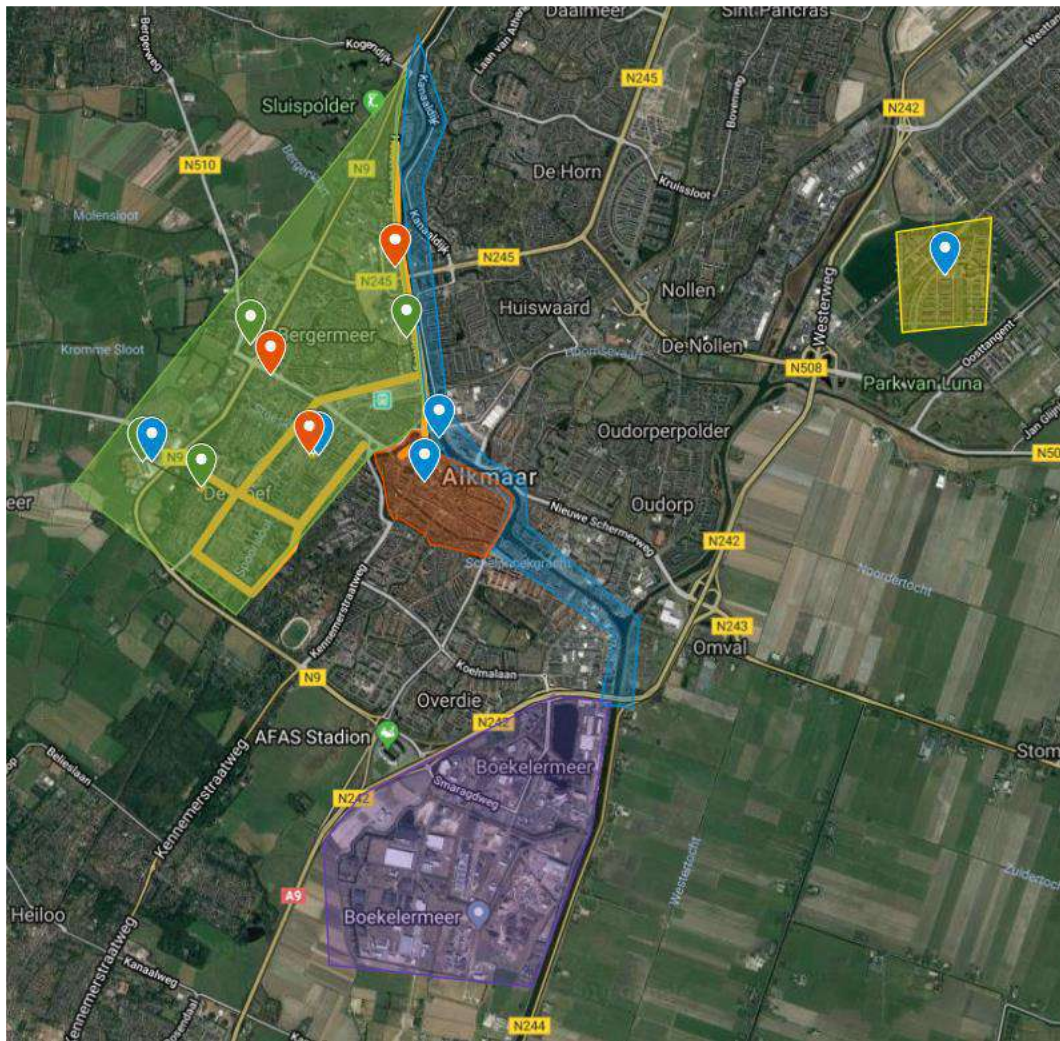


Figure 3: In Green the Westrand district; In Blue the Canal Zone replication area; In Red the historical city center replication; In Purple the Boekelermeer replication industrial area; In Yellow the pre-pilot project Heerhugo Stad van de Zon (Sun City)

### 3.1.1 Characteristics of PED Westrand

The area can be considered a typical urban periphery area with 12,300 residents living in the 637Ha Westrand area. The current energy needs are 17,000 MWh/year for electricity and 8 million m<sup>3</sup> (78,000 MWh/year) of natural gas. The district is home to around 6,050 households, with a distribution of 55% of homeowners, 28% social housing, 15% private rental and 2% unknown. The energy usage is that of a typical Dutch household, with a peak in the morning and a high peak in the evening.<sup>1</sup>

## 3.2 PEB description and demonstration activities

For a more detailed description of the PEBs, please see POCITYF - D7.5 - City Vision and Master Plan for ETT1.

<sup>1</sup> POCITYF GA Document AMD 864400-15



### 3.2.1 PEB 1.1 Sport-Complex de Meent

The Building Sports Complex de Meent (Figure 4) is the Alkmaar sports location, which includes an ice rink, a gymnasium and an indoor sports stadium; total floor area of 11.450m<sup>2</sup>. Within ETT#2 the following Innovative Elements will be installed or utilized:

- IE 2.1.7 - ReFlex (prev. PowerMatcher): ReFlex is a software solution enabling aggregators to create a VPP and support with congestion management. For more details, see [Chapter 4.1.3](#)
- IE 2.1.8 - Stationary batteries (Li-on batteries): The batteries installed at De Meent will be connected to an external aggregator. For more details, see [Chapter 4.1.4](#)
- IE 2.1.9 - Virtual Power Plant (VPP): the VPP connects multiple power generating and storage devices. More details can be found in [Chapter 4.1.3](#) and [Chapter 4.1.5](#)
- IE 2.2.3 - Low temp heat grid: The low temperature heat grid will benefit De Meent as well as surrounding buildings. For more information, see [Chapter 4.2.1](#)
- IE 2.2.5 - Low temp waste heat (and cooling): the low temperature waste heat demonstration connects to the Aquifer Thermal Energy Storage (ATES) (IE 1.2.7) and the low temperature heat grid (IE 2.2.3). More details can be found in [Chapter 4.2.3](#)



Figure 4: PEB 1.1 - De Meent with installed PV panels above the car port



### 3.2.2 PEB 1.2 Woonwaard Highrise van der Veldelaan

Woonwaard Highrise (Figure 5) will be retrofitted with circular roof insulation and a combined solar/wind renewable energy system. Circular materials will make the building more sustainable. Within ETT#2 the following Innovative Element(s) will be installed or utilized:

- IE 2.1.8 - Stationary batteries (Li-on battery): The battery installed at Woonwaard Highrise van der Veldelaan with the main purpose to peak shave the installed solar system. For more details, see [Chapter 4.1.4](#)



Figure 5: Woonwaard Highrise van der Veldelaan with visualization of the solar construction

### 3.2.3 PEB 1.3 Bloemwijk

The Bloemwijk area (Figure 6) will be a combination of low-rise residential apartments and terraced houses. They will be fitted with high-quality innovative circular insulation, regular and integrated panels on the roofs, and some electrical batteries. There will be an integral heating system with booster and acoustic heat pumps, buffers and PV thermal solar panels. Within ETT#2 the following Innovative Elements will be installed or utilized:

- IE 2.1.7 - ReFlex (prev. PowerMatcher): ReFlex is a software solution enabling aggregators to create a VPP and support with congestion management. For more details, see [Chapter 4.1.3](#)
- IE 2.1.8 - Stationary batteries (Li-on battery): During the POCITYF project, van Alckmaer will install 5 batteries in Bloemwijk dwellings. For more details, see [Chapter 4.1.4](#)
- IE 2.1.9 - Virtual Power Plant (VPP): the VPP connects multiple power generating and storage devices. More details can be found in [Chapter 4.1.5](#)





Figure 6: Visualization of finalized Bloemwijk project

### 3.2.4 PEB 1.4 InVesta Expertise Center

The InVesta building (Figure 7) is an expertise center located in the replication area that stimulates and facilitates the development and marketing of innovative green molecules initiatives by connecting entrepreneurs, researchers and governmental bodies, offering a test, pilot and demonstration facility where technologies will be further developed. Within ETT#2 the following Innovative Elements will be installed or utilized:

- IE 2.1.7 - ReFlex (prev. PowerMatcher): ReFlex is a software solution enabling aggregators to create a VPP and support with congestion management. For more details, see [Chapter 4.1.3](#)
- IE 2.1.8 - Stationary batteries (Stationary battery (NiMH, Lithium NMC, Lithium FePO<sub>4</sub>, Flow battery or Titanium): During the POCITYF project, the InVesta Expertise Center will purchase a battery to be installed on location. For more details, see [Chapter 4.1.4](#)
- IE 2.1.11 - DC Network: An internal DC grid will be implemented that covers the solar panels, battery, led lighting and EV chargers. For more information, see [Chapter 4.1.6](#)
- IE 2.1.12 - Fuel Cell: The Fuel Cell will be implemented in the technical room adjacent to the workplace on the ground floor. More details can be found in [Chapter 4.1.7](#)





Figure 7: InVesta center of expertise

### 3.2.5 PEB 1.5 Woonwaard Dillenburg

Dillenburgstraat apartments (Figure 8) will be connected to the lower temperature heating district network which runs from municipal wood waste and their roof will be equipped with PV panels. Within ETT#2 the following Innovative Elements will be installed or utilized:

- IE 2.1.8 - Stationary batteries (Li-ion): The battery installed at Woonwaard Dillenburg is connected to the central system (elevators, lights, etc.). For more details, see [Chapter 4.1.4](#)
- IE 2.2.4 - Indirect Delivery Sets: The installed Indirect Delivery Sets can be used to create a separation between the water from HVC and the water from indoor installation in the home, eliminating heat transmission stations from the heat district network. For more details, see [Chapter 4.2.2](#)



Figure 8: Apartments at Dillenburgstraat where IE 2.2.4 will be demonstrated



### 3.2.6 Other demonstration activities

Some IEs within the POCITYF project are not directly linked to a demonstration area but have a more holistic impact within the project. During the duration of the project, it became apparent, that the optimization and extension of the Alkmaar district heating grid cannot be considered in silo. Therefore IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher) expanded to encompass the entire PED demonstration area to achieve a holistic approach and support the decision-making process of the city of Alkmaar to increase grid flexibility and viable solutions to connect the historical buildings in the city center. Also, IE 2.1.6 - City Energy Management System (CEMS) is an aggregation of IE 1.1.8 - Building Energy Management System (BEMS). This translates into all BEMS together make up the CEMS. Within ETT#2 the following Innovative Elements will be installed or utilized:

- IE 2.1.5 - P2P Energy Trading: Municipality Alkmaar and Van Alckmaer will work together with the residents of Bloemwijk to develop a P2P Energy Trading use case. For more details, see [Chapter 4.1.1](#).
- IE 2.1.6 - City Energy Management Platform: This IE relates to IE 1.1.8 BEMS within ETT#1 on which CEMS will be built upon. For more details, see [Chapter 4.1.2](#).
- IE 2.1.11 - DC grid with (smart) lampposts (Figure 9): Within the Oranjebuurt area, a fully operating DC grid is installed with 92 DC lampposts. For more information, see [Chapter 4.1.6](#)
- IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher): This simulation of the heat grid in Alkmaar is done collaboratively between HVC and TNO. For more information, see [Chapter 4.2.4](#)



Figure 9: Street view of Oranjebuurt with existing lampposts



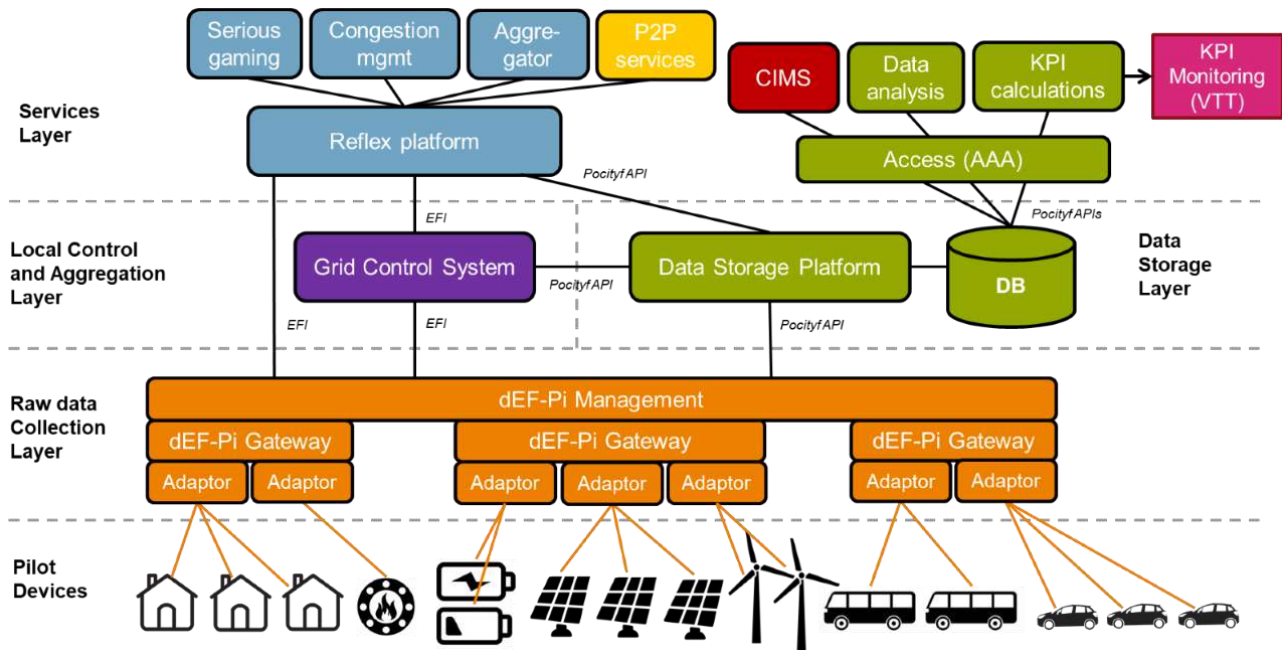


Figure 10: Conceptual visualization of the stacked architecture for Alkmaar monitoring and control of existing devices.



## 4 Demonstrating ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility

The center of POCITYF strategy is built around 4 (four) multidisciplinary and complementary Energy Transitions Tracks. These ETTs aim to enhance the integration of commercialized and innovative energy systems, leading the way towards transforming existing city blocks into becoming self-sustainable and more environmentally friendly for their citizens. The term Transition Track is an overarching terminology used to group interdisciplinary and complementary Integrated Solutions taking the terms and focuses they address under an umbrella term. In general, the objective is to further the energy performance levels of urban districts in historical city centres and develop a large amount of Positive Energy Districts by 2050.

| <br>ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility |                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Integrated Solutions                                                                                                                                         | <br>IS 2.1   | <b>Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions</b><br>2nd life residential batteries // Energy Communities management platform // Control algorithms // P2P energy trading platform // City Energy Management System // Powermatcher (DSM platform) // Stationary batteries // Virtual Power Plant (VPP) // V2G // DC grid (with smart lampposts) // Fuel cells (hydrogen) |
|                                                                                                                                                              | <br>IS 2.2 | <b>Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions</b><br>(Freezing storage in store // Market-oriented building flexibility services // low temperature heat grid // indirect delivery sets // low temperature waste heat // ATEs (heat/cold storage) // HEAT matcher thermal grid controller // Heat Island concept)                                                     |

Table 4: ETT#2 Integrated Solutions

### 4.1 IS 2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions

Within ETT#2, IS 2.1. Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions encapsules seven Innovative Elements for the city of Alkmaar. The exploration within IS 2.1 is how to deal with a higher share of RES in the coming decades and the connected grid challenge due to the irregular nature of RES energy production. Here, technology can support with the call for more flexibility and reduce energy curtailment.

In the following chapters, an overview of each IE will be provided. Some IEs (e.g., IE 2.1.8 - Stationary Batteries) are implemented by different partners at different locations. In order to keep readability up, the IEs that will be implemented at different locations and by different partners are described in separate tables, whereas IEs that will be/are implemented by the same partner but at multiple locations (e.g., IE 2.1.7 - ReFlex (prev. PowerMatcher)) will be handled in one table, with headers referring to the specific locations where applicable. An overview of the IEs and partners involved is provided in the following table (Table 5):



Table 5: Overview of Innovative Elements in IS 2.1

| Innovative Element                         | Partners involved                                     | Demonstration area in ETT#2                                |
|--------------------------------------------|-------------------------------------------------------|------------------------------------------------------------|
| IE 2.1.5 - P2P energy trading platform     | Gemeente Alkmaar / Van Alckmaer / TNO                 | PEB 1.3 - Bloemwijk                                        |
| IE 2.1.6 - City Energy Management System   | NEROA                                                 | PED - Westrand                                             |
| IE 2.1.7 - ReFlex (prev. PowerMatcher)     | TNO                                                   | PEB 1.1 - De Meent, PEB 1.3 - Bloemwijk, PEB 1.4 - InVesta |
| IE 2.1.8 - Stationary Batteries            | Van Alckmaer / Woonwaard / InVesta / Gemeente Alkmaar | PEB 1.1 - De Meent, PEB 1.2 - Woonwaard, PEB 1.4 - InVesta |
| IE 2.1.9 - Virtual Power Plant             | TNO                                                   | PEB 1.1 - De Meent, PEB 1.3 - Bloemwijk                    |
| IE 2.1.11 - DC grid (with smart lampposts) | Gemeente Alkmaar                                      | PED - Westrand                                             |
| IE 2.1.12 - Fuel Cell (hydrogen)           | InVesta                                               | PEB 1.4 - InVesta                                          |

#### 4.1.1 Demonstrating IE 2.1.5 - P2P energy trading platform

In the below overview (Table 6), partners involved in the P2P Energy Trading Platform provide a general description of the Innovative Element that will be demonstrated within the POCITYF project. The partners provide a joint overview of the past, ongoing and future developments and the respective achievement to be accomplished by the end of the project. The table below describes the demonstration activities until the time of the deliverable.

Table 6: IE 2.1.5 - P2P Energy Trading Platform

| IE 2.1.5 - P2P Energy Trading Platform - PEB 1.3 - Bloemwijk                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p>The goal mentioned in the Grant Agreement (GA) is to create a local P2P energy trading platform as an implementation of a city energy management system where the users/owners of the buildings can buy/sell energy to each other and sell flexibility to the DSO. In this case, the city of Alkmaar will demonstrate, in selected demonstration areas, technologies for P2P Energy Management and Storage for electric grid flexibility and the Municipality will be the operator.</p> <p>Due to changes in the demonstration areas, it was necessary to (re)define the P2P energy trading platform. The involved buildings need the energy themselves, leaving not much flexibility that can be sold to the DSO. Especially now with the net-congestion, selling to the DSO is not really an option.</p> <p>The original use case that was being investigated for the P2P energy trading platform in Bloemwijk was:</p> <ul style="list-style-type: none"> <li>• 5 houses with batteries / 5 houses without batteries</li> <li>• External battery (large scale battery) placed on the premises of ProRail</li> <li>• Giving excess energy to ProRail</li> </ul> <p>After extensive exploration of this idea, the feasibility of this use case reduced due to the following reasons:</p> <ul style="list-style-type: none"> <li>• technically possible, however not very much flexibility</li> </ul> |



- high costs for large battery needed, unclear who was going to invest
- too many legal and financial issues (also since ProRail and private persons pay different amounts for energy)

The goal is to have a P2P exchange not only in an administrative way, but preferably also to have a use case that is actually exchanging energy between residents within Bloemwijk. Therefore, the P2P energy trading was combined with a social approach on community building.

In order to reach this goal, it was necessary to start by creating/strengthening the community within Bloemwijk. The residents who will stay/return to the newly built houses and in the area would like to involve newcomers in the community of Bloemwijk. The outcome of several working session with tenants was that it is important to them to keep the strong connection within the neighbourhood and to define and strengthen the values of the neighbourhood.

