



POCITYF

Transition Track #3

Activities for Alkmaar- Version 1.1

D7.9

WP7, T7.5

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* PU = Public

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Executive Summary

The following deliverable falls under WP 7 - Alkmaar Lighthouse City demonstration activities, T7.4 - Demonstration ETT#3: E-mobility Integration into Smart Grid and City Planning.

This deliverable is the first version of D7.9. - Energy Transition Track#3 (ETT#3) 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.

ETT#3 encompasses 2 Integrated Solutions (IS): IS-3.1 deals with Smart V2G EVs Charging while IS-3.2 deals with E-mobility Services for Citizens and Auxiliary EV Technologies.

The document provides a detailed analysis of the current implementation of all ETT#3 related activities to be carried out at POCITYF Lighthouse City of Alkmaar.

The focus of this deliverable is the implementation of the Integrated solutions; therefore, the document is structured to first provide an overview of the POCITYF Lighthouse City of Alkmaar and a short overview of the demonstration locations, followed by an overview per Innovative Element.

Due to delays for some IEs, the deliverable will provide an overview of all developments leading up to this deliverable and 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
ATES	Aquifer Thermal Energy Storage
BEMS/HEMS/CEMS	Building/Home/City Energy Management System
BMS	Building Management System
DHC	District Heating Cooling
DSM	Demand Side Management
DSO	Distribution System Operator
ESCO	Energy Service Company
ETT	Energy Transition Track
EV	Electric Vehicle
FC	Fellow City
GAF	Grant Agreement Form
GDPR	General Data Protection Regulation
ICT	Information and Communications Technology
IE	Innovative Element
IS	Integrated Solution
KPI	Key Performance Indicator
LH	Lighthouse
LV/MV	Low Voltage/Medium Voltage
P2P	Peer-to-Peer
PEB	Positive Energy Building
PED	Positive Energy District
PV	Photovoltaic
RES	Renewable Energy Source
SCC	Smart Cities and Communities
SDG	Sustainable Development Goals
SEAP	Sustainable Energy Action Plan
V2G	Vehicle to Grid
VPP	Virtual Power Plant
WP	Work Package



Acknowledgements

This document is written with the information provided by Alkmaar's consortium partners as of the end of November 2022. The writer of the document cannot be held responsible should any information have been incorrect. During the project many activities are carried out so it is possible that the last known status on paper may not correspond exactly to the actual status in practice. It is therefore recommended to contact the consortium partner directly in case of questions or uncertainties. Of course, each partner has made every effort to reflect the status as accurately as possible. It took considerable effort, so a big thank you to the consortium partners is appropriate



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



1 Introduction

POCITYF major goal is to deliver a set of Positive Energy Blocks (PEBs) in the Lighthouse cities (LHCs) of Évora (PT) and Alkmaar (NL) and their Fellow Cities (FCs) Granada (ES), Bari (IT), Celje (SI), Ujpest (HU), Ioannina (GR) and Hvidovre (DK). With the creation of Positive Energy Blocks (PEBs) and Districts (PEDs), POCITYF aims to transform those cities' mixed-urban environments, with a strong emphasis on cultural and historical protected areas, into greener, healthier, more accessible, and reliable spaces for their citizens. Going beyond the bounds of a purely technological project, POCITYF aims to improve, in a sustainable and citizen-driven manner, the wellbeing in the 8 mentioned cities, by incorporating and facing challenges in the political, economic, urbanistic, and social domain. To achieve the abovementioned goals, POCITYF consortium deploying total of 10 integrated solutions (ISs), comprising 73 individual Innovative Elements (IEs), such as technologies, tools, methods, rooted under the existing City Information Platforms.

The project will be carried out along 4 Energy Transition Tracks (ETTs), namely:

ETT#1: tackling the transformation of existing and new building stock into energy positive.

ETT#2: focusing on the application of grid flexibility strategies and storage systems, supported by Demand Side Management (DSM) platforms for optimizing energy flows to maximize self-consumption and reduce grid stress.

ETT#3: addressing the integration of e-Mobility to promote the decarbonisation of the mobility sector and alleviate inner-city traffic.

ETT#4: as an enabling layer of the above transition tracks, this intends to offer inclusive and holistic services for interdisciplinary citizen engagement and cocreation strategies with the city stakeholders and industry, towards the development of each city's own bold city-vision up to 2050.