Residents would like to contribute to the issue of neighborhood caring and sharing and the potential of P2P energy networks. They have had conversations in the past about the potential of energy exchanges and would like to work with POCITYF to see what else is possible in this area. They understand the value of energy for the neighborhood and therefore have concrete examples of issues they have with energy.

#### Role of partners involved

- Gemeente Alkmaar: Leading the IE design and implementation
- Van Alckmaer: by joining and collaborating during the meetings with the residents
- TNO: helping Gemeente Alkmaar with the societal approach and later the P2P energy trading

#### Progress achieved to M38

Over the past months it was important to define a good use case to put into practice. Several possibilities were discussed and research explored options available and of added value for the tenants.

Besides the uses case mentioned in the goal and description we have researched the possibilities of

- Rephrase P2P to use HESI lab battery and HP validation and simulate different scenarios - end result determines the best case scenarios for tenants/grid operators/housing cooperation
- Collaboration with the local Alkmaar Energy Cooperation in setting up P2P energy trading for neighbourhood centres (still ongoing to see if there are possibilities)
- Connecting with the solution being made at Boekelermeer by partners (Firan, Municipality, Investa) - Boekelermeer is a replication area. To solve an urgent net-congestion issue, POCITYF partners are creating a solution where energy will be exchanged by companies in this area. Investigation into the possibility to contribute by creating the P2P energy trading platform. Research is still ongoing.

Contact with the residents has been made and the approach to strengthen the community is being made at this moment to start in 2023.

#### Faced Barriers and Lessons Learned (M0 - M38)

- Ownership of this IE has been challenging. It is difficult for a municipality to be the operator for a P2P platform. They have no knowledge or capacity to do this. Since there are no technology partners this is challenging.
- It was important that the energy exchange is not reduced to a simulation, but also to see if it is possible for a real exchange of energy within a community to happen. Ambitious, and accompanied with more challenges in this respect.



- A P2P energy trading platform is a solution, but the best use case was difficult to define. Who benefits / needs P2P energy trading? Due to the energy crisis and the major net-congestion in Alkmaar, opportunities arose.
- High possible investments if one would like to use a battery in the technological solution.
- Cooperation with the Alkmaar Energy Cooperation was difficult. It is a small group of volunteers with limited time availability. In addition, in the past they have had bad experiences with working together with the municipality. Restoring this relationship was a crucial first step that had to be done.
- In general, the idea of P2P may sound simple, but the solution is complex to prepare due to the required involvement of different parties and organisations with busy agendas and different scopes.
- Finally, a key challenge for P2P is the community aspect. If there is no community that would like to make use of energy trading, there is no P2P energy trading possible. Therefore, significant effort is needed for developing a community that wants and will use the technological solutions/platforms.

#### Next steps

The approach is being finalized and will start in Q1 2023 with the first steps

#### Connected IEs within ETTs

- IE 2.1.6 - CEMS (in case of administrative exchange of energy)
  - IE 2.1.8 Lion batteries Bloemwijk (in case of 5 houses exchanging energy will be part of the final solution)
- IE4.1.a and 4.1.b: the Valuebased design / handbook made by TNO. This is a basis for the approach

## 4.1.2 Demonstrating IE 2.1.6 - City Energy Management System (CEMS)

The City Energy Management System (CEMS) is the overarching element of the IE 1.1.8 - Building Energy Management System (BEMS) as being demonstrated in ETT#1. After final implementation this IE will be monitoring the operation of consumption and generation devices at district level. The CEMS will effectively demonstrate the monitoring of the energy devices within the lighthouse city.

NEROA will provide an overview of the past, ongoing and future developments and the respective achievement to be accomplished by the end of the project. The table below describes the demonstration activities until the time of the deliverable.

Table 7: IE 2.1.6 - City Energy Management System

| IE 2.1.6 - City Energy Management System - PED Westrand                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>The IE 2.1.6 - CEMS (City Energy Management System) is used to monitor (and unlock the availability to control) the energy devices in all pilot areas combined. Therefore, this section is closely related to the IE BEMS (within ETT#1).</p> <p>CEMS includes demand-side management/smart grid in the pilot area buildings by using the Energy Flexibility Interface (EFI). EFI bridges the gap between smart energy devices and Demand-Side Management (DSM) solutions. EFI aims to disseminate the energy flexibility of devices, providing all the</p> |



necessary information for control algorithms, without needing any device specific details. EFI is being standardized through CENELEC to ensure long term stability and gain a larger support base and (ReFlex) Powermatcher Technology. The EFI interface was finalized in July 2021 and archived as the ‘S2 interface’ under registration number EN 50491-12-2<sup>2</sup>.

POCITYF will introduce the use of a City Energy Management System (CEMS) which includes demand side management/smart grid in the pilot area buildings by using the Energy Flexibility Interface (EFI).

The goal of this innovative element is to be able to use flexibility offered by the different energy assets (Battery, heat pump, etc.). The interface is the link with the optimisation algorithm IE 2.1.7 - ReFlex (prev. PowerMatcher). With this interface the algorithm is able to use the available energy flexibility in the buildings.

The CEMS can be seen as the overarching layer to which all BEMSs are connected. As mentioned in the BEMS (see Deliverable 7.5 - City Vision and Master Plan for ETT#1), the relevant energy devices per pilot area will be connected to the dEF-Pi platform. Compared to the BEMS which monitors and potentially controls the performances of the energy devices per building/pilot, the CEMS enables the possibility to do the same on a city level.

The CEMS will also be connected to IE 2.1.7 - Reflex to communicate with the devices and to manage them in favour of energy efficiency, this also includes RES integration, reduction of grid-stress as objectives of ETT#2. It enables to ‘trade’ energy between the pilot areas or to offer flexibility to grid operators. In essence, the CEMS thus (i) monitors the performances of the energy devices of all pilot areas as an overarching layer and (ii) enables the possibility to manage and control the devices on the city level in favour of energy efficiency and flexibility.

With regards to the dEF-Pi platform, no adjustments are needed compared to the BEMS. The platform functions the same, but now covers the whole city rather than just one building/pilot.

The S2 protocol communicates with (more) resource manager(s) to determine how much flexibility is available and to manage the resources. There is one resource manager per energy asset. See below for an example

<sup>2</sup> The S2 interface is used to communicate the energy flexibility of smart devices to the Customer Energy Manager (CEM).



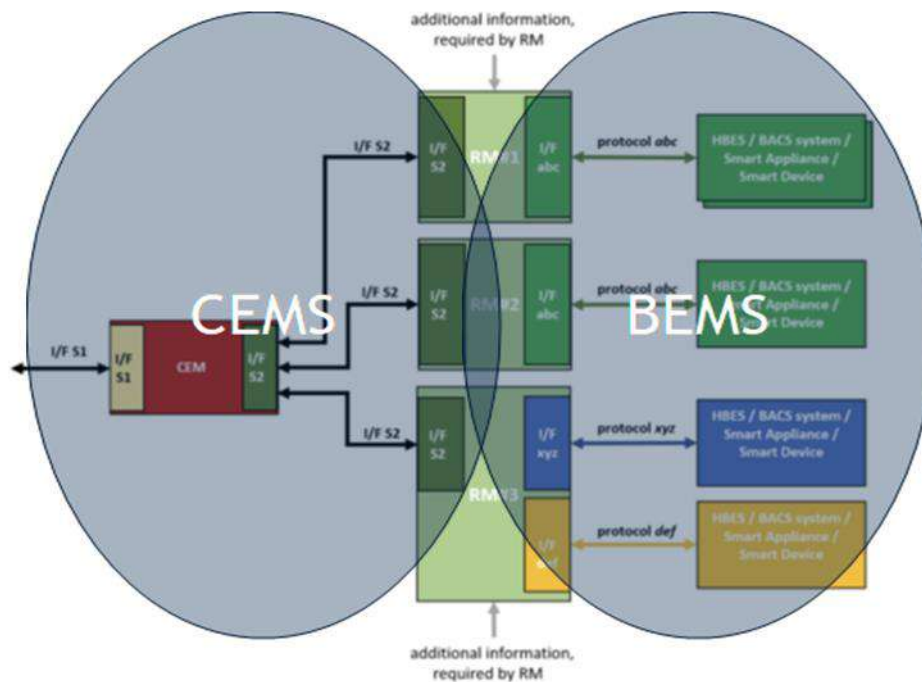


Figure 11: Example of a combination of a CEMS communicating via different resource managers to BEMS

To be able to install and deploy the CEMS and BEMS a test environment has been installed using the dEF-Pi platform. This platform allows to install the software needed (the interface and management software).

#### De Meent:

For De Meent Firan has developed a resource manager to control the operation of the battery in order to utilize the energy flexibility. The resource manager is a dotnet 6.0 WebApi Service application and TNO delivered the Swagger/OpenAPI specification of the relevant S2 interface.

Recently it was discovered that there is a capacity transport limit at the power grid at De Meent. To prevent that ReFlex instructs the battery to an operation that causes the consumption and/or production of De Meent to surpass the capacity limit, ReFlex now also requires measurements and forecasts at the grid connection of De Meent. With this information, ReFlex can calculate any left-over capacity in the grid connection and will only instruct the battery to use the unused capacity and prevent the battery from surpassing the capacity limit.

#### Test implementation of dEF-Pi:

The dEF-Pi platform server has been deployed in the Agroweb-cloud. This allows any dEF-Pi client to connect to this centralized server. The clients will be part of the energy-flexible assets that will be controlled. When the backoffice is ready and running, it will be able to connect clients. In order to deploy a def-Pi client, the first step is to write the dEF-Pi client image on a SD card.<sup>3</sup>

<sup>3</sup> For more information, please refer to: <https://fan-ci.sensorlab.tno.nl/builds/defpi-documentation/master/html/architecture.html>



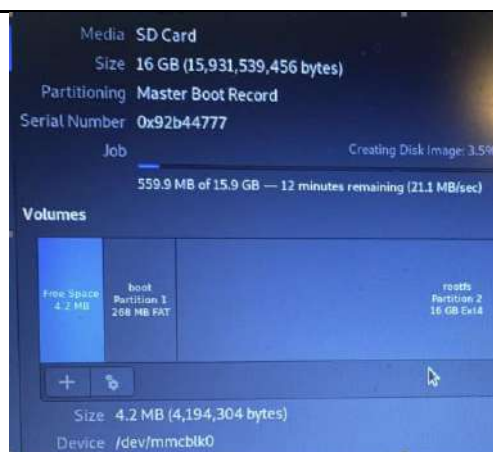


Figure 12: Creating dEF-Pi-image on SD card

The dEF-Pi server depends on several other open source solutions such as Docker Swarm, Maven and Java/Python and must be installed on the server. This installation must carefully be prepared because each component has specific concerns to solve; e.g., Docker swarm has its own network.

The software requires to be updated with additional software components. During the process all the errors must be resolved step by step. The error above is referring to a Protobuf error which needed to be resolved.

The final result is that connections between all modules are made automatically and creates the first workable dashboard.

Before the S2 resource manager interface can be implemented, the characteristic of each energy asset needs to be clear. For each energy asset an analysis regarding how they can and could behave with respect to the device itself. An example of this is, e.g. the possibility to use a hybrid heatpump as a flexible asset. Prior to using the device as a flexible device it needs to be clear what the impact of switching/modulating the energy asset is.

#### Role of partners involved

- NEROA is the leading partner on the IE 1.1.8 - HEMS/BEMS, implementing the connection with the CEMS (ReFlex) and developing the S2 resource manager interface for flexible energy assets.
- TNO is involved supporting the implementation of the S2 resource manager and the dEF-pi platform
- Firan is involved in developing the S2 resource manager for the battery at De Meent

#### Progress achieved to M38

- A test deployment of the dEF-Pi platform including the orchestrator and a test node has been successful. The intermediate steps were described in the previous section.
- Test implementation of the dEF-pi platform
- Modeling of a hybrid heatpump in a S2 resource manager model (not yet finished).
- Analysis of the hybrid heat pumps how to steer them with respect to comfort for the occupant, and life time. Discussions with manufacturers are still ongoing.

#### Faced Barriers and Lessons Learned (M0 - M38)

- The test implementation and deployment of dEF-pi platform took more time and effort than expected. There were dependencies on 3<sup>rd</sup> software module parties, but with support from TNO, we managed to get the platform online.



- It can take more time receive all the information that is needed such as how to best realize the hardware (usb, 2-wire, rg11, etc) and software interface, especially prior to all technical details of the interface are known. This can be due to the fact that there are multiple organizations involved. With the investor of the energy asset being a project partner, they can set up a meeting with the installer, who in turn is the contact point with the manufacturer Intergas, Elgra and Rehema. In the case of this IE, the manufacturer had concerns with sharing information. To solve these situations several meetings, assurances and commitments are needed.

For some locations specific hardware needs to be installed before the software can be installed. The initially selected RaspberryPi as a hardware platform has proven to be challenging due to material and product shortages. Therefore, alternatives need to be explored, such as using a cloud/backoffice solution where possible.

#### Next steps

- Further development of different S2 interfaces. The number of S2 interfaces depends on if the assets can offer flexibility which is useful to balance the grid. During the project it will be determined which of the exact assets are useful. Seeing that it is not fixed which assets will be installed, this information cannot be provided yet. Together with the team it was decided that the hybrid heat pumps are valid assets and also the medium size (battery) storage assets might be useful.
- Managing the communication with the manufacturers and/or installers of the energy assets
- Evaluate the use of dEF-Pi with TNO to publish a newer version of dEF-Pi which is more mature.
- Functional analyses of the IE's regarding flex potential / comfort / technical constraints.

#### Connected IEs within ETTs

- The CEMS is the overarching IE for IE 1.1.8 - Building Energy Management System (BEMS) within ETT#1 and is closely linked to almost all IEs in the POCITYF Lighthouse city of Alkmaar:
- CEMS will be demonstrated at the following locations:
  - PEB 1.1 - De Meent
  - PEB 1.2 - Woonwaard Highrise
  - PEB 1.3 - Bloemwijk
  - PEB 1.4 - InVesta
  - PEB 1.5 - Woonwaard Dillenburg

### 4.1.3 Demonstrating IE 2.1.7 - ReFlex (formerly PowerMatcher)

In the below overview, TNO will provide a general description of the Innovative Element ReFlex (formerly PowerMatcher) that will be demonstrated within the POCITYF project. IE 2.1.7 p ReFlex (formerly PowerMatcher) will be implemented in three different pilot sites; PEB 1.1 - De Meent, PEB 1.3 - Bloemwijk, and PEB 1.5 - InVesta. The aim is to optimize the usage of available energy flexibility provided by controllable (energy consuming) devices. The input is provided by the City Energy Management System, which comprises all the information from the Building Energy Management System (BEMS). Based on the available controllable devices, ReFlex (previously PowerMatcher) send corresponding control signals depending on objectives determined by the Virtual Power Plant (VPP) or demand side management methods.

TNO will provide an overview of the past, ongoing and future developments and the respective achievement to be accomplished by the end of the project. The table below describes the demonstration activities until the time of the deliverable.



Table 8: IE 2.1.7 - ReFlex (form. PowerMatcher)

## IE 2.1.7 - ReFlex (form. PowerMatcher) - PEB 1.1, PEB 1.3, PEB 1.4

## Goal and Description of IE at the PEB

ReFlex is a software solution to manage and optimize multiple flexible electricity assets at a location and at the same time create a virtual power plant of that location.

The goal of ReFlex is to optimize the consumption and the production of electricity at De Meent. ReFlex can be configured for different optimization goals, such as mitigating grid congestion at the power connection, improve self-consumption, optimize for energy tariffs, or offer any overproduction of power to the grid (as a Virtual Power Plant, VPP).

All these goals are geared towards making the three different locations more sustainable and become a PEB or PED.



Figure 13: Bloemwijk before the renovation

## Location PEB 1.1 -De Meent

At De Meent several changes have been made to the electrical system within the POCITYF project. The Ice Ring's cold is now provided by electrical heat pumps, and a large battery is added (June 2022, see ). Furthermore, it has installed 646 PV panels on the roof of the gymnasiums (deployed March 2016), 1080 PV panels on the roof of the ice rink (deployed March 2021), 60 PV panels on top of the bike port (deployed August 2021) and 852 PV panels on top of the carport (deployed February 2021).





Figure 14: Battery installation at De Meent

These changes create an energy system with intermittence (solar PV) and flexibility (battery) allowing and requiring the previous mentioned optimizations.

ReFlex uses the new S2 standard (EN 50491-12-2, a standard to communicate energy flexibility) to communicate with the battery.



Figure 15: De Meent Ice Rink. On top of the ceiling, 1080 PV panels are installed



**Location PEB1.3 - Bloemwijk**

The Bloemwijk area with social housing is being completely rebuilt. This process is currently in progress. After the rebuild is ready (estimated Q3 2023), the (well-insulated) 55 buildings will be equipped with PV panels, generating around 280.000/300.000 kWh electricity per year. Besides that, there are 10 houses that will be part of the pilot with ReFlex optimization. All houses have a heat pump and 7 kWp PV on each of the rooftops. Five of them will be equipped with an additional battery of 6.5 kWh storage capacity (see IE 2.1.8).

ReFlex will be used to optimize the electricity system of the ten houses, in particular the five batteries, as they provide the most energy flexibility. The exact optimization goal is still under discussion.

**Location PEB 1.4 - InVesta**

The InVesta building is equipped with several innovative renewable technologies such as a Thermo Acoustic Heat Pump, Solar and Facade PV and Battery (for more details see the descriptions of the IEs belonging to InVesta). At the location the FerroAmp technology is used to integrate all the electrical (DC-based) equipment.

ReFlex will be used to optimize the flexible assets (such as the battery) provided by the location towards the earlier mentioned goals. The exact optimization goal is still under discussion and depends on the final selection of assets that will be installed.

**Role of partners involved****Location PEB 1.1 - De Meent**

- Gemeente Alkmaar / De Meent sports complex - investing in sustainable assets, such as the battery and electric heat pumps.
- TNO - provides/installs optimization software ReFlex
- Firan - operates the battery and provides an S2 resource manager for the implementation, such that ReFlex can optimize the battery usage.
- NEROA - monitoring of assets for measuring KPIs

**Location PEB 1.3 - Bloemwijk**

- Van Alckmaer - Housing corporation, rebuilding the Bloemwijk area
- NEROA - monitoring of assets for measuring KPIs
- TNO - provides/installs optimization software ReFlex

**Location PEB 1.4 - InVesta**

- InVesta - Owner of the InVesta building
- TNO - provides/installs optimization software ReFlex

**Progress achieved to M38****Location PEB 1.1 - De Meent - Current status**

- Installation of heat pumps and battery at De Meent
- Implementation of the S2 interface for the battery (using the new EN 50491-12-2 standard, published in June 2022)
- Adaptation of ReFlex software to support the use case at De Meent, such that it can optimize the usage of the battery.