The POCITYF objective #3 is framed within the activities under POCITYF Energy Transition Track #3: E-mobility Integration into Smart Grid and City Planning. ETT#3 encompasses 2 Integrated Solutions (IS): IS-3.1 deals with Smart V2G EVs Charging while IS-3.2 deals with E-mobility Services for Citizens and Auxiliary EV Technologies. Such as the previous two objectives, WP1 and the LHCs-related WPs have actively contributed to this goal within POCITYF first year. Starting with WP1: in D1.9 -City Vision and Master Plan for ETT#3 Solutions, T1.5 -, consortium is proceeding with a more detailed characterisation of the pre-pilots, demonstration, and replication activities linked with ETT#3 solutions. D1.1 will serve, again, as a support to the demonstration activities of this set of IEs. Évora and Alkmaar local consortiums (WP6 and WP7), parallelly to the work performed for ETT#1 and ETT#2, have been preparing the demonstration of these solution and dealing with corrective actions that were needed to comply with project impacts (e.g., replacement of solutions).

The city of Alkmaar will demonstrate, in selected demonstration areas, the integration of e-Mobility to promote the decarbonisation of the mobility sector and alleviate inner-city traffic. The selected integrated solutions are listed in the table below. Selected indicative paradigms of, but not limited to, such technologies/methods are:

- V2G technologies
- Charge technologies
- Intelligent charging control algorithms

All selected integrated solutions to be implemented in Alkmaar are listed in the table below.



ETT #3	IS3.1	PED 1 Westrand	V2G (buses)	3.1.4	Connexxion
			Intelligent and optimal control algorithm	3.1.6	TNO
			Smart solar charging (buses)	3.1.7	Connexxion
			Lamppost integrated EV charger	3.1.9	Municipality
		PEB 1.1 de Meent	Smart solar charging (cars)	3.1.7	Municipality
		PEB 1.3 Bloemwijk	V2G (cars)	3.1.4	Van Alckmaer
	IS3.2	PEB 1.4 InVesta	Smart solar charging (cars)	3.1.7	InVesta
		PED 1 Westrand	Hydrogen Powered HD Vehicles	3.2.2	Municipality
			Noise screen (alternative solar road)	3.2.3	Municipality
		PEB 1.3 Bloemwijk	EV sharing	3.2.1	Van Alckmaer

Table 1: ETT#3 Integrated Solutions

The initial report, delivered in the beginning of the monitoring phase, described the status of all the demonstration activities under the POCITYF Energy Transition Track 3. As M39 will also be the end of implementation stage, this report will provide information regarding the achieved compliance with the envisioned in the implementation plan for these activities.

1.1 Scope and objectives of the deliverable

The POCITYF project aims to embrace the Energy Transition Strategy by deploying four Energy Transition Tracks (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.

Each of the ETT3 solutions are identified to support the demonstration, replication, and acceleration of mature and innovative technologies.

This deliverable *D7.7 - Transition Track #3 Activities for Alkmaar* represents the first version due in M39, with the second version due in M60. The deliverable is part of T7.4 which encompasses all implementation activities planned under ETT#3. This report is to be submitted to describe the status of all the demonstration activities, and provides information regarding the achieved progress envisioned within the implementation plan. For Innovative Elements (IEs) that are still in the process of being finalized in their implementation, will provide an overview of current achieved status. The second version will provide the reiteration of the deliverable with updates up to M60.

1.2 Relation to other tasks and deliverables

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.

Due to the nature that this deliverable discusses, POCITYF Lighthouse City of Alkmaar relations to the other WPs are also relevant.



1.3 Structure of the deliverable

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

Chapter 1 - Introduction

Chapter 2 - Methodological Approach

Chapter 3 - Alkmaar Demonstration Area Description ETT#3

Chapter 4 - Demonstrating ETT#3: E-mobility Integration into Smart Grid and City Planning

Chapter 4.1; Smart V2G EVs Charging

Chapter 4.2; E-mobility Services for Citizens and Auxiliary EV Technologies

Chapter 5 - Conclusions

References



2 Methodological approach

This is not a technical deliverable; therefore, the methodical 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 questionnaire 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 questionnaires. All information was shared and presented to partners during a physical Alkmaar meeting in September and followed up by email with summarized instructions and links to the template questionnaires 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 questionnaires.

Next, the leaders of each ETT track consolidated the information from the questionnaires in this document and managed the reviewing process of the deliverable. Each ETT document was reviewed by another foreign partner in the POCITYF consortium. The POCITYF Partners were assigned by the POCITYF project management. This writing and reviewing process lasted for 1,5 months.

The document was finalized and uploaded in the EC portal before end of year 2022.

Timeline

Activity	Timeline	Involved Partners
Presenting upcoming deliverables during POCITYF Alkmaar partner meeting	14/09	ETT-leaders
Sending instructions to the Alkmaar partners	17/09	ETT-leaders
Providing input on the progress of demonstration activities of the different Innovative Elements	19/09 - 31/10	All POCITYF Alkmaar partners
Writing and consolidating deliverables	1/11 - 1/12	ETT-leaders
Review of the deliverables by assigned POCITYF partners	1/12 - 12/12	Reviewers
Finalization of the deliverables	12/12 - 20/12	ETT-leaders
Uploading the deliverables in the EC portal	20/12 - 31/12	João Bravo Dias
Final review and submission	20/12-31/12	ETT, Reviewers, PO

Figure 1: Timeline Methodological approach



3 Alkmaar Demonstration Area Description

- ETT#3

POCITYF aims to demonstrate and perform replication studies for the idea of V2G and smart solar power-driven charging stations to support the demand-supply energy management (with a scheme of smart charging management) at district-level, while increasing their large-scale energy storage capacity and promotion of more environmentally friendly mobility solutions. From the citizen perspective, this solution is the linking pin between ETT#1 and ETT#2 but addresses as well e-mobility aspects. As a result, the added value for citizens is the lower and stable energy bills, higher comfort and a more liveable and safer district resulting from ETT#1 and ETT#2 solutions, as well as affordable e-mobility thanks to this solution

The bases of POCITYF strategy are built around 4 multidisciplinary and complementary Energy Transitions Tracks (ETT). 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 (IS) taking the terms and focusses 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 (PEDs) by 2050.

Energy Transition Track (ETT) focuses on the increasing share of RES in the coming times. A key aspect of this is that energy generation will shift towards decentralized generation on the local household and block/district level operating in 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.

The IE listed below shows the integrated solutions within ETT#3. Each of these integrated Solutions will be discussed in chapter 4.1; smart V2G EV charging and 4.2; E-mobility Services for Citizens and Auxiliary EV Technologies.

- IE 3.1 Smart V2G EV charging include:
 - V2G charging of buses and cars
 - Charge control algorithms
 - Solar charging of buses and cars
 - Lamppost integrated EV chargers

IE 3.2 E-Mobility services for citizens and auxiliary EV technologies include:

- EV Sharing
- Hydrogen powered Heavy Duty Vehicles
- Noise screens

More details can be found in section 1.3.4 of the proposal. This chapter will provide an overview of the different demonstration locations in the POCITYF Lighthouse City of Alkmaar. For more background on the POCITYF Lighthouse City of Alkmaar, please see section 1.3.2 (of proposal) and D1.8 - City Vision and Master Plan for ETT#2 Solutions - version 2.