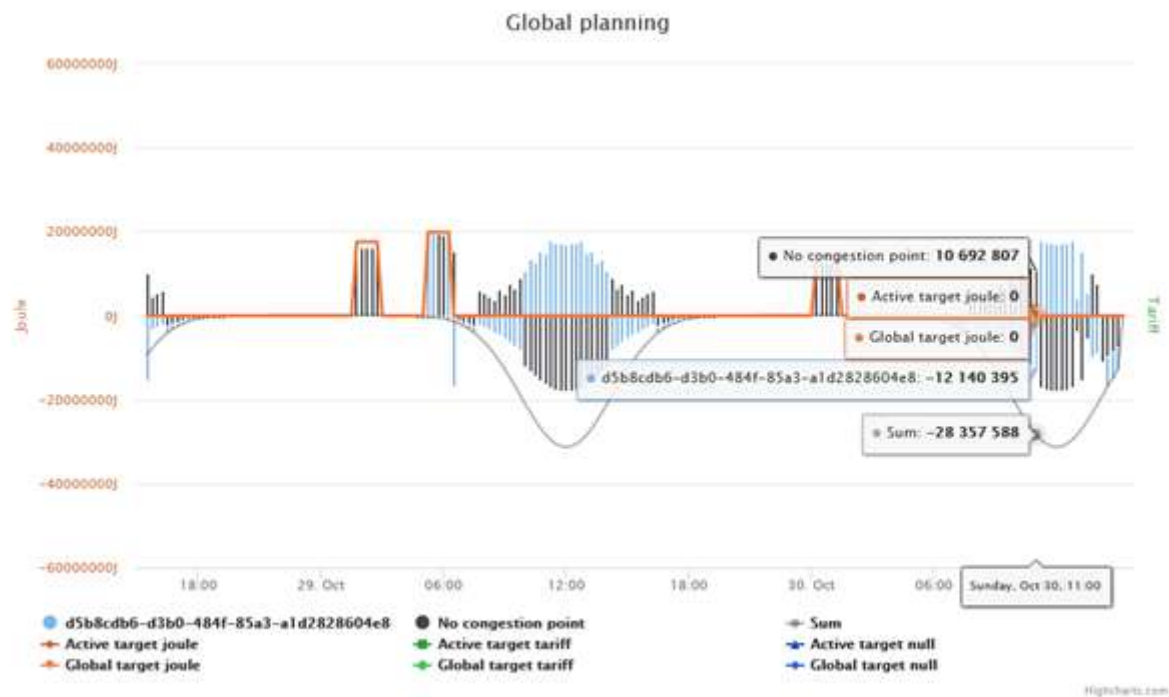


Figure 16: ReFlex Dashboard showing the forecast of the upcoming 48 hours of energy consumption and production (negative values) (example)

Next steps:

- Provide monitoring data and collect KPIs
- 3 months' field trial.
- Collect and document results

#### Location PEB1.3 - Bloemwijk - Current Status

The area is currently being reconstructed. June 2023 is currently the expected date to be ready for former inhabitants to return to their housing.

The heat pump and battery are in the process of being transported to the HESI lab of TNO in order to implement the integration with the ReFlex software and test the ability to control these devices. Additionally, the lessons learned (such as connecting the systems to the internet connection at the new houses) will be used by the installers at the location.

#### Location PEB 1.4 - InVesta - Current Status

The InVesta pilot is waiting for the last innovative technologies to arrive and be installed in the building (expected end of 2022). After that, the integration of these technologies with ReFlex is required.

### Faced Barriers and Lessons Learned (M0 - M38)

#### Location PEB 1.1 - De Meent

- Delays in the delivery of hardware due to lack of availability
- Availability of (skilled) people working on this use case

#### Location PEB1.3 - Bloemwijk

- Delays in the delivery of hardware due to lack of availability
- Availability of (skilled) people working on this use case
- The transformation of Bloemwijk is a large project on which this IE is dependent.



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Location PEB 1.4 - InVesta</b></p> <ul style="list-style-type: none"> <li>Delays in the delivery of hardware due to lack of availability</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><b>Next steps</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p><b>Location PEB 1.1. - De Meent</b></p> <ul style="list-style-type: none"> <li>The test and start operational phase where ReFlex will be piloted and control the battery according to the goals.</li> <li>Monitoring phase to collect KPI measurements</li> </ul> <p><b>Location PEB 1.3 - Bloemwijk</b></p> <ul style="list-style-type: none"> <li>Test and integrate with the hardware in the TNO lab.</li> <li>Define the optimization goals</li> <li>Plan the roll-out of the IE</li> <li>Demonstrate the IE</li> </ul> <p><b>Location PEB 1.4 - InVesta</b></p> <ul style="list-style-type: none"> <li>Development of implementation plan of connecting ReFlex with the hardware at the location</li> <li>Define the optimization goals.</li> <li>Plan the roll-out of the IE</li> <li>Demonstrate the IE</li> </ul>                                                                                                                                                                                                |
| <p><b>Connected IEs within ETTs</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>Location PEB 1.1. - De Meent</b></p> <ul style="list-style-type: none"> <li>This IE is connected to IE2.1.9 of Location De Meent. This IE describes the Virtual Power Plant (VPP) functionality that ReFlex provides.</li> <li>It is also connected with all the hardware related IE (e.g., PV, Battery) of PEB 1.1 De Meent</li> </ul> <p><b>Location PEB 1.3 - Bloemwijk</b></p> <ul style="list-style-type: none"> <li>This IE is connected to IE2.1.9 of Location Bloemwijk. This IE describes the Virtual Power Plant (VPP) functionality that ReFlex provides.</li> <li>IE 1.1.14 (Solar roofs and facades)</li> </ul> <p><b>Location PEB 1.4 - InVesta</b></p> <ul style="list-style-type: none"> <li>This IE is connected to:</li> <li>IE 1.1.14, Solar roofs and facades, describing the PV system</li> <li>IE 2.1.8 (Stationary battery)</li> <li>IE 2.1.9 of Location InVesta. This IE describes the Virtual Power Plant (VPP) functionality that ReFlex provides.</li> <li>IE 2.1.11 (DC grid)</li> </ul> |

#### 4.1.4 Demonstrating IE 2.1.8 - Stationary batteries

Stationary batteries, IE 2.1.8, are being demonstrated at four different pilot sites: PEB 1.1. - De Meent, PEB 1.2 - Woonwaard Highrise, PEB 1.3 - Bloemwijk and PEB 1.4 - InVesta. PEB 1.1 - De Meent has installed a battery of nominal capacity of 240 kWh, PEB 1.2 - Woonwaard Highrise has installed a Li-ion battery from the company iwel (i.e., the model Power Cube), with 32,5 kWh/35kW and 400 V, and PEB 1.3 - De Meent will install five LG RESU6.5 batteries at Bloemwijk dwellings. For each PEB a goal is to store locally produced



energy at the locations. The current state of the IE is listed in a separate table for each location. Each demonstration location is listed separately given the different types, implementation steps and current status vary.

Table 9: IE 2.1.8 - Stationary Batteries - Gemeente Alkmaar

| IE 2.1.8 - Li-ion Batteries - PEB 1.1 - De Meent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeable battery. Battery Energy Storage Systems (BESS) store electricity locally, for later consumption. The stored energy commonly originates from on-site solar photovoltaic panels, generated during daylight hours, and the stored electricity consumed after sundown, when domestic energy demand peaks in homes unoccupied during the day.</p> <p>A BESS can serve as a technology to reduce the amount of imported electricity, leading to a reduction of the associated CO<sub>2</sub> emissions. The battery is used to store energy originated from solar photovoltaic panels. The solar panels are present on the large roof above the 400 meters ice rink as well as more solar panels that are present on the structures above the car and bicycling parking lots. With a battery, monitoring and smart control (BEMS/CEMS), a complete smart grid can be realized to balance the produced electricity by the solar panels with demand installations like heat pumps (ATES) while excessive energy can be sold.</p> <p>The application of a battery has multiple advantages:</p> <ul style="list-style-type: none"> <li>• it can reduce the import of electricity from grid;</li> <li>• it can reduce the maximum peak load required from the electricity grid, making it possible to reduce grid congestion;</li> <li>• it can add flexibility to the electricity grid, so that the battery can respond to signals from either the market or the grid operator.</li> </ul> <p><b>DETAILS</b></p>  <p>Figure 17: Li-ion Battery at De Meent</p> |



The complete battery system contains a 1x 10-foot container with air conditioning and 8x 19" cabinets each equipped with 1x 30kW converter, 13 battery modules, and 1x Battery Management System.

The system is controlled and checked via the Storage Control System (SCS) that can be controlled with different protocols by an external aggregator. The SCS enables remote monitoring of the various functions of the system. Such as output or charged power, State of Charge (SoC) of the batteries etc. It is also possible to display the production of existing PV panels via the same interface and therefore also to display the ratio between purchased PV and battery energy; it is a containerised system.

The energy storage system is installed in a fully enclosed reefer container that integrates an industrial grade HVAC system that can cool, heat and de-humidify the system.



Figure 18: Energy Storage System at De Meent

#### DETAILS

Capacity: 240 kWh

Charging rate: 240kW max, 120kW advised

Efficiency complete cycle of charging and discharging: 96%

COST: Investment cost: € 203,000.00, Installation cost: € 5,000.00

#### DIMENSION

Size: 600 x 700 x 1800 mm (w x h x d) per battery rack

Weight: 75 kg per battery rack

Installation time: 1 month

Start-up time: 1 hour

#### SAFETY

No dendrite formation, no risk of spontaneous fire and explosion

Modules designed for 1500V, UN3480, UL2054

SUSTAINABILITY: Reefer container reuses, Electrodes can be recycled, Batteries get second life by Ateps.

Role of partners involved



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



- FIRAN (Alliander): the battery is the heart of the Grid Control Platform that Firan is developing for the Meent. They perform a various number of tests regarding charging and discharging, adjusting control mechanisms and algorithms
- NEROA: API connection with GridControl Platform regarding data delivery KPI/ CEMS
- TNO: connected to IE 2.1.7 - ReFlex

#### Progress achieved to M38

- Preparation of tender: Q4 2020,
- Award of tender: April 2021
- Realization: Summer 2021
- Implementation: September 2021.
- Operationalisation started, finetuning by Firan
- Monitoring (partly) has started



Figure 19: Li-ion Battery at De Meent

#### Faced Barriers and Lessons Learned (M0 - M38)

##### Lessons learned:

Margin of charge and discharge is narrow. 100% charge and discharge is according to Firan / Ateps not yet possible. That limits its use. In addition, it is needed for peak-shaving the demand and supply to the grid (already necessary and very important looking at the net congestion in Alkmaar).

Advice after an independent verification: placing a UBM400 near the inverter container is recommended to attenuate resonance and supra harmonic. The data from the UMG605pro in the procurement field is important for assessing long-term Power Quality. The recommendation is to make it available, in addition to checking that all parameters important at that point are logged.



A failure in the battery system was recently encountered. The failure encountered was caused by one converter being removed from the control system. As a result, 13 batteries came in at too low a voltage to be recharged in the storage system and were exchanged. Analysis is taking place at this moment what was the cause of this issue. A key advice is to check your fire insurance, since this is an important extra installation.

### Next steps

Finalizing the operationalization of the battery in connection with the grid control system of Firan. Full monitoring has to be started; we expect end 2022 - Q1 2023

### Connected IEs within ETTs

Directly connected to:

- IE 1.1.8 - HEMS/BEMS
- IE 1.1.14 - Solar roofs and facades
- IE 1.1.18 - Cascaded heatpumps
- IE 2.1.7 - Reflex (prev. PowerMatcher)
- IE 2.1.9 - Virtual Power Plant (VPP)
- IE 3.1.7 - Smart Solar Charging

## De Meent

Schematische weergave toekomstige situatie

Firan

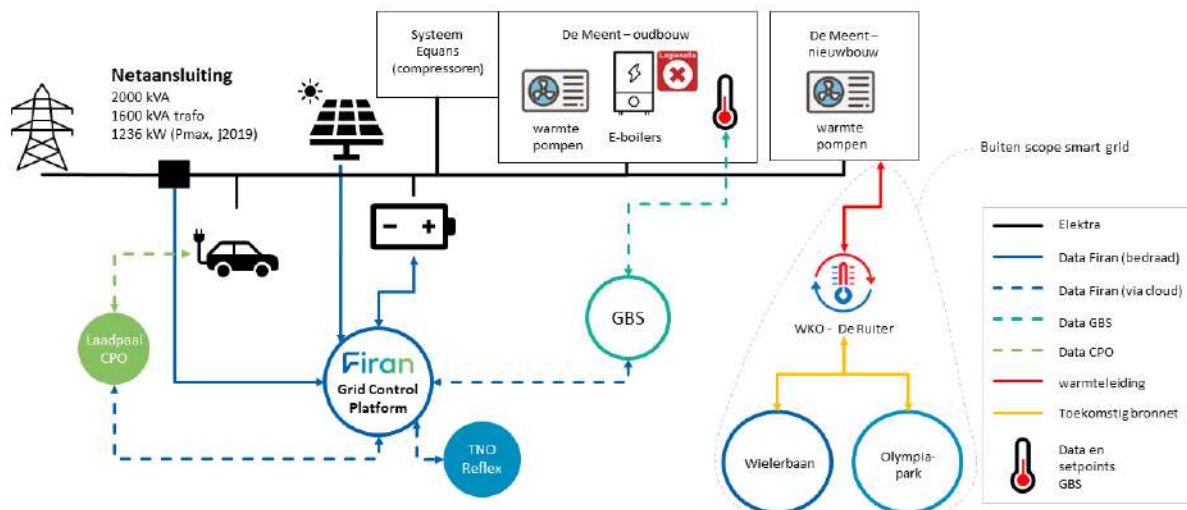


Figure 20: Overview of inteconnection of Li-ion Battery at De Meent



Table 10: IE 2.1.8 - Stationary Batteries - Woonwaard Highrise

| IE 2.1.8 - Li-ion Batteries - PEB 1.2 - Woonwaard Highrise                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p>The primary goal of installing the Li-ion batteries is storing locally produced electricity, to prevent the public electrical-grid to get overloaded, without having to lower the production capacity of the new solar-panel system. The Highrise building will have a total of 910 solar panels installed.</p> <p>In the preparation phase, a grid-check at Alliander led to the conclusion that the public electrical grid in the street could not handle the power that will be generated by these panels during peak moments.</p> <p>Although a part of the electricity will be used directly by the building itself (e.g., by the two elevators, the ventilation system, and internal lighting), the panels connected to the central building facilities will generate an amount of electricity that would lead to an overload of the local power grid.</p> <p>In the long-term Alliander is planning a newer and bigger power grid in this part of Alkmaar, but the timeline (in a couple of years) totally does not match with the plans and timeline Woonwaard has for this building.</p> <p>Curtailement of the solar panels would lead to a much lower effectiveness of the solar panel system because it will be forced to lower the production during the sunniest part of the day.</p> <p>In order to lower the chance that the system will overload the grid, Woonwaard will install two 60 kW Li-ion batteries. These two batteries will be able to store the amount of electricity the system produces during about two hours during the peak moments.</p> <p>Only after both the batteries are fully loaded, curtailement of the system will be the next step that will have to be taken. Placing the batteries will be able to ensure that curtailement will occur a lot less frequent.</p> <div data-bbox="668 1211 922 1749" data-label="Image"> </div> <p data-bbox="375 1767 1219 1800">Figure 21: Image of Li-ion battery to be installed at PEB 1.2 - Highrise</p> <p>In addition, there is a ‘mismatch’ between the moment that the maximum power is produced by the solar panels (around noon) in relation to the moment that the use of electricity of the building is at its maximum (approximately between 16:30 and 22:00 of the day).</p> |



Installing the batteries will provide grid flexibility in the building itself, but also to the main power grid. The batteries will ‘shave’ off the power peaks provided by the panels, by locally storing the excess electricity instead of delivering it back to the grid. Meanwhile, in the evening and during night-time, when there is no electricity production by the solar panels, the electricity used by the building will first be provided by the battery that was charged during daytime. At the moment, when the battery runs out of power, the electricity will be taken from the normal grid. In this way the batteries also contribute to ‘shave’ off a peak in the grid at the demand side.

### Technical specifications:

The Li-ion batteries Woonwaard is planning to install are from the company i-well, type Power Cube. Woonwaard will install two batteries of 30 kW (400V) each, in total 60 kW will be installed.

The storage capacity of the batteries is 32.5 kWh. each, in total 65 kWh. The size of one battery is about 70x60x80 cm and weighs about 500 kG.

In the future the battery system can be further expanded in steps of 30 kW, up to a maximum of 210 kW in housing as shown in .

At this moment the expectation is that installing the two batteries meet the technical necessity for the building.



Figure 22: Example of i-well battery expansion capabilities

### Role of partners involved

Woonwaard is in contact with partner Alliander about the net-congestion issues.

The final outcome of the discussions was that Alliander could not solve the problem within the requested timeframe. Alliander nevertheless is planning to increase the capacity of their grid over the coming years, outside the building as well as inside the building.

Woonwaard is working closely together with partner NEROA to arrange the installations that are necessary for monitoring the installations and reporting to the POCITYF project about the results of the IE. This information will be transferred to the POCITYF partner InHolland.

### Progress achieved to M38



The building permit for the solar panel system on the roof and façade was issued in August 2022.

The prices of steel and solar panels went frantically up during the last months, which led to an extra consultation round with the Woonwaard board to get extra budget. On the 25<sup>th</sup> of October the board approved the extra budget needed for this project and in the same week Woonwaard gave the order to the main contractor. Based on the latest planning, the first elements of the steel construction for the solar roof will be delivered in December 2022. The current planning is to have the entire installation, including the batteries operational in March 2023.

#### **Delivery of materials, equipment and technology:**

All the materials and equipment were ordered in week 43-2022.

Woonwaard's contractor is in close touch with the market-parties to make sure that all the materials and equipment is delivered in time to match with the designed planning. At the moment of writing this deliverable, Woonwaard still is not 100% sure this will be the case but will put in the best effort to stick to the planning.

#### **Planning and monitoring:**

When all the installations and materials are available, Woonwaard will commence with the mounting of the steel construction for the panels on the building as soon as possible.

As mentioned above, Woonwaard plans to have everything ready in March 2023. That also will be the moment that will start the monitoring phase of the solar panels and the batteries.

#### **Faced Barriers and Lessons Learned (M0 - M38)**

- The cabling inside the building is from the 1970's and will have difficulties to cope with distributing the electricity of the panels to the individuals' homes. However, by laying out a big puzzle about how to connect the solar panels with different orientations to different parts of the cabling inside the building, this problem could be solved.
- Woonwaard has already installed about 15 smaller i-well batteries (15 kW) in their other apartment buildings. For these smaller batteries Woonwaard and i-well use a lease-construction. From the beginning it is unsure if these bigger batteries could be part of the same construction. Recently, it turned out that the lease construction being used for the small batteries, will not be applicable for these bigger ones. As a result of that Woonwaard will buy the batteries instead of leasing them.
- The battery system will be placed in the basement of the building, near the point where the central connection to the electrical grid enters the building.
- According to the building regulations in the Netherlands, when a battery of over 50 kW is installed inside a building, extra measures for fire prevention have to be taken. Instead of the one battery initially planned (35kW) Woonwaard will now have to install two batteries of 30 kW each (in total 60 kW). This forces Woonwaard to take extra measures to meet with these regulations.
- The price of the batteries itself as well as the extra fire prevention measures needed, leads to a plan that at this moment will not be financially interesting for commercial organizations or private individuals.
- Housing corporations on the other hand have a longer outlook and a longer depreciation period for these kinds of investments. At this moment the limits of the public power grid sometimes prevent corporations from making their buildings more sustainable, not only in Alkmaar, but in



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| large parts of the Netherlands. So as part of the solution, housing corporations probably will be more willing to put these kinds of investments for battery-solutions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Next steps</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Woonwaard plans to start with the steel construction for the solar panels on the roof of the building in December 2022.</li> <li>• Depending on the delivery-date, the solar panels will be mounted as soon as possible after that in December 2022 and January 2023.</li> <li>• In the meantime, Woonwaard will start with the cabling for the solar panels and preparing the grid for the two batteries.</li> </ul> <p>If the planning comes together, the construction works, and the electrical installations will be ready and operational in March 2023. That will also be estimated starting moment of the monitoring.</p>                                                                                                                                               |
| <b>Connected IEs within ETTs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• The installations on the Highrise building are not connected to other innovative elements within POCITYF.</li> <li>• The goal of this IE, the Li-ion batteries was to solve a local issue with the electrical grid which could not cope with the electricity generated by our new solar power system.</li> <li>• The building is connected to the public power grid and in a way it balances the generation and use of power by the building as a whole; shaving off the peaks on the delivery-side as well as on the demand-side.</li> </ul> <p>Within the location itself, the interventions in the building combine the circular roofing material under ETT#1, the lifted solar roof also under ETT#1 and the installation of these two Li-ion batteries, part of ETT#2.</p> |

Table 11: IE 2.1.8- Stationary Batteries - Van Alckmaer

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| <b>IE 2.1.8 - Li-ion Batteries - PEB 1.3 - Bloemwijk</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Goal and Description of IE at the PEB</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>The goal of the innovative element to be installed in Bloemwijk is to increase the direct use of local produced solar energy and to avoid feeding local produced solar energy into the grid. Furthermore, to increase the direct use of local produced solar energy and to avoid feeding local produced solar energy into the grid. Batteries maximise electricity-demand flexibility. This reduces power peaks in the grid and helps to minimise the risk of exceeding the power capacity of the grid (connected to IE 1.1.14 - Solar roofs and facades (VA)) and loss of produced solar electricity.</p> <p>In dwellings like the ones in Bloemwijk (with 6,7 kWp of installed solar power) the solar electricity is only for approx. 20-30% self-consumption (avoiding purchasing from the grid) and 80-70% is directly fed into the grid. The current financial compensation for feeding into the grid is less than the kWh that the cost for electricity from the grid. Together with the Dutch intention to reduce the financial compensation for feeding into the grid (afbouw salderingsregeling) the coming years, increasing self-consumption becomes more interesting.</p> |



Concluding, batteries help to increase the financial benefit from local produced energy, avoid peaks in the electricity grid and increase the flexibility in time to use and store electricity.



Figure 23: Representation of the rebuilt dwellings of PEB 1.3 Bloemwijk

shows the Bloemwijk area and the rebuilt dwellings. Type C represents the small single family houses to be equipped with Li-ion batteries.

Five houses in Bloemwijk will be equipped with Li-ion batteries, each with 6.5 kWh capacity. The batteries will be LG RESU 6.5 ( ) and the technical specifications are listed in the table below (but current availability will define the brand and type at the end):





Figure 24: Example of a potential battery to be installed

| Models                       |         | RESU3.3         | RESU6.5                                   |
|------------------------------|---------|-----------------|-------------------------------------------|
| Total Energy [kWh]           |         | 3.3             | 6.5                                       |
| Usable Energy [kWh]          |         | 2.9             | 5.9                                       |
| Capacity [Ah]                |         | 63              | 126                                       |
| Nominal Voltage [V]          |         | 51.8            | 51.8                                      |
| Voltage Range [V]            |         | 42.0-58.8       | 42.0-58.8                                 |
| Max Power [kW]               |         | 3.0             | 4.2                                       |
| Peak Power [kW] (for 3 sec.) |         | 3.3             | 4.6                                       |
| Dimension [W x H x D, mm]    |         | 452 x 401 x 120 | 452 x 654 x 120                           |
| Weight [kg]                  |         | 31              | 52                                        |
| Enclosure Protection Rating  |         |                 | IP55                                      |
| Communication                |         |                 | CAN 2.0 B                                 |
| Certificates                 | Cell    |                 | UL1642                                    |
|                              | Product |                 | UL1973 / TUV (IEC 62619) / CE / FCC / RCM |

Figure 25: Technical specifications LG RESU 6.5

Role of partners involved

Van Alckmaer is involved as housing corporation that contracts a builder who installs the batteries.

Progress achieved to M38

The installation of the IE is currently in progress. However, the batteries are being delivered later due to reduced availability. Confirmation of the order is still outstanding.





Figure 26: Construction site of houses in Bloemwijk

#### Faced Barriers and Lessons Learned (M0 - M38)

A key challenge for this IE is the availability, but als the unknown benefit of applying batteries in practice, due to the application not being common yet. Finding more and new ways to benefit from the storage is necessary.

#### Next steps

- Following the purchasing of the batteries, the next step is to receive confirmation of the order and have the batteries delivered.  
After delivery, the batteries need to be installed, after which the set up can be tested.

#### Connected IEs within ETTs

- The batteries installed in the five houses at Bloemwijk and may be later linked to IE 2.1.5 - P2P energy trading and used for energy flexibility which is also connected to IE 2.1.7 - ReFlex (prev. PowerMatcher).

Table 12: IE 2.1.8- Stationary Batteries - InVesta



## IE 2.1.8 - Stationary battery - PEB 1.4. - InVesta

### Goal and Description of IE at the PEB

Due to the intermittent nature of Renewable Energy Sources (RES) such as solar and wind, and the fluctuating demand of energy, there is a need to temporarily store energy to balance the system. Through the application of a stationary battery, overproduced electricity from the various solar panels during times of peak production (or low electricity demand) is temporarily stored and discharged during peak electricity demand (or low production). With the demonstration of this a stationary battery (IE 2.1.8), at InVesta's center of expertise (PEB 1.4), InVesta maximizes its own usage of produced electricity and minimizes the need of electricity from the electricity grid.

Multiple potential stationary batteries have been explored on which more information is provided in 'progress achieved to M38' and 'faced barriers and lessons learned'. On the 29<sup>th</sup> of November 2022, New Energy Coalition initiated a meeting with InVesta, Indutecc (potential technology provider) and other stakeholders to determine the preferred option. Based on this meeting, InVesta will likely order a 90 kWh Pylontech (LifePO4) (see Figure 27) battery for which InVesta intends to get a board approval before the end of 2023. After the likely approval of InVesta's board, the order will be given to Indutecc to purchase the stationary battery. A description and detailed specification of the likely to be ordered stationary battery can be found below. As indicated in the description below, the proposed stationary battery can be connected to the solar panels (IE 1.1.14 - Solar roofs and facades) and EV Charger (IE 3.1.7 - Smart Solar Charging) via an internal DC Grid (IE 2.1.11) through the so called Ferroamp EnergyHub XL that optimizes that energy flows (IE 1.1.8 - Building energy management system).

#### Pylontech Energy Storage

81 kWh / 36 kW

#### Multi-purpose energy storage

- Fully compatible with the EnergyHub system
- Safe LiFePO4 technology
- Long life, +4000 cycles
- Integrated 36 kWDC/DC converter
- Parallel cabinet operation for more capacity



#### DC coupled energy storage

The Pylontech Energy Storage cabinet with storage capacity 81 kWh and power capacity up to 36 kW connects directly to your EnergyHub DC nanogrid. The versatile storage can be configured to achieve combined functions such as reducing peak power cost, enable faster Electric Vehicle charging and maximizing self-consumption of PV energy.

| DC coupled energy storage                                |                                                                                                                |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Pylontech 81/36                                          |                                                                                                                |
| Battery                                                  |                                                                                                                |
| Storage capacity, $W_{\text{WH}}$                        | 90 kWh                                                                                                         |
| Usable capacity @ 90% DoD                                | 81 kWh                                                                                                         |
| Maximum power rating, $P_{\text{MAX}}$                   | 36 kW                                                                                                          |
| Nominal battery voltage, $V_{\text{NOM}}$                | 608 V                                                                                                          |
| Maximum cont. battery charge current, $I_{\text{CC}}$    | 60 A                                                                                                           |
| Maximum cont. battery discharge current, $I_{\text{CD}}$ | 60 A                                                                                                           |
| Electrical roundtrip efficiency incl. DC/DC converter    | 93 % typical                                                                                                   |
| Cycle life <sup>1)</sup>                                 | 4000 cycles @ 80% DoD, EOL capacity 80%                                                                        |
| Cell chemistry                                           | LiFePO4                                                                                                        |
| Maximum battery potential to ground                      | 1000 Vpk                                                                                                       |
| Battery fuses                                            | 20 A, 1000 V, 10x38 mm gPV                                                                                     |
| SOC precision                                            | ± 5 %                                                                                                          |
| Standby consumption incl. DC/DC converters               | ≤ 20 W                                                                                                         |
| Protection functions                                     | Over voltage, over temperature, over current, isolation fault, pre-charge protection, short-circuit protection |
| DC nanogrid                                              |                                                                                                                |
| Number of included ESO DC/DC converters                  | 6                                                                                                              |
| DC bus voltage, $V_{\text{DC}}$                          | 760 V (nominal)                                                                                                |
| DC bus voltage range, $V_{\text{DC}}$                    | 720 - 800                                                                                                      |
| Maximum DC bus current, $I_{\text{CCMAX}}$               | 64 A                                                                                                           |
| DC bus connection                                        | 3-wire [L+, L-, PE]                                                                                            |
| DC bus communication                                     | Narrow band power line communication (PLC)                                                                     |
| Physical                                                 |                                                                                                                |
| Dimensions H x W x D                                     | 2130 x 815 x 659 mm                                                                                            |
| Weight                                                   | 1060 kg                                                                                                        |
| Color                                                    | Black                                                                                                          |
| Installation                                             |                                                                                                                |
| Ambient temperature <sup>2)</sup>                        | 0°C - 40°C                                                                                                     |
| Humidity                                                 | 10 - 90% RH non-condensing                                                                                     |
| Degree of protection                                     | IP 20                                                                                                          |
| BMS Power supply                                         | 230 VAC                                                                                                        |
| Compliance                                               |                                                                                                                |
| Battery safety                                           | EN 62619, UN38.3                                                                                               |
| LVD                                                      | EN 62477-1                                                                                                     |
| EMC                                                      | EN 61000-6-3, EN 61000-6-2                                                                                     |

Figure 27: Technical specifications of Pylontech Energy Storage battery)

### Role of partners involved

- InVesta - PEB owner and responsible POCITYF partner for the implementation and demonstration of this innovative element.



- NEC - Co-writing the ‘program requirements’ to guarantee the POCITYF scope is sufficiently incorporated in the energy system. NEC also explores potential technologies and technology providers that fit the above-described scope (as well as the POCITYF Grant Agreement).
- Municipality of Alkmaar - Co-writing the ‘program requirements’ for the energy system of InVesta’s center of expertise

#### Progress achieved to M38

InVesta is on the verge to order the 90 kWh Pylontech stationary battery system. Other potential stationary systems have been explored but were renounced due to financial reasons, delivery times and/or lack of interfaces with the Ferroamp EnergyHub (that controls and optimizes electricity flows).

##### 1. Preparation phase

This phase started right after the formal agreement that InVesta would replace Duurzaam Bouwloket as a partner to the POCITYF consortium. As elaborated upon in the ‘faced barriers and lessons learned’ section, InVesta with the help of New Energy Coalition explored multiple potential stationary battery systems. With the (preliminary) determination to opt for the Pylontech option, the board of InVesta now first have to agree on the purchase of the battery which is expected to be agreed upon in the month of December 2022.

##### 2. Delivery of the materials, equipment and technology

No exact date can be given by Indutecc on the delivery of the proposed energy storage system. A rough estimation is that the installation will be delivered in the summer of 2023.

##### 3. Installation/implementation of the innovative element

If the battery system is delivered in the summer of 2023, it is expected that the technology could be installed within two months of delivery.

##### 4. Operationalization phase

Again, assuming the battery is delivered in the summer of 2023, it is expected that the technology will become operational within one month of the installation date.

##### 5. Monitoring phase

The monitoring period is expected to start in the third quarter of 2023.

#### Faced barriers and lessons learned

Initially InVesta planned to demonstrate a Nickel Metal Hydride (NiMH) battery as advised by Indutecc due its superior sustainability, circularity and performance characteristics. However, due to a scarcity of materials resulting in delivery times being delayed (without any guarantees this would be the maximum delay), the decision was made to explore other options.

In total, InVesta together with New Energy Coalition and Indutecc thoroughly explored and analyzed the following battery types that were ultimately not ordered:

- Lithium-ion
- LiNMC (Lithium Nickel Manganese Cobalt Oxide)
- Titanium
- Flow battery

Three main barriers were encountered by InVesta when it comes to the demonstration of a stationary battery:

- Stationary batteries, albeit widely regarded as a key solution to avoid or mitigate grid congestions issues, are currently very expensive. Investment costs often come close to €1000/kWh (storage



capacity). Since it was agreed upon, as part of latest Amendment, that InVesta would install a significant battery (storage capacity of +/- 100 kWh), the investment costs is approximately €100,000.00

- The delay in delivery times of stationary batteries is the second barrier that was faced by InVesta (e.g., for the NiMH battery). Due to geopolitical instabilities in the world, high demand in energy storage systems, and rare and critical materials being required for the development of stationary batteries, delivery times have increased significantly.
- Finally, since an integrated electricity (and heating & cooling) will be realized at InVesta there is a need for an energy management system that optimizes energy flows. In the case of InVesta, a Ferroamp EnergyHub system, ordered via Indutecc, will be installed. However, to monitor and ultimately optimize energy flows going in and out the battery it is of importance that the software of the battery has to be aligned to the software of the Ferroamp system. For multiple batteries it would take a significant amount of time before the systems can 'talk to each other' which leads to longer delays. This ultimately resulted to the final determination to opt for the Pylontech stationary battery as these batteries are the only type that can currently be connected to the Ferroamp EnergyHub.

### Next steps

As delineated above, the most pressing next step is to order for the Pylontech battery. The following action points were the outcome of the meeting between InVesta, New Energy Coalition, Indutecc and other parties involved:

- Indutecc will reserve the order for the Pylontech stationary battery to speed up the process once the final go of InVesta is given
- Indutecc will update that latest financial proposal
- InVesta will ask for approval from its board for the final proposal, which is hopefully given before the end of 2022.

Once the order has been approved, the focus shifts towards the smooth integration of the stationary battery with the Ferroamp EnergyHub (and solar panels & EV charger(s)). For this phase the installer, Klaver Giant, will be instructed on the implementation and integration of the stationary battery (with guidance from Indutecc). As already indicated, a rough estimation on the process is that the battery will be delivered and installed in the summer of 2023.

Once the battery system is installed and running, the phase of monitoring the performance of the energy system at InVesta's center of expertise will be carried out.

### Connected IEs with ETTs

The stationary battery is connected to the regular PV-, Building Integrated PV (BIPV)- and Photovoltaic Thermal (PVT) panels (IE 1.1.14 - Solar roofs and facades) that produce energy to charge the stationary battery. Also, the stationary battery is connected to the electronic devices, such as the (smart DC) EV chargers (IE 3.1.7 - Smart Solar Charging) and water/water heat pump, that consume the stored and discharged electricity from the stationary battery. The energy flows are monitored and optimized by a Ferroamp EnergyHub XL, a building energy management system (IE 1.1.8 - BEMS), in which the innovative elements within POCITYF are connected through an internal direct current (DC) grid (IE 2.1.11 - DC grid).



### 4.1.5 Demonstrating IE 2.1.9 - Virtual Power Plant (VPP)

The IE 2.1.9 - Virtual Power Plant (VPP) is connected to the IE 2.1.7 - ReFlex (prev. PowerMatcher). This will be demonstrated within PEB 1.1 - De Meent. In order to create the VPP, different energy generating devices as well as energy storage devices are connected digitally together. As a whole they will act as a power plant for De Meent and in times of energy excess also for surrounding areas.

Table 13: IE 2.1.9 - Virtual Power Plant

| IE 2.1.9 - Virtual Power Plant                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>A virtual power plant is an aggregation of capacities of heterogeneous distributed energy resources (RES). Where a power plant is usually a single system that produces power, a virtual powerplant combines the power of several smaller units into a virtual one and by connecting them digitally they can act as a real one.</p> <p>In the context of POCITYF this mechanism is implemented by TNO's ReFlex tool. ReFlex has the ability to run in different modes of which one is a Virtual Power Plant. For more information on how ReFlex is used in the different pilots, please see IE2.1.7 - ReFlex (form. PowerMatcher).</p> <p>For information on IE 2.1.9 - VPP, please see <a href="#">Chapter 4.1.3</a> - Demonstrating IE 2.1.7 - ReFlex (form. PowerMatcher).</p> <p>IE 2.1.9 - VPP will be demonstrated at PEB 1.1 - De Meent and PEB 1.3 - Bloemwijk.</p> |

### 4.1.6 Demonstrating IE 2.1.11 - DC grid (with smart lampposts)

The IE 2.1.11 - DC grid (with smart lampposts) will be operated in the Oranjebuurt area. Gemeente Alkmaar will provide a description below regarding the current status. For PED 1.4 - InVesta will provide an overview of the current status.

Table 14: IE 2.1.11 - DC grid (with smart lampposts) - Gemeente Alkmaar

| IE 2.1.11 - DC grid (with smart lampposts) - PED Westrand                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PED                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p>In Oranjebuurt a fully operating DC grid is installed, consisting of 92 DC lampposts. As the technology of the smart lamppost in the pre-pilot Rietland was not properly in operation and the smart LED drivers inside the lampposts were malfunctioning, the lampposts in Oranjebuurt do not have these (expensive) prototypes of smart LED drivers.</p> <p>Main priority for the pilot is stability of the DC grid of Oranjebuurt. The lampposts are being monitored as a group monitored by their grid to ensure they are functioning correctly, but the lampposts cannot be monitored individually. Communication and continuous DC feeding over the cabling will be tested as well in Oranjebuurt.</p> <p>In Oranjebuurt the DC technology inside the lamppost is from Schreder. The electronics located in the feeding cabinet are from Phoenix. A reason to choose another supplier than in the pre pilot is to gain experience with two suppliers in order to have more competition in the future. The suppliers can learn and the technology can evolve faster in this way.</p> <p>The existing poles of the lampposts are being re-used, these are tapered poles with a 4 meter height.</p> |



The LED lamps of the lampposts will be from the Schreder, type Friza ( )



Figure 28: Example of Solarlamp to be installed

The cable used in Oranjebuurt consist of 4 wires with 4mm<sup>2</sup>. These wires are thicker than needed for a DC grid, but temporary it was necessary to still use the grid as AC with a limited amount of AC fed lampposts.

In Oranjebuurt there are three cables installed (three chains) each with approx. 30 lampposts; see . The cable length of each chain is approx. 1600 meter.

The demonstration area is 'Oranjebuurt' and not Bloemwijk, due to the fact that the Bloemwijk area will be renewed completely and public lighting is one of the last public facilities to be installed, after all houses are built and heavy construction traffic is gone. The planning for Bloemwijk is that the installation of the public lighting would happen in 2025, which will be too late for the POCITYF project. Oranjebuurt is a small area where the Municipality of Alkmaar needed and foresaw to renew the lamppost grid.

The goal of this pilot is to have experience with a successful DC grid with lampposts. No smart LED drivers will be installed in Oranjebuurt.



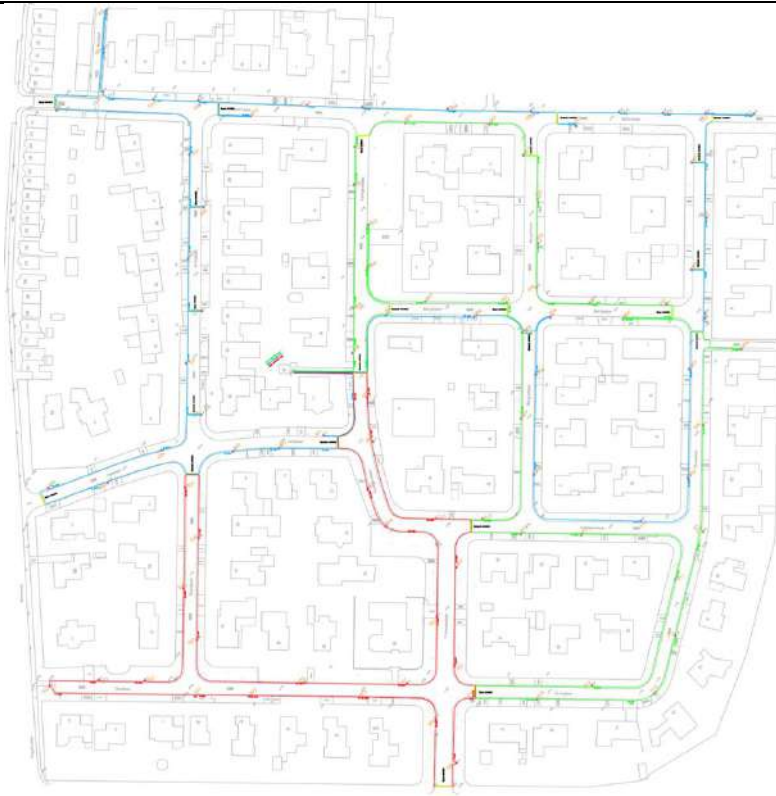


Figure 29: Overview of area of installation



Figure 30: Physical implementation in neighborhood



|                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                            |
| Role of partners involved                                                                                                                                                                                                                                                                                  |
| Gemeente Alkmaar is leading the implementation of this IE                                                                                                                                                                                                                                                  |
| Progress achieved to M38                                                                                                                                                                                                                                                                                   |
| <ul style="list-style-type: none"> <li>• IE is implemented in Q1 2021 and fully operational.</li> <li>• Monitoring has been an issue. Since the data is static and a separate meter was expensive and difficult to put in the feeding cabinet it was decided to not constantly monitor this IE.</li> </ul> |
| Faced Barriers and Lessons Learned (M0 - M38)                                                                                                                                                                                                                                                              |
| The technology used in the pre-pilot Rietland of the supplier DC Current was not functioning correctly. Therefore the Municipality of Alkmaar has decided to continue at the Oranjestraat with the company Schreder.                                                                                       |
| Next steps                                                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>• Only monitoring activities</li> </ul>                                                                                                                                                                                                                             |
| Connected IEs within ETTs                                                                                                                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>• NA</li> </ul>                                                                                                                                                                                                                                                     |

Table 15: IE 2.1.11 - DC grid - InVesta

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IE 2.1.11 - DC Grid - PEB 1.4 InVesta</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p>Traditionally, electricity is transmitted and distributed through the high-, medium-, and low-voltage power lines via alternating current (AC) electric power. However, many electronic devices operate on direct current (DC) electric power. This results in the need for multiple AC/DC conversion steps that entail significant energy losses. Also, Renewable Energy Sources (RES) - such as wind and solar - and Energy Storage Systems (ESS)- such as stationary batteries - operate on DC electric power as well. Nowadays, the sustainable generated DC electricity is first converted to AC for distribution after which it is converted back to DC for many electronic devices, with additional conversions being made once a battery is integrated (as displayed below, Figure 31).</p> |



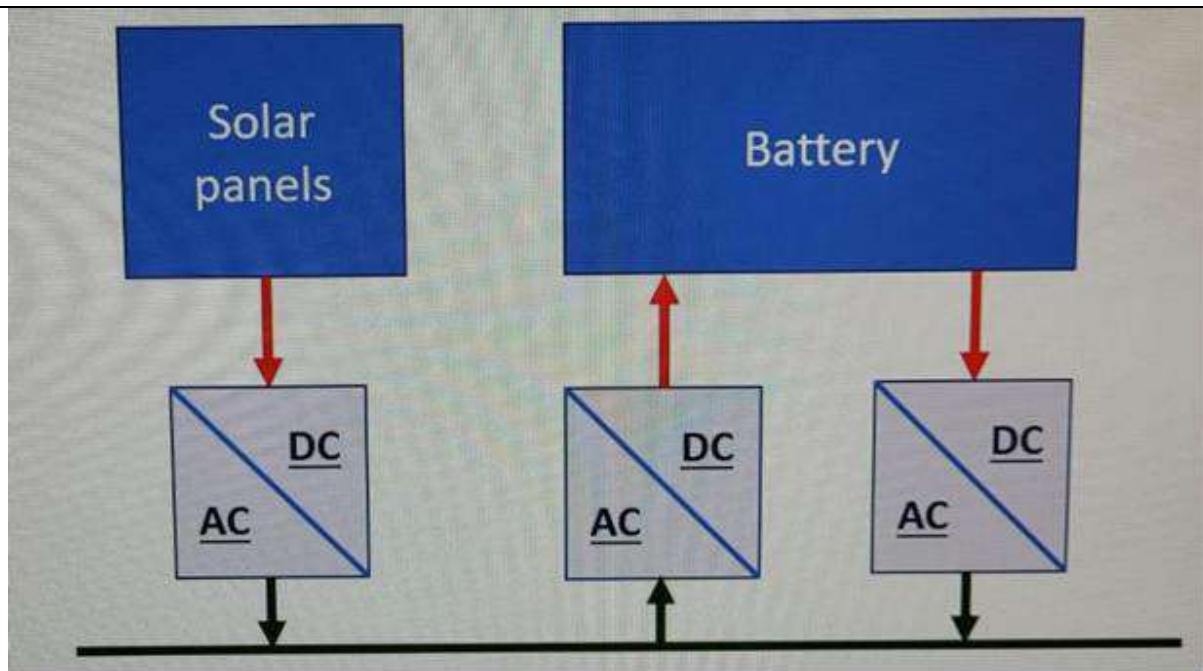


Figure 31: Display of electricity conversion

Depending on the total number of conversions this could result in 20% energy losses. To mitigate these entailed energy losses, the aim of this specific innovative (IE 2.1.11) is to demonstrate an internal DC circuit at InVesta's center of expertise (PEB 1.4). The use case of InVesta comprises a variety of innovative solar panels (thus RES), a stationary battery (thus ESS) and EV chargers (thus electronic devices), and therefore, suits perfectly for an internal DC grid.

The following innovative elements that will be demonstrated at InVesta will be connected by an internal DC grid:

- **IE 1.1.14 - Solar roofs and facades**
  - 120 regular PV panels with an estimated annual electricity production of 47 MWh
  - 24 Photovoltaic thermal (PVT) panels with an estimated annual electricity and thermal energy (heat) production of respectively of 7 MWh and 48 GJ.
  - 50 m<sup>2</sup> of Building Integrated PV (BIPV) panels with an estimated annual electricity production of 6 MWh
- **IE 2.1.8 - Stationary battery**
  - 1 stationary battery, type has yet to be determined with a storage capacity of approximately 100 kWh
- **IE 3.1.5 - Smart Solar Charging**
  - 1 DC EV charger, type has yet to be determined, with a charging capacity of 11 or 22 kW

More information of these connected innovative elements is found in the dedicated section on IE 1.1.14 (solar roofs and facades) in D7.5, IE 2.1.8 (Stationary battery) in this deliverable and IE 3.1.5 (Smart Solar Charging) in D7.9.

The energy flows of the internal DC grid will be monitored and optimized by a FerroAmp EnergyHub XL that will be operate as the heart of the energy system. In terms of POCITYF, this technology corresponds with IE 1.1.8 - Building energy management system (BEMS) and IE 2.1.7 - ReFlex. The internal, or nano,



DC grid will operate parallel and in connection to a standard alternating current (AC) grid. A description and detailed specifications on this Ferroamp EnergyHub XL can be found below (Figure 32):

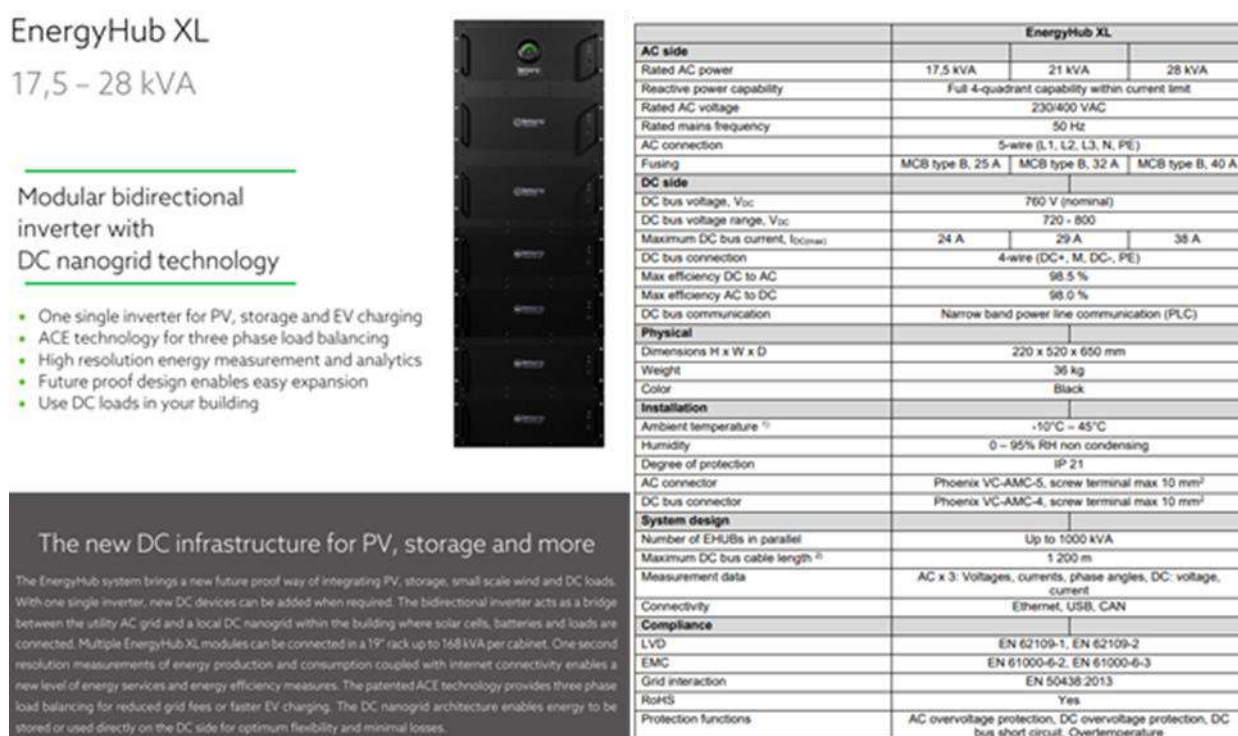


Figure 32: Specifications of EnergyHub XL

#### Role of partners involved

- InVesta - PEB owner and responsible POCITYF partner for the implementation of this innovative element.
- NEC - Co-writing the 'program requirements' to guarantee the POCITYF scope is sufficiently incorporated in the energy system.
- GA - Co-writing the 'program requirements'.

#### Progress achieved to M38

By November 2022, the configuration has been made to connect the solar panels, stationary battery and (smart) EV charging point via an internal direct current (DC) grid at InVesta. As said, the Ferroamp EnergyHub XL forms the heart of these connections and will be installed in January 2023. With regard to the solar panels, the regular PV panels were installed in August 2022, and the building integrated PV (BIPV) panels and PVT panels are expected to be installed by the end of January 2023.

##### 1. Preparation phase

This phase started right after the formal agreement that InVesta would replace Duurzaam Bouwloket as a partner in the POCITYF consortium. This phase firstly consisted of writing the 'program requirements' of the energy system to match the needs of POCITYF. Secondly, the phase comprised the identification of potential technologies that could be connected through an internal DC grid. No final determination on the battery and smart EV charger have been made yet.

##### 2. Delivery of the materials, equipment and technology



So far only the regular solar panels and PVT panels are delivered (July 2022). The Ferroamp EnergyHub and BIPV panels are expected to be delivered in December 2022. InVesta aims to have both, the smart EV charger and stationary battery, to be delivered in the summer of 2023.

### 3. Installation/implementation of the innovative element

The regular solar panels are in place since August 2022. The PVT panels are expected to be installed by the end of November, and the BIPV panels and Ferroamp energy system in Q1 2023. This system will be further extended with the installment of the battery and EV charger (hopefully) in the course of Q3 2023.

### 4. Operationalization phase

The first phase of the internal DC grid, connecting the solar panels to the EnergyHub, is expected to be operational in the course of Q2 2023. The final extension of the system, also connecting the battery and smart DC EV charger, is expected to be operational by the end of Q3 2023.

### 5. Monitoring phase

The monitoring period is expected to start once the Ferroamp EnergyHub and solar panels are installed and operational (end of spring 2023). The final configuration of the internal DC grid, with the connection to the stationary battery and smart DC EV charger, can be monitored from Q3 2023 onwards.

## Faced barriers and lessons learned (M0 to M38)

The first barrier that was faced by InVesta was the ‘lack of’ electronic devices that could be connected to the internal DC grid. Initially, also ventilation and LED lighting were planned to be connected directly to the internal DC grid. However, it appeared that despite these electronic devices operating on DC electric power they could only be fed by AC with a follow-up AC/DC conversion within the installations themselves. At this moment in time, technology providers are still hesitant to develop installations that directly operate on DC since AC is still the standard. Nonetheless, with the incorporation of the solar panels, stationary battery and smart EV charger, the internal DC grid does cover RES, ESS and an electronic device.

The second barrier that still has to be overcome is the final determination of the, to be ordered, stationary battery and smart DC EV chargers. More information on this can be found in the dedicated section on the stationary battery (IE 2.1.8) in this deliverable and Smart Solar Charging (IE 3.1.4) in D7.9.

The third and final barrier, that also still must be overcome, is the issue of grid congestion. As a result of growing demand and supply of renewable electricity, the grid capacity has reached its limits. A growing number of regions within the Netherlands, including the Boekelermeer in Alkmaar where InVesta is situated, cannot connect new premises with a relatively high electricity demand and/or electricity feed-in to the electricity grid. Since the center of expertise will host multiple demonstration projects with a significant electricity demand, InVesta also encounters this issue. Multiple solutions are currently being explored, in which one of them is being pursued further together with a regional heat operator (HVC) and distribution system operator (Liander).

## Next steps

Multiple steps still must be taken for the implementation of the DC grid at InVesta’s center of expertise. At this moment in time only the regular PV panels are installed, and the PVT panels are delivered and ready to be installed by the end of November 2022. The BIPV and Ferroamp EnergyHub are expected to be delivered in December 2022 and are planned to be installed in January 2023. No final decision has been



made on the to be ordered stationary battery (IE 2.2.8) and DC smart solar charging unit (IE 3.1.4) as elaborated upon in the dedicated sections within this deliverable (for IE 2.2.8) and D7.9 (for IE 3.1.4).

Furthermore, a connection to the electricity grid has to be established before the system can become operational. As a result of the grid congestion, InVesta is currently operating on construction power. It is expected that by the end of spring of 2023 a grid connection can be established by which also the solar panels and Ferroamp EnergyHub can become operational. This establishment of a grid connection will also be the starting point of the monitoring phase in which the performance of the (energy) system will be monitored. Note that the operationalization phase will be expanded with the integration of the stationary battery and (smart) DC EV charger at a later stage (Q3 2023).

#### Connected IEs with ETTs

As delineated above, the internal DC grid (IE 2.1.11) at InVesta connects the following other Innovative Elements being demonstrated at InVesta's center of expertise (PED 1.4):

- IE 1.1.14 - Solar roofs and facades
- IE 2.1.8 - Stationary battery
- IE 3.1.4 - Smart Solar Charging

The oval system is being monitored and optimized by the Ferroamp EnergyHub XL (IE 1.1.8 - Building Energy Management System (BEMS)).

### 4.1.7 Demonstrating IE 2.1.12 - Fuel cell (hydrogen)

InVesta will provide an overview of the past, ongoing and future developments and the respective achievement to be accomplished by the end of the project. The table below describes the demonstration activities until the time of the deliverable.

Table 16: IE 2.1.12 - Fuel Cell (hydrogen)

| IE 2.1.12 - Fuel Cell (hydrogen) - PEB 1.4 - InVesta                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>Most dwellings and buildings can become (more) sustainable through the electrification of the heating (and cooling) system or by connecting them to regional heating grid. However, some dwellings and buildings are less suitable for these technologies due to the absence of a nearby heating grid or due to poor insulation values of the building's envelope. Furthermore, the electrification puts additional pressure on the electricity grids that more often result in grid congestion in which no new (large-scale) connections to the electricity grid can be made.</p> <p>For these houses and buildings hydrogen can provide an alternative solution for the energy provisioning. The fuel cell is such a technology in which hydrogen is being used to provide electricity (and residual heat). The goal of this innovative element (IE) is to demonstrate an alternative method of energy provisioning based on a renewable energy carrier, in this case hydrogen. The IE is planned to be tested and/or demonstrated at InVesta's center of expertise (PEB 1.4).</p> <p>In the specific case of InVesta, the generation and application of hydrogen is part of the core business as InVesta focuses on the development and commercialization of green molecules (such as green gas and hydrogen). The demonstration of a hydrogen solution might not directly solve a building related issue (the building is well insulated) but merely fits the development and commercialization of hydrogen as an energy carrier as part of the anticipated H2HUB of InVesta. This anticipated H2HUB is comprised of a</p> |



hydrogen infrastructure (pipelines, storage vessel, compressor and hydrogen fueling facility) and pilot and demonstration projects that produce and consume hydrogen.

The technical specifications of the IE to be demonstrated technology cannot yet be provided since no decision has been made on the final technological configuration. One potential solution is to demonstrate a hydrogen fuel cell in which hydrogen is used to provide electricity and heat to InVesta's center of expertise. However, the application of a hydrogen fuel cell requires a broader hydrogen infrastructure with a production facility, compressor and storage unit, or external hydrogen supply. It is unsure whether such an infrastructure as part of the anticipated H2HUB will be in place by the time the hydrogen fuel cell should be implemented. Therefore, the preferred solution would be to install a stand-alone solution that makes the further need for a broader hydrogen infrastructure redundant.

A potential stand-alone technology is being developed by Hydrogen Powered Solutions (H2PS). H2PS develops a hydrogen generator, 'Hydrogen power unit' (HPU), in which the generated hydrogen could directly be used for heating provisioning through a (hydrogen) boiler. The hydrogen can be mixed with natural gas but ideally forms the input to boiler without the natural gas. The technology is schematically displayed in the representation below. It should be noted that this technology solely serves the heating demand and does not complement electricity provisioning of dwellings or buildings which would be the case with a hydrogen fuel cell.

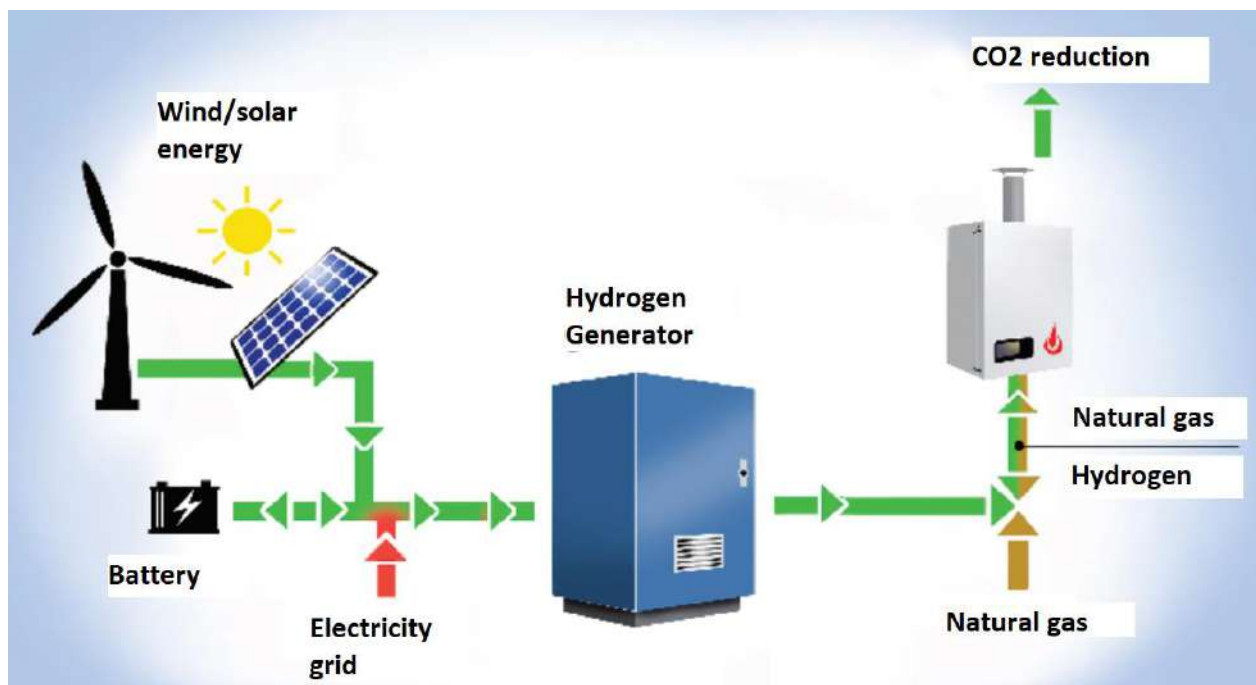


Figure 33: Visualization of Fuel Cell (Hydrogen) at InVesta





Figure 34: Example of Fuel Cell

#### Role of partners involved

- InVesta - PEB owner and responsible POCITYF partner for the implementation of this innovative element.
- NEC - Co-writing the 'program requirements' to guarantee the POCITYF scope is sufficiently incorporated in the energy system. NEC also explores potential technologies and technology providers that fit the above-described scope (as well as the POCITYF Grant Agreement).

#### Progress achieved to M38

By November 2022, New Energy Coalition has reached out multiple times to H2PS, as well as to other potential technology developers/providers (such as PICEA and H2 Powercell) that offer solutions that match the above-described scope. So far, these efforts did not result in concrete plans for the implementation of a hydrogen solution.

##### 1. Preparation phase

This phase started right after the formal agreement that InVesta would replace Duurzaam Bouwloket as a partner to the POCITYF consortium. This phase firstly comprised of writing the 'program requirements' of the energy system to match the needs of POCITYF. Secondly, the phase comprised the identification of potential technologies that fit the preferred scope. As mentioned earlier, we are still in the preparation phase and soon need to make progress on the identification of a suitable solution.

##### 2. Delivery of the materials, equipment and technology

n/a yet

##### 3. Installation/implementation of the innovative element

n/a yet

##### 4. Operationalization phase

n/a yet

##### 5. Monitoring phase



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| n/a yet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Faced Barriers and Lessons Learned (M0 - M38)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>The first and foremost barrier that is faced is the identification of a suitable technology matching the wishes and needs of InVesta and POCITYF. So far, efforts by NEC to get into contact with potential technology providers have not led to the determination of a technology that meets the POCITYF requirements. The contacted technology providers either did not cover the Dutch market or did not respond to the request so far. It should be noted that the so far unsuccessful search can be clarified by the fact that such a stand-alone solution is rather innovative and thereby relatively ‘immature’ (TRL5-6). More efforts will be put into this search from January 2023 onwards.</p> <p>If no suitable stand-alone solution has been identified by the end of the first quarter of 2023, it will be considered to explore the opportunity of ordering a, little less innovative, hydrogen fuel cell. This hydrogen fuel cell could then be temporary fed with hydrogen by an external supplier until a broader hydrogen infrastructure at the center of expertise is established.</p> |
| <b>Next steps</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>The most pressing next step is to identify a suitable hydrogen solution. If this remains to be a struggle, a decision can be made to ‘simply’ install a hydrogen fuel cell. This hydrogen fuel cell can temporarily be provided with hydrogen through an external supplier (e.g., by using a tube trailer) until the hydrogen infrastructure at InVesta itself is sufficiently established.</p> <p>It should be noted that the hydrogen solution is not a necessity for creating a pleasant indoor heating (and cooling) climate. The installation of a water/water heat pump sourced by Photovoltaic Thermal (PVT) panels (IE 1.1.14) will sufficiently provide the thermal energy for heating (and cooling) purposes. That being said, the implementation of this IE is considered to be a necessity to meet the POCITYF Grant Agreement promises and also fits the core business operations of InVesta. Therefore, additional efforts will be put into the exploration of a suitable solution from January 2023 onwards.</p>                                                                            |
| <b>Connected IEs within ETTs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>The hydrogen solution, depending on its final configuration, could be connected to the various solar panels (IE 1.1.14) if the electricity production is used to produce hydrogen (via electrolysis). Also, as already touched-up earlier, the solution is one element within a broader integrated thermal energy system consisting of PVT panels, a heat buffer vessel, a water/water heat pump and a thermoacoustic heat pump (IE 1.1.15). These elements integrated together creates a Heat Island Concept (IE 2.2.8) in which electricity flows are being optimised and monitored by a Ferroamp EnergyHub (IE1.1.8 - Building Energy Management System).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 4.2 IS 2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions

Within ETT#2, IS 2.2 - Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions is comprised of five Innovative Elements for the city of Alkmaar. The following chapters provide an overview of each IE. To keep the overview of the IEs comprehensive and inline with the methodology, IEs that will be/are implemented by the same partner at multiple locations this will be handled in one table.



IEs that will be/are implemented by multiple partners and at multiple locations will be described separately. An overview of the IEs and partners involved is provided in the following table:

| Innovative Element                                           | Partners involved | Demonstration area in ETT#2 |
|--------------------------------------------------------------|-------------------|-----------------------------|
| IE 2.2.3 - Low Temperature Heat (smart) grid                 | Gemeente Alkmaar  | PEB 1.1 - De Meent          |
| IE 2.2.4 - Indirect Delivery Sets                            | HVC               | PEB 1.5 - Dillenburg        |
| IE 2.2.5 - Low temperature Waste Heat                        | Gemeente Alkmaar  | PEB 1.1 - De Meent,         |
| IE 2.2.7 - Thermal Network Design Toolkit (alt. HeatMatcher) | TNO               | PED - Westrand              |
| IE 2.2.8 - Heat Island Concept                               | InVesta           | PEB 1.4 - InVesta           |

Table 17: Overview of Innovative Elements in IS 2.2

#### 4.2.1 Demonstrating IE 2.2.3 - Low Temperature heat (smart) grid

In line with goals of ETT#2, the IE 2.2.3 - Low temperature heat (smart) grid aims to reduce the consumption of fossil energy and increase the share of locally produced energy used. This IE will be demonstrated at PEB 1.1 - De Meent and Gemeente Alkmaar provides an overview in the table below.

Table 18: IE 2.2.3 - Low Temperature Heat (smart) grid

| IE 2.2.3 - Low Temperature Heat (Smart) Grid - PEB 1.1 - De Meent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <p>Main goal of IE 2.2.3 - Low Temperature Heat (Smart) Grid is to reduce consumption of fossil energy by increasing the amount of locally produced energy. This locally produced energy is specifically going to be used as the primary source for heating and cooling in PEB 1.1. - De Meent. The energy positivity is so high that other energy users around De Meent also require less fossil energy or go towards energy-neutral.</p> <p>The heat produced by the two ice machines in De Meent 1.0 is 'wasted' by cooling towers. Simultaneously, the new Sport Complex De Meent 2.0 requires a lot of heat for space heating and showering purposes. For these purposes fossil fuel (natural gas) is used, with the associated CO<sub>2</sub> emissions.</p> <p>By using the waste heat created by the ice machines, there is no need for heating De Meent 2.0 with fossil fuels. Furthermore, the excessive volume of waste heat could be transported via a heat grid to neighbouring buildings.</p> <p>Also, a new cold network is being constructed in De Meent; this cold network will supply cold to various users to improve comfort in PEB 1.1 - De Meent.</p> <p>For this, various cooling batteries and fan coils need to be installed and the heating installation of the new building will be equipped with a change-over system. The main infrastructure of the cold network is prepared for future connection to the WKO (warmte/koudeopslag, eng. ATES) source network, the import of residual heat from the ice machine and the supply of new heat pumps in the old and new buildings.</p> <p>The cold network can be temporarily connected to a leased chiller so that cold can be supplied even without a WKO source network.</p> <p>The low temperature heat (smart) grid the PEB 1.1 - De Meent consists out of:</p> |



- Hot and cold source, source pipes (ATES)
- Cooling batteries
- Fancoils
- Heatpumps
- Changeover cooling exchanger
- Residual heat exchangers
- Cold grid
- Heatbuffer

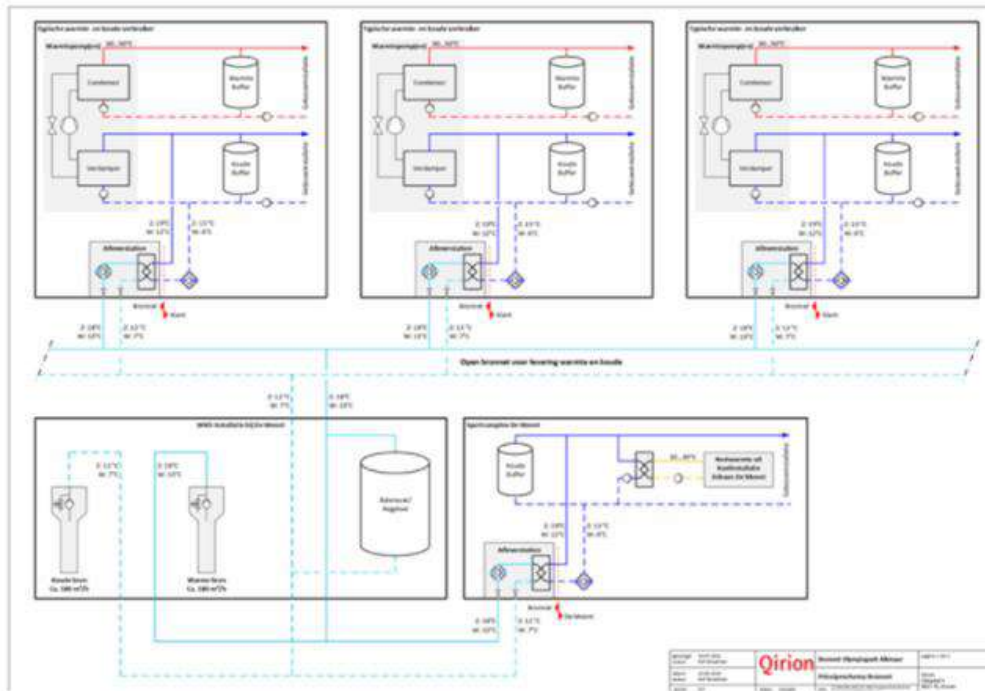


Figure 35: Low temp heat grid at DeMeent





Figure 36: Delivery station and piping

Tabel 3.2 | Uitgangspunten afleveret ijsbaan De Meent

| Dimensionering afleveret De Meent: |    |     | Temperatuur primair | Temperatuur secundair |
|------------------------------------|----|-----|---------------------|-----------------------|
| Verwarmingsvermogen                | kW | 600 | 13-7*               | 12-6*                 |
| koelvermogen                       | kW | 600 | 12-18               | 13-19                 |

\* Voor verwarming wijken de temperaturen af van de ontwerptemperatuur van het WKO ringnet om te kunnen voldoen aan de warmtebehoefte in de opstartfase (ongeladen bronnen).

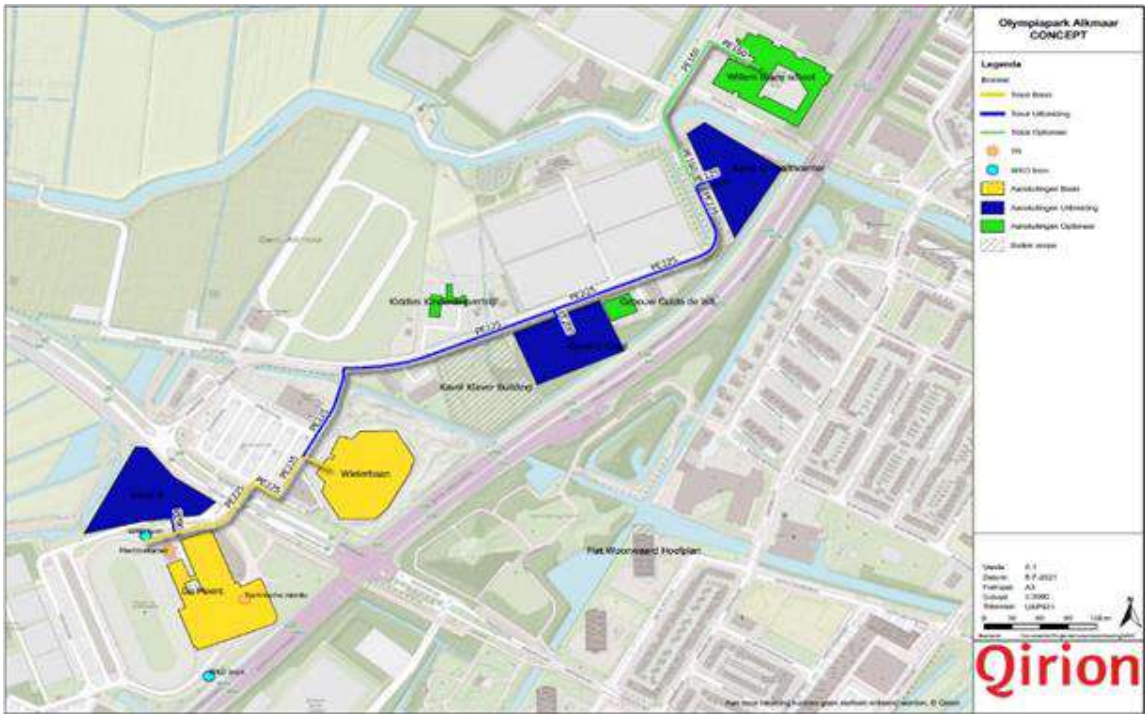


Figure 37: Overview of low temp heat grid at Olympiapark



Two low temp heat grids Olympiapark are under decision making ( ).

1. The YELLOW parts will be connected: De Meent and Wielerbaan'.
2. Besides the YELLOW buildings, we would like the BLUE new external neighbours to connect to the low temp heat grid. These external (new) neighbours are: Kavel A: a restaurant, Kavel C: a hotel, and Kavel D where a new health centre is planned. The owners / developers are very enthusiastic in connecting to this low temp heat grid

The total length of the low temp heatgrid is about 2 km.

The total demand for all stages comes to (indicatief, businesscase is being made at this moment.)

Heatdemand MWh/jr 2.949

Cold demand: MWh/jr 3.71

Heating capacity: kW2.200

Cooling capacity: kW 1.006

#### Role of partners involved

- Qirion (subsidiary Alliander): making the calculations of the grid

#### Progress achieved to M38

##### Status low temp heat grid the Meent

- Preparation phase (research, design): detailed design finished in September 2022
- Delivery of the materials, equipment and technology: all materials and equipment are ordered. Last meters are being ordered to make sure we can monitor everything we want.
- Installation/implementation of the innovative element: implementation is ongoing at this moment.

##### Status low temp heat grid Olympiapark

- Preparation phase (research, design): research and design has been made, including a cost estimation. Presentations are given at the developers, information is given to the elderman. Decision about the final grid has to be made in November / December 2022

#### Faced Barriers and Lessons Learned (M0 - M38)

##### Barrier low temperature heat (smart) grid PEB 1.1. - De Meent

- When installing a low temperature heat system in the cultural buildings more space is required for technical rooms and pipelines
- Due to higher prices of materials and since it is a complex change, it needed a lot more funding to implement this IE. Decision making about this budget took a lot of time, also due to a change of city council (elections), over 7 months.
- Very complex engineering because integration into all the existing installations is needed, and rebuilding is required while the work is ongoing.
- Problem with the longer time needed to install and to properly make the waste heat system functional.

##### Barrier low temperature heat (smart) grid Olympiapark

- Current discussion about ownership of the sources and infrastructure, some legal barriers of ownership. However, the new Ministry of Economic Affairs and Climate Policy has sent all local



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>governments a letter that local ownership of heat and coldgrids must be in governmental hands. This change provides a big opportunity.</p> <ul style="list-style-type: none"> <li>• Business case is quite complex. Initially it was thought that Firan Business Development could help, but politicians did not want to commit themselves to one party (agreement on the letter of intent was not reachable). Therefore, we (Cees Groot) made the businesscase by himself.</li> <li>• Connecting external parties to a local governmental owned infrastructure is politically challenging.</li> </ul> |
| <b>Next steps</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <p><b>Low temperature heat grid De Meent</b></p> <ul style="list-style-type: none"> <li>• Operationalization phase: complete installation will be finished March 2023</li> <li>• Monitoring phase starts in April 2023</li> </ul> <p><b>Lowtemp heat grid Olympiapark</b></p> <ul style="list-style-type: none"> <li>• Tender has to be started in January 2023</li> <li>• Selection of supplier / constructor in April 2023</li> <li>• Installation in September 2023</li> <li>• Operationalization phase: Q4 2023</li> </ul>                                                                            |
| <b>Connected IEs within ETTs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p>This IE is connected to the other IEs:</p> <ul style="list-style-type: none"> <li>• IE 1.1.18 - Cascaded Heatpumps;</li> <li>• IE 1.2.7 - ATES</li> <li>• IE 2.2.5 - Low temperature waste heat</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                             |

## 4.2.2 Demonstrating IE 2.2.4 - Indirect delivery sets

The current status IE 2.2.4 - Indirect delivery sets will be detailed in below table. This IE is implemented by POCITYF partner HVC with the aim to have an additional separation between the water from HVC and from the central heating, thus optimizing direct delivery sets.

Table 19: IE 2.2.4 - Indirect Delivery Sets

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IE 2.2.4 - Indirect Delivery Sets - PEB 1.5 - Dillenburg</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Goal and Description of IE at the PEB</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p>Standard applied delivery sets are ‘direct’ sets in which the demiwater from the local heat district will also be in the indoor installation of the house that is connected to the heat grid. This system is able to deliver only one sole temperature without possibility of variation in temperature.</p> <p>The system can cause several negative effects in the house and has a risk of malfunctions. Besides it can cause serious problems to the system or the house in case of misuse or mismanagement by the house owner. The system also limits the freedom of choice of the house owner in terms of material (particularly pipes and designer radiators) and temperature choices.</p> |



Innovation is therefore needed to make the system more sustainable (applicable for the use of lower temperature residual heat coming from the heat grid) and safer and to offer more freedom of choice to the customer.

Taking this into consideration, indirect delivery sets can be used to create an extra separation between the water from HVC and the water from the indoor installation (central heating) in the home. Indirect delivery sets create a separation between temperature and pressure between both installations.



Figure 38: Picture (left) and image (right) of the AquaHeat Arctic-HEX-120 system



The indirect deliveryset is an AquaHeat Arctic-HEX-120 system.



### Technische gegevens Arctic-HEX-120:

| Warm tapwater:                           |           | Indirect verwarmen van koud tapwater d.m.v. een warmtewisselaar.                                                                                             |     |      |      |
|------------------------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|------|
| CW klasse                                |           | 3                                                                                                                                                            | 4   | 5    | 6a   |
| Warmwater capaciteit ca.                 | liter/min | 6                                                                                                                                                            | 7,5 | 9    | 12,5 |
| Vermogen                                 | kW        | 21                                                                                                                                                           | 26  | 31,4 | 43,6 |
| Drukverlies in de unit ca.               | kPa       | 10                                                                                                                                                           | 12  | 15   | 30   |
| Drukklasse                               | kPa       | 1000                                                                                                                                                         |     |      |      |
| Ontwerp gegevens warmtewisselaar         |           | Tapwater 10 °C → 60 °C / primair warmte >65 °C → 35 °C                                                                                                       |     |      |      |
| Verwarming (t.b.v. binneninstallatie)    |           | Indirect verwarmingssysteem                                                                                                                                  |     |      |      |
| Opvoerhoogte circulatiepomp              | kPa       | 5 – 40, instelbaar op circulatiepomp                                                                                                                         |     |      |      |
| Capaciteit maximaal                      | kW        | 20                                                                                                                                                           |     |      |      |
| Ontwerp platenwarmtewisselaar            |           | Primair: 65°C/45°C – Secundair: 60°C/40°C                                                                                                                    |     |      |      |
| Drukklasse                               | kPa       | 600 (PN6)                                                                                                                                                    |     |      |      |
| Koeling (t.b.v. binneninstallatie)       |           |                                                                                                                                                              |     |      |      |
| Regeling                                 |           | N.v.t.                                                                                                                                                       |     |      |      |
| Vermogen                                 | kW        | N.v.t.                                                                                                                                                       |     |      |      |
| Ontwerp gegevens warmtewisselaar         |           | N.v.t.                                                                                                                                                       |     |      |      |
| Drukklasse                               | kPa       | N.v.t.                                                                                                                                                       |     |      |      |
| Primair systeem                          |           | 2-pijpsysteem verwarmen                                                                                                                                      |     |      |      |
| Aanvoerwater temperatuur verwarmen       |           | 65- 95 °C                                                                                                                                                    |     |      |      |
| Aanvoerwater temperatuur koelen          |           | N.v.t.                                                                                                                                                       |     |      |      |
| Drukverschil min.- max.                  |           | 50 kPa- 250 kPa                                                                                                                                              |     |      |      |
| Drukklasse                               | kPa       | 1000 (1600)                                                                                                                                                  |     |      |      |
| Eisen m.b.t. de waterkwaliteit           |           |                                                                                                                                                              |     |      |      |
| pH waarde                                | (-)       | 7- 9                                                                                                                                                         |     |      |      |
| Chloride gehalte max.                    | mg/l      | 100 ( tot een maximale medium temperatuur van 80 )                                                                                                           |     |      |      |
| Totale hardheid                          |           | [Ca <sup>2+</sup> , Mg <sup>2+</sup> ] / [HCO <sub>3</sub> ] <sup>-</sup> > 0,5                                                                              |     |      |      |
| Geleidbaarheid                           | µS/cm     | 10...500                                                                                                                                                     |     |      |      |
| Algemeen                                 |           | KEMA richtlijn voor stadsverwarmingswater 33476-PPP-94-4055A                                                                                                 |     |      |      |
| Afmetingen, aansluitingen                |           |                                                                                                                                                              |     |      |      |
| Breedte x diepte x hoogte (excl. beugel) | mm        | 580 mm x 260 mm x 570 mm                                                                                                                                     |     |      |      |
| Gewicht                                  | kg        | 20                                                                                                                                                           | 21  | 23   | 25   |
| Warmte aansluitingen                     |           | ¾" wartel, vlak dichtend                                                                                                                                     |     |      |      |
| Tapwater aansluitingen                   |           | Warm water 15 mm klem, koud water 15 mm buis                                                                                                                 |     |      |      |
| Elektrische aansluitingen                |           | 230 V, AC, N-L-PE                                                                                                                                            |     |      |      |
| Thermostaat aansluitingen                |           | Aan/uit thermostaat voorzien van potentiaalvrij contact, of OpenTherm thermostaat uitsluitend in overleg.<br>Tijdens warmtevraag moet contact gesloten zijn. |     |      |      |
| Passtuk energiemeter                     |           | In aanvoer, DN15 (¾" bui.dr. vlak) Inbouw lengte= 110 mm                                                                                                     |     |      |      |





| Faced Barriers and Lessons Learned (M0 - M38)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HVC is leading the implementation of this IE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Next steps                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p>The monitoring of the building connections started in December 2021.</p> <p>As a result of remarks of the POCITYF organization, it was decided that the monitoring should be done more specific. The data that HVC now provides is on an apartment level, because of privacy-regulations this is done on adress basis and not to be connected to the name and adress details.</p> <p>The data per apartment will be delivered to NEROA and next to InHolland. The process to do so is now being executed.</p> <p>It is expected that this step will be finalized within a couple of weeks from now.</p> |
| Connected IEs within ETTs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p>The connection to the district heating grid at the Dillenburg is connected to ETT1, IE 1.1.14; the solar roof at the Dillenburg.</p> <p>There is no specific connection with the ETT's of other POCITYF partners.</p>                                                                                                                                                                                                                                                                                                                                                                                   |

### 4.2.3 Demonstrating IE 2.2.5 - Low temperature waste heat

Gemeente Alkmaar will provide an overview of the past, ongoing and future developments and the respective achievement to be accomplished by the end of the project. The table below describes the demonstration activities until the time of the deliverable.

Table 20: IE 2.2.5 - Low temperature Waste Heat

| IE 2.2.5 - Low Temperature Waste Heat - PEB 1.1 - De Meent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p>The heat produced by the two ice machines in De Meent 1.0 is “wasted” by cooling towers. Simultaneously, the new Sport Complex De Meent 2.0 requires a lot of heat for space heating and showering purposes. For this purposes fossil fuel (natural gas) is used, with the associated CO<sub>2</sub> emissions.</p> <p>By using the waste heat created by the ice machines, there is no need for heating De Meent 2.0 with fossil fuels. The waste heat demonstration will be connected to an ATES (described in IE 1.2.7) and the low temperature (smart) heat grid (2.2.3). The inclusion of an ATES will increase the efficiency of waste heat usage. According to Qirion's study, 65-75% of the heat demand of De Meent can be covered by the waste heat of the cooling machines in combination with the already existing heat pump. By the means of the ATES the waste heat of the cooling system can be stored when the cooling installation is in full operation (from October till March) and redistributed throughout the year when requested.</p> <p>The existing ammonia refrigeration plant will be equipped with a heat exchanger that allows residual heat (condenser heat) to be disconnected. This residual heat will be used to regenerate the ATES via the</p> |



cold network to bring it into balance. At times when the water/water heat pumps and the NH<sub>3</sub> refrigeration plant are in operation simultaneously, this residual heat can be (partially) utilized directly. A new software solution is implemented to better match the waste heat streams to the heating demand of the sports complex. Furthermore, the usage of CO<sub>2</sub> as a refrigerant and inclusion of heat pump are expected to increase the potential waste heat utilisation. The upcoming winter will prove whether the alternations will have a positive impact.

Disconnection of waste heat from NH<sub>3</sub> refrigeration plant: capacity: 600 kW

Heat demand and supply: see overview

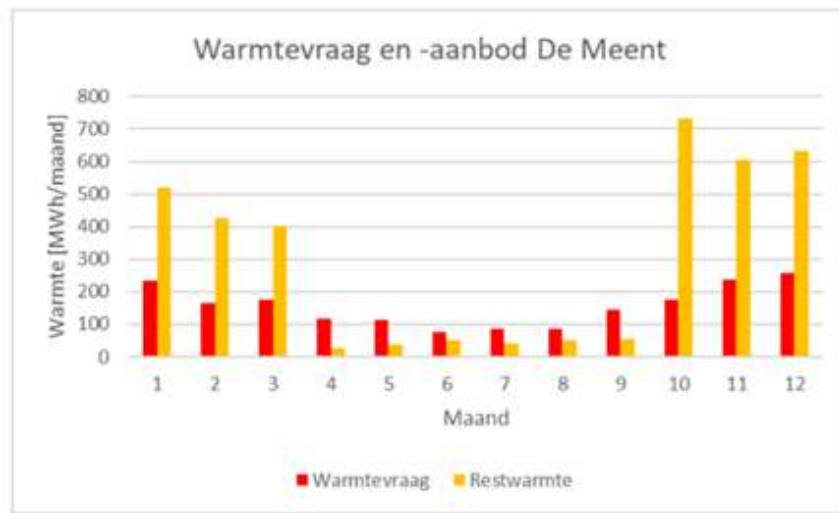


Figure 39: Heat demand and supply





Figure 40: Buffervessels, each 25m<sup>3</sup> for buffering heat

#### Role of partners involved

Qirion: made the calculations and principle scheme of the low temp waste heat

#### Progress achieved to M38

Preparation phase (research, design): finished summer (2022), final detailed engineering finished in October 2022.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Faced Barriers and Lessons Learned (M0 - M38)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"> <li>Detailed engineering takes a lot of time (over a year). Not a barrier, but an advice to take that into account.</li> <li>Due to delivery issues, it was not possible to implement the NH<sub>3</sub> heat exchanger before the start of the skating season. The impact on the main process is too big and too risky (since working with NH<sub>3</sub>)</li> </ul>                                                                                                                                                                                                          |
| <b>Next steps</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>Delivery of the materials, equipment and technology: everything is orderd, the NH<sub>3</sub> heat exchanger is being delivered in February (late, due to delivery problems).</li> <li>Installation/implementation of the innovative element: after 12 March 2023. The installation of the needed NH<sub>3</sub> heatexchanger has a huge impact on the icemaking. We can not afford to have any interruption in this process during the iceskating season.</li> <li>Operationalization phase: end of March 2022</li> <li>Monitoring phase: starts in April 2023</li> </ul> |
| <b>Connected IEs within ETTs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| ATES (described in IE 1.2.7) and the low temperature heat grid (IE 2.2.3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

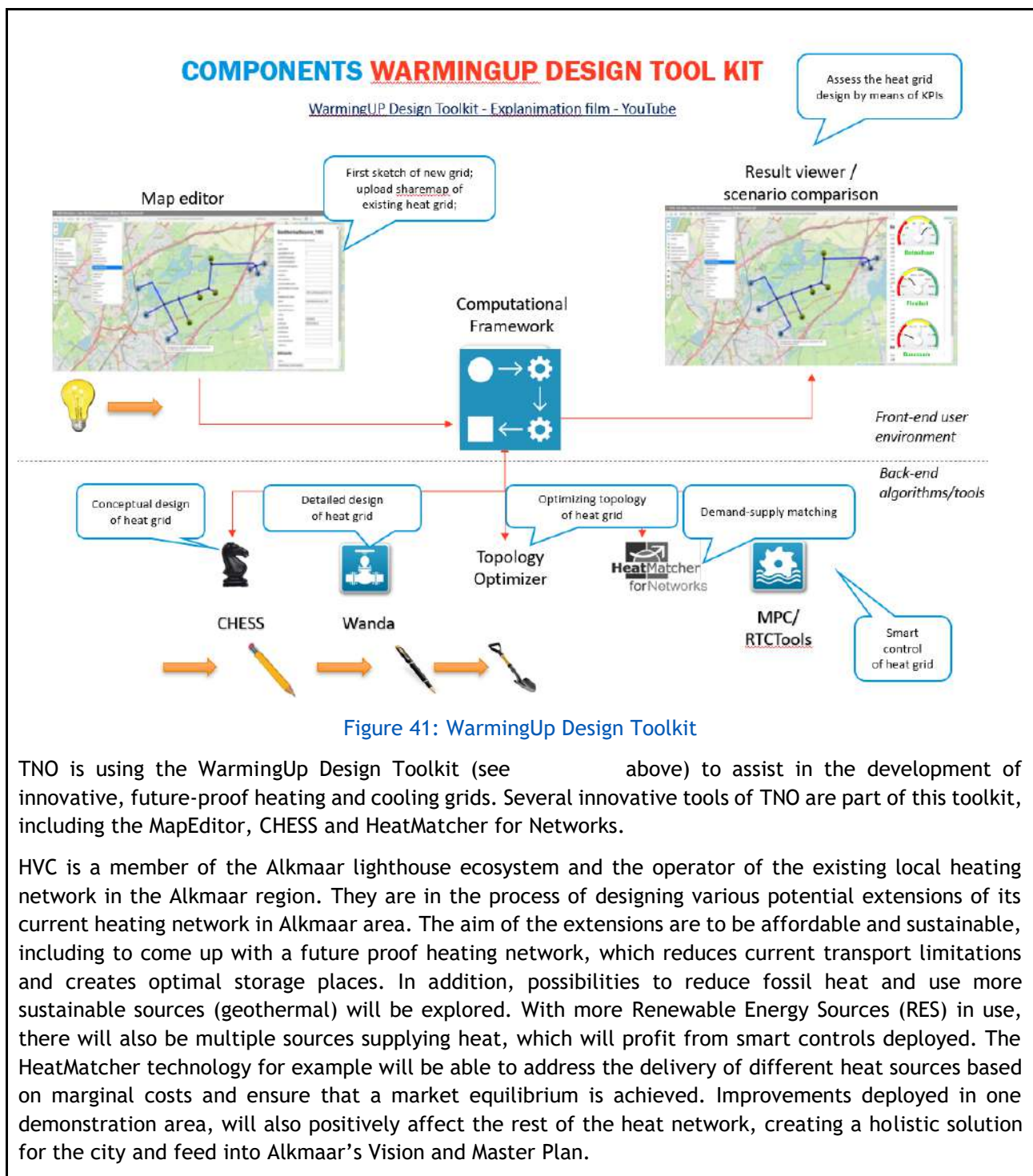
#### 4.2.4 Demonstrating IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher)

Within the context of ETT#2 Alkmaar aims to demonstrate innovative solutions for grid flexibility. The IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher) targets the heating grid to explore affordable, sustainable and future-proof innovations extensions of the current heating network. The scope of the IE encompasses the whole PED demonstration area and the replications areas as well, providing a holistic approach to be beneficial for the city of Alkmaar in the long term.

Table 21: IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher)

|                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher) - entire PED demonstration area + replication areas</b>                                                                                                                                                                                                                                                                                           |
| <b>Goal and Description of IE at the PEB</b>                                                                                                                                                                                                                                                                                                                                                                       |
| <p>The WarmingUp Design Toolkit is a software product that supports designers of heat networks in their design of future-proof heat networks. The Design Toolkit connects different innovative tools for planning, design, hydraulic engineering and control of heat networks in one software package. It is made by experts in a Dutch consortium of 38 participants relevant for the heat part of the energy</p> |





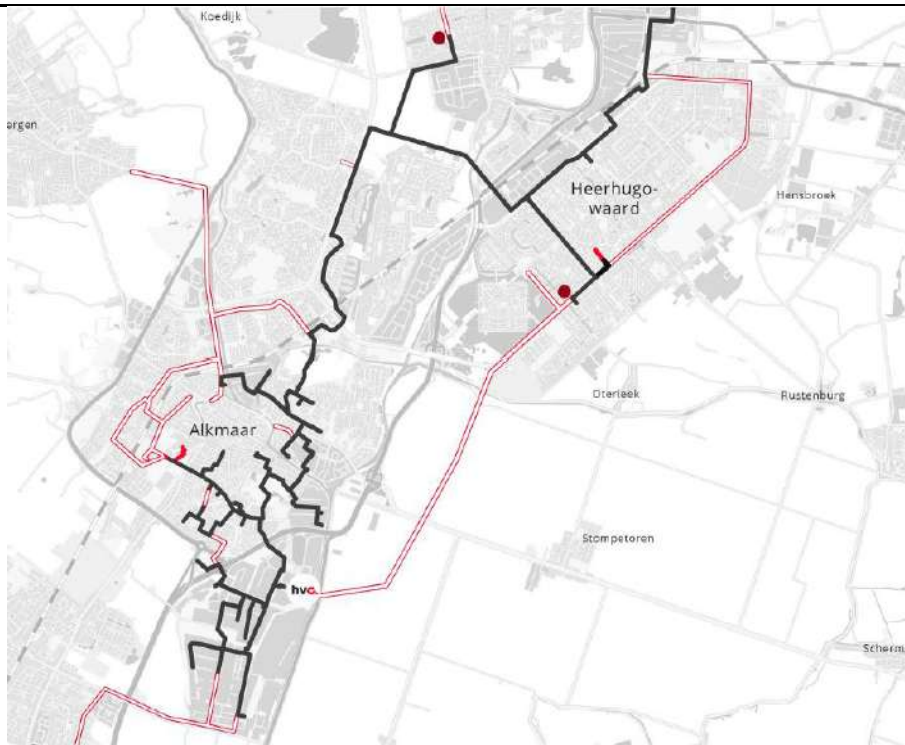


Figure 42: Current (black) and possible future expansion (red) of the heat network in Alkmaar

#### Role of partners involved

- TNO is responsible for analysing the different solutions for the heat network in Alkmaar. TNO is strongly dependent on other partners (HVC, Gemeente Alkmaar) for their information on installed capacity, type of appliances, expected sustainable energy production and plans for the future expansion.
- HVC is the owner and operator of the district heating grid in the Alkmaar region; they are active as a partner to their shareholders (amongst which the municipality of Alkmaar) in the phase out of the use of natural gas for heating buildings. HVC plans a further roll-out of the heating grid in the city.  
Gemeente Alkmaar, regarding future plans for heat networks in the city.

#### Progress achieved to M38

- TNO has built the digital surrounding in the ESDL MapEditor in which the existing and future heat network is displayed and in which the current and future heat demand is modelled.
- HVC and Gemeente Alkmaar have delivered all necessary input to create several scenarios that can be simulated and analysed.
- This concerns, among other things, current and future heat demand (which districts will participate), operational and possible new heatsources and heatstorage locations. Several meetings and workshops have taken place to discuss the current and future developments and design the future heat network, decide on technical details, new infrastructure and pipeline routes as well as heat storage and sustainable



- In multiple workshops with relevant partners, a consideration of the interests of the various stakeholders has led to a thorough visual approach for future developments. This matrix is depicted below.



Figure 43: Matrix showing the priorities that stakeholders give to certain solutions to expand the heat network



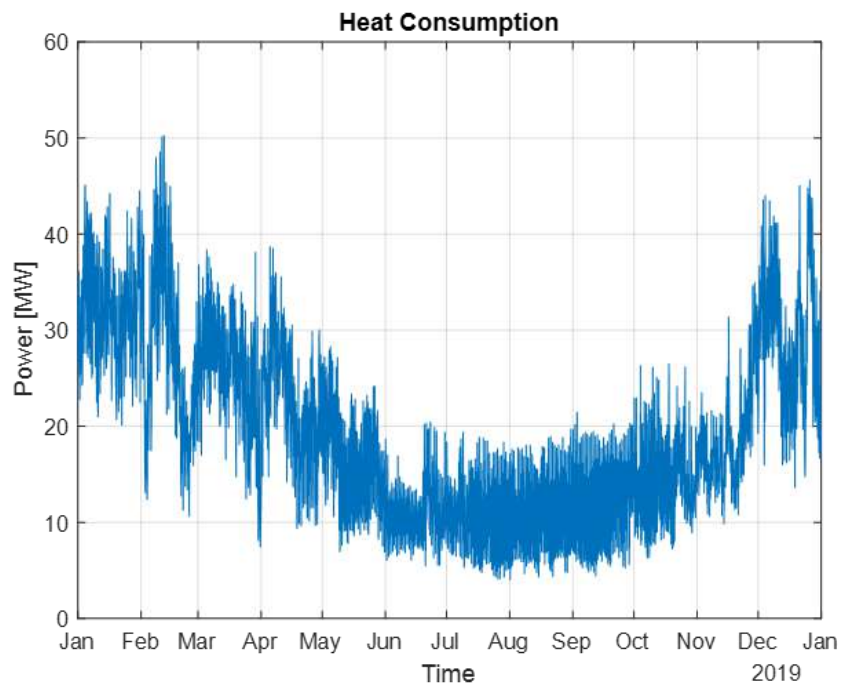


Figure 44: Total heat consumption throughout a year for the current heat network. This hourly base data is input for the CHESSS simulations

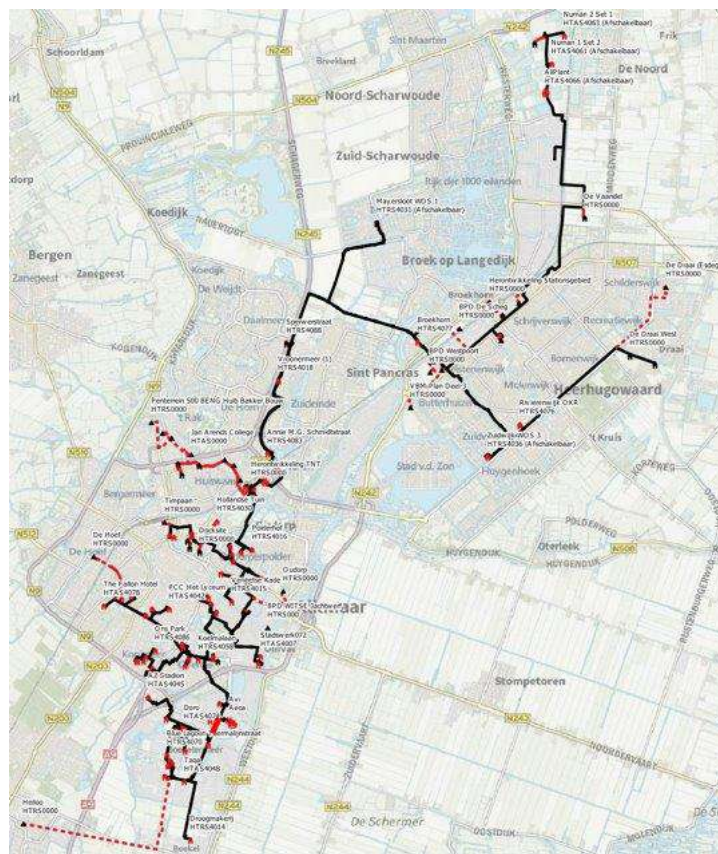


Figure 45: Possible expansions of the network (denoted by the dotted lines)



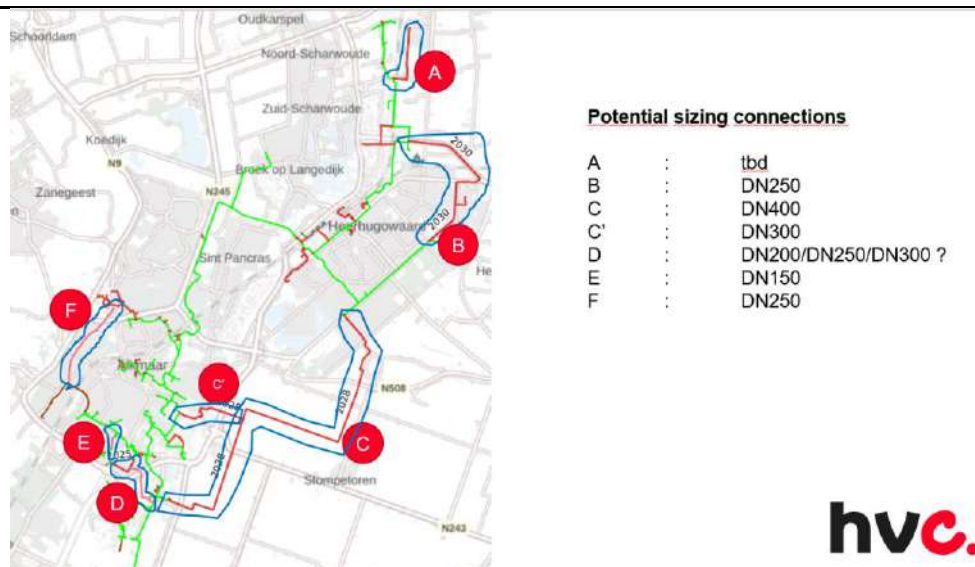


Figure 46: Possibilities of new pipelines to increase the supply in certain parts of the network and their possible diameters

- Several meetings have taken place to discuss the current and future developments and to design the needed heat network, decide on technical details, new infrastructure and pipeline routes as well as heat-storage- and sustainable heat source locations.
- Based on a matrix, a consideration of the interests of the various participants has led to a thorough visual approach for the model.
- In the screenshot below ( ) shows a part of possible future expansions for the heat network, as modelled in the ESDL MapEditor. This serves as input for TNO's heat network simulator CHES



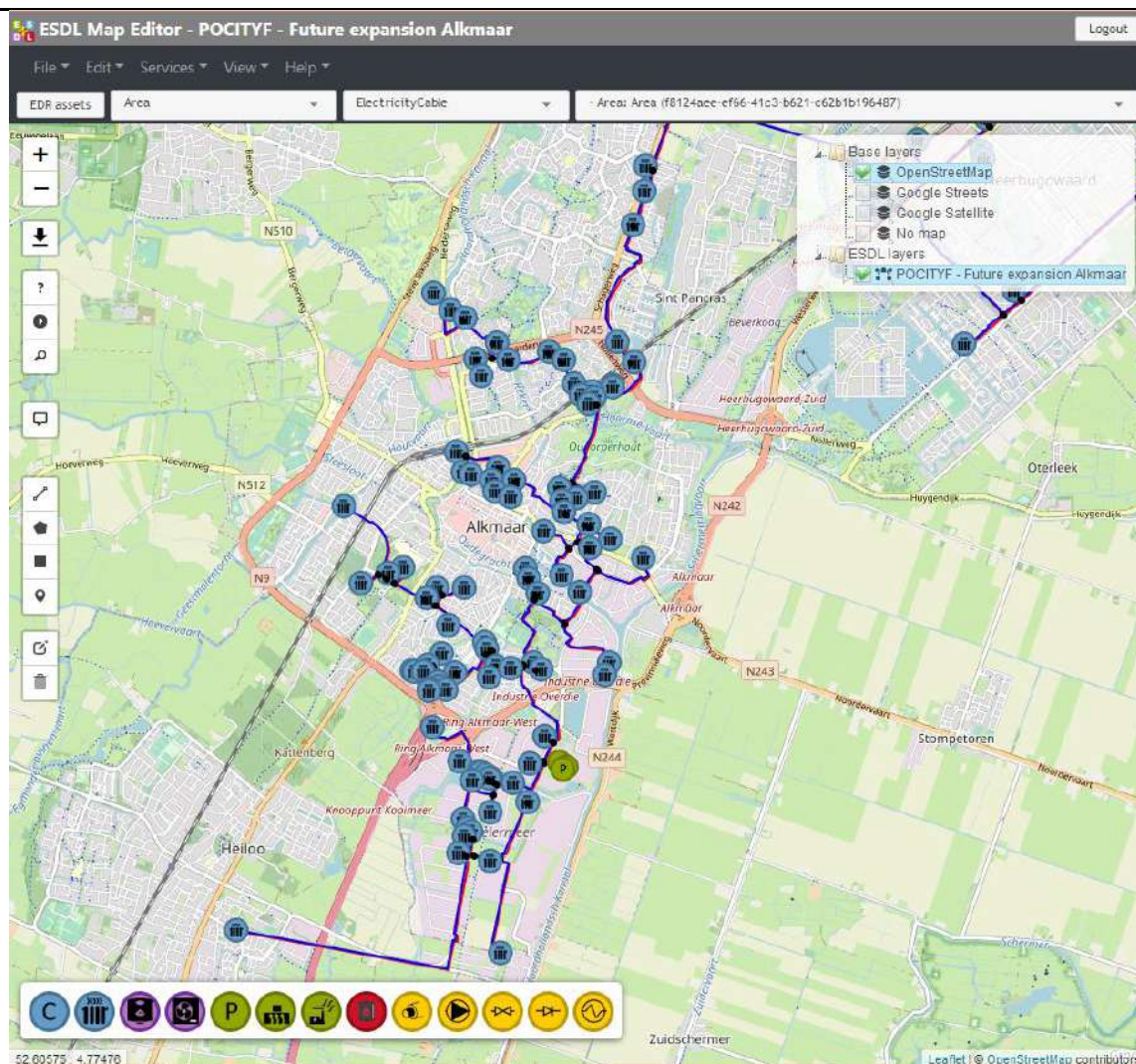


Figure 47: A future scenario in the ESDL MapEditor (part of the Design Toolkit), served as input for simulations

#### Faced Barriers and Lessons Learned (M0 - M38)

Getting the right input information is always a difficult process, which caused some delays in this activity. Therefore, the results of the simulations are not yet part of this version of this deliverable.

#### Next steps

- Definition of the logical scenarios that require simulation.
  - Simulate the scenarios with the CHES tool (as part of the Design toolkit).
  - Analyse the results of each simulation run.
  - Compare the different scenarios.
- Report on the analysis of all scenarios (including the next version of this deliverable)

#### Connected IEs within ETs



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



The Thermal Network Design Toolkit (incl. HM) represents a holistic view of the heat grid in Alkmaar not directly connected to other IEs within ETT#2 or other ETTs.

#### 4.2.5 Demonstrating IE 2.2.8 - Heat Island Concept

The demonstration of a Heat Island Concept, in which a building has a standalone heating and cooling system independent from external heating sources, has the potential to positively affects the score of dwellings and (utility) buildings on the second BENG indicator. While most dwellings and buildings rely on the natural gas grid and partly grey electricity grid for heating and cooling purposes, a Heat Island Concept based on own renewable energy sources allows dwellings and (utility) buildings completely removes the need for fossil fuel usage for heating and cooling. InVesta aims to demonstrate this Innovative Element by creating an independent heating and cooling system based on renewable energy sources.

Table 22: IE 2.2.8 - Heat Island Concept

| IE 2.2.8 - Heat Island Concept - PEB 1.4 - InVesta                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Goal and Description of IE at the PEB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p>The goal of the Heat Island Concept (IE 2.2.8) is to demonstrate a stand-alone heating (and cooling) system that operates without the need of an external energy source or infrastructure. Traditionally, Dutch dwellings and buildings are connected to the natural gas grid for the heating provisioning. In recent times, many houses and buildings are connecting to a regional heating grid or being electrified by a heat pump or e-boiler. However, not all dwellings and buildings are geographical located near a regional heat grid and/or heat source. Also, as a result of the grid congestion, electrification of the heating system via heat pumps or e-boilers is hampered in many regions. The Heat Island Concept provides an alternative heating (and cooling) system without the need for these external electricity and/or heating grids.</p> <p>The concept will be demonstrated at <b>InVesta's center of expertise</b> and consists of the following elements</p> <ul style="list-style-type: none"> <li>• IE 1.1.14 - Photovoltaic thermal (PVT) panels <ul style="list-style-type: none"> <li>○ Number: 24 PVT panels</li> <li>○ Capacity: 380 Wp/panel with a total of 9,12 kWp</li> <li>○ Set-up: East-West</li> <li>○ Electricity production: 7.200 kWh/y</li> <li>○ Thermal energy production: 48 GJ/y</li> </ul> </li> <li>• Water/water heat pump <ul style="list-style-type: none"> <li>○ Brand: Nibe</li> <li>○ Type: Modular water-water solo heat pump</li> <li>○ Capacity: 20 - 25 kW</li> </ul> </li> <li>• Buffervessel (heat storage) <ul style="list-style-type: none"> <li>○ Brand: Nibe</li> <li>○ Type: UKV 20-220 NIBE</li> <li>○ Capacity: 218 liter + 1400 liter</li> </ul> </li> <li>• Heat exchanger</li> <li>• (IE 1.1.15 - Thermo acoustic heatpump (TAHP)) <ul style="list-style-type: none"> <li>○ Brand: Blue Heart Energy</li> <li>○ Capacity: +/- 6 kW</li> </ul> </li> </ul> |



The Photovoltaic thermal (PVT) panels serve as the starting point of the Heat Island Concept. These solar panels not only produce electricity but also generate thermal energy (heat). This generated heat will be stored in a buffer vessel that serves as the source for the Nibe water-water heat pump. Finally, as part of a test, a thermo-acoustic heat pump will be temporary integrated to the Heat Island Concept.

Note that the required electricity for the heat pump to operate is also generated on site by the PVT-, BIPV- and regular PV panels, and can also be discharged from the stationary battery (IE 2.2.8) at the site.

#### Role of partners involved

InVesta - PEB owner and responsible POCITYF partner for the implementation of this innovative element.

NEC - Co-writing the 'program requirements' to guarantee the POCITYF scope is sufficiently incorporated in the energy system.

GA - Co-writing the 'program requirements'.

#### Progress achieved to M38

By November 2022 the following individual elements, that together form the Heat Island Concept, are delivered to the InVesta site: PVT panels, buffer vessel and heat exchanger. The water-water heat pump is expected to be delivered in December 2022. In order to become operational, all installations first have to be installed and integrated.

##### 1. Preparation phase

This phase started right after the formal agreement that InVesta would replace Duurzaam Bouwloket as a partner to the POCITYF consortium. This phase firstly consisted of writing the 'program requirements' of the energy system to match needs of POCITYF. Secondly, the phase comprised the identification of potential technologies as well as technology providers to create the Heat Island Concept

##### 2. Delivery of the materials, equipment and technology

The PVT panels were delivered by July 2022, and the heat exchanger and buffer vessel are delivered in november 2022. The Nibe water/water heat pump is expected to be delivered in December.

##### 3. Installation/implementation of the innovative element

All individual elements (with the exception of the TAHP) as listed above are expected to be installed by Q1 2023.

##### 4. Operationalization phase

The complete integrated heating (and cooling system), in other words the Heat Island Concept, is expected to become operational by the end of Q2 2023.

##### 5. Monitoring phase

The monitoring period is expected to start within two months of the battery being operational which would mean during the summer of 2023.

#### Faced Barriers and Lessons Learned (M0 - M38)



There are two barriers that InVesta faced/is facing when it comes to the demonstration of the Heat Island Concept, and led to the innovative element not being implemented yet:

1. The delivery of multiple elements, e.g., the Nibe water/water heat pump, are/were delayed. This is the result of geopolitical instabilities in the world and due to these elements being very high in demand to diminish the dependence on natural gas. It should also be noted that the equipment prices have increased significantly as a result of the geopolitical instabilities (such as the war in Ukraine) and shortage of materials.
2. Despite this IE enabling a stand-alone heating (and cooling) system, there is still the need for a grid connection in order for certain elements to become operational. As a result of growing demand and supply of renewable electricity, the grid capacity has reached its limits. A growing number of regions within the Netherlands, including the Boekelermeer in Alkmaar where InVesta is situated, cannot connect new premises with a relatively high electricity demand and/or electricity feed-in to the electricity grid. As the center of expertise will host multiple demonstration projects with a significant electricity demand, InVesta also encounters this issue. Multiple solutions are currently being explored, and one potential solution has been identified that has the potential to solve this issue by the end of spring 2022. Once this connection is established the PVT panels and heat pump can be operationalized.

#### Next steps

As already indicated above, the most pressing next step is the delivery of the heat pump. Next, all elements will be installed in Q1 of 2023 after which the integrated thermal energy system is aimed to become operational in Q2 of 2022 (once a grid connection has been established). Finally, the monitoring can start by the summer of 2022.

#### Connected IEs within ETTs

As already indicated above, the integrated thermal energy system consists of multiple elements with the ones demonstrated within POCITYF being:

- IE 1.1.14 - solar roofs and facades (PVT)
- (IE 1.1.15 - Thermo-acoustic heat pump)

In addition, the innovative element is also connected to the other PV panels (IE 1.1.14) - BIPV and regular solar panels - and the battery as these installations provide the electricity for the heat pump to operate on. Also, a Ferroamp EnergyHub, the building energy management system (IE 1.1.8) is connected to the Heat Island Concept as it optimizes the energy (electricity) flows from the solar panels and battery to the heat pump.



## 5 Conclusions

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The deliverable D7.7 - Transition Track #2 - Activities for Alkmaar - version 1, provides a first overview of the developments across all demonstration sites. Since the background of each demonstration site is extensively covered in deliverables related to WP1, and more specifically in D1.8 City Vision and Master Plan for ETT#2 Solutions - version 2, only a short overview was given in this deliverable. Furthermore, the main objective of this deliverable is to provide a status update of the different IEs included in ETT#2.

In order to get all the information necessary, each partner responsible for an IE was requested to complete a template questionnaire for each IE they are involved in. This process started in September 2022 to give partners sufficient time and was harmonized across ETT#1, ETT#2, ETT#3 and ETT#4.

The deliverable initially gives a brief overview first of what the essence of ETT#2 is, including the demonstration sites and what IEs are and will be demonstrated across them. Within ETT#2 there are two Innovative Solutions, in which the different IEs fall. For each IE a table has been created to give an overview of the current status. Given that this deliverable is the first version, with the second deliverable to follow at the end of the project, the information included also discusses the next steps that will be taken. The information not yet available will be part of the second version and updated accordingly.

This first version of the deliverable provides a first glance at what has been done, what efforts went into the planning phase and what obstacles were encountered. These are valuable lessons in the process of implementing the different IEs and lend support in the next steps to come.

IEs such as IE 2.2.4 - Indirect delivery sets, IE 2.2.7 - Thermal Network Design Toolkit (incl. HeatMatcher) or IE 2.1.8 - Stationary Batteries (at Woonwaard Highrise) are either already completed or in the final stages, showing good progress of the IEs to be implemented. Some delays due to COVID-19 as well as availability of materials have slightly slowed down the implementation of some IEs. Here, especially Q1 2023 will be a crucial time for finalizing the implementation of many IEs.

This links to the ambitions for the second version of this deliverable, which is to further describe the development steps and finalization of the implementation of the IEs, including any potential additional barriers encountered.



## 6 Annex A: Template for data collection

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>IE X.X.X - XXXXX</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Goal and Description of IE at the PEB</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Location XXX <ul style="list-style-type: none"> <li>What is the goal of the innovative element and how does it contribute to the overall goal(s) of POCITYF.</li> <li>Provide a clear description of the innovative element</li> <li>What are the specifications of the innovative element, such as:</li> <li>Type and brand of the technology, capacity, energy production/consumption, size/measurements, ....</li> </ul>                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Role of partners involved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Location XXX <ul style="list-style-type: none"> <li>Which POCITYF partner(s) are involved and what is the role with the demonstration of this specific innovative element</li> <li>(only describe/specify the involved POCITYF partner, other parties involved don't have to be listed)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Progress achieved to M38 (partners to provide input on timeline of IE, research, delivery, installation, testing, etc.)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Location XXX <p>Current status of the IE (what has been achieved?)</p> <ul style="list-style-type: none"> <li>Paragraph on where the demonstration of this specific innovative element stands by the time of month 38 (November 2022)</li> <li></li> <li>Describe for the following phases (if applicable) what has been carried out and when it has been carried out. If a certain phase has not been carried out yet it can be left blank and be further described in the 'next steps' section. Also, feel free to add phases if better suitable.</li> <li>Preparation phase (research, design)</li> <li>Delivery of the materials, equipment and technology</li> <li>Installation/implementation of the innovative element</li> <li>Operationalization phase</li> <li>Monitoring phase</li> </ul> |
| <b>Faced Barriers and Lessons Learned (M0 - M38)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Location XXX <ul style="list-style-type: none"> <li>What barrier(s) has/have been faced and what are the lessons that could be retrieved from circumventing/resolving the barrier(s).</li> <li>Also describe potential changes in the to be demonstrated solutions as well as the reasoning for the change of applicable.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Next steps (what will be done/what still has to be done - add dates if known)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Location XXX <ul style="list-style-type: none"> <li>What are the most pressing upcoming next steps, and again, add dates and timelines to these next steps. Potential next steps could be:</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |



- Finalization of the design, ordering the equipment/materials/technology, installing the innovative element, Getting the innovative element operational
- The final next steps for (most) innovative elements should be the monitoring of the performance.

#### Connected IEs within ETTs

##### Location XXX

- If applicable (which for most Innovative elements is the case), describe the connections and linkages to other innovative elements. As for all of the PEBs and even sometimes between different PEBs we aim to create an integrated energy system there should be many linkages between the different IEs.



## 7 References

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POCITYF - A Positive Energy CITY Transformation Framework, H2020 - European Commission. Available online: <https://pocityf.eu> (accessed 28 November 2022)

POCITYF GA Document AMD 864400-15



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