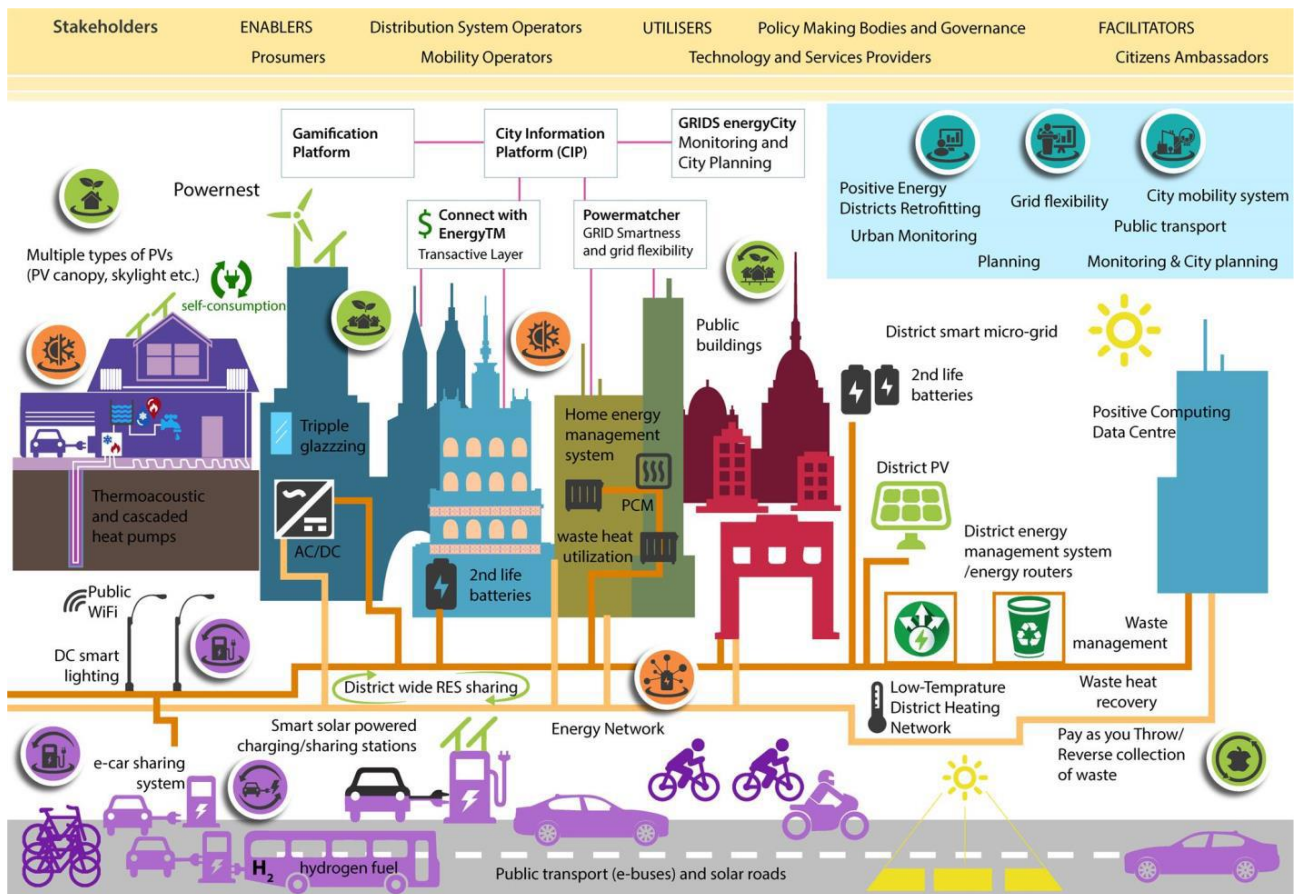


Figure 2: High-level conceptual mapping of POCITYF Integrated Solutions within the Lighthouse districts

3.1 PED Westrand

The city of Alkmaar is one of two lighthouse cities in the POCITYF project. The city is in the province North-Holland, a half hour from Amsterdam. The demonstration district for Alkmaar will be the Westrand area. The Westrand demonstration district of Alkmaar is in the west of Alkmaar. Over the years, the area has become densely populated and next to household's 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: the Westrand district; Green area

In Blue the Canal Zone replication area; In Red the historical city centre 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 m³ (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 usages are that of a typical Dutch household, with a peak in the morning and a high peak in the evening.

3.1.2 PEB description and demonstration activities

3.1.2.1 PEB 1.1 Sportcomplex de Meent

The Building Sports Complex de Meent is the Alkmaar sports location, which includes an ice rink, a gymnasium, and an indoor sports stadium; total floor area of 11.450m². Within ETT#3 the following Innovative Elements will be installed or utilized:



Innovative Element 3.1	Partners involved
IE 3.1.4 - V2G buses	Connexxion
IE 3.1.6 - Charge control algorithm	TNO / Connexxion
IE 3.1.7 - Solar Charging buses	TNO / Connexxion
IE 3.1.7 - Solar Charging cars	Municipality Alkmaar
IE 3.1.9 - Lamppost integrated EV charger	Municipality Alkmaar

Innovative Element 3.2	Partners involved
IE 3.2.2 - Hydrogen powered HD vehicles	Municipality Alkmaar
IE 3.2.3 - Noise screen	Municipality Alkmaar

Table 2: ETT#3 Innovative elements per Integrated Solution and partners involved



Figure 4: Location of sport complex De Meent

3.1.2.2 PEB 1.2 Woonwaard Highrise van der Veldelaan

Woonwaard Highrise 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#3 no innovative Element(s) will be installed or utilized.



3.1.2.3 PEB 1.3 Bloemwijk

The Bloemwijk area 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. ETT#3 focuses on V2G and EV sharing topics. Within ETT#3 the following Innovative Elements will be installed or utilized:

Innovative Element 3.1	Partners involved
IE 3.1.4 - V2G cars	Van Alckmaer

Innovative Element 3.2	Partners involved
IE 3.2.1 - EV Sharing	Van Alckmaer

Table 3: ETT#3 Integrated Solutions at Bloemwijk



Figure 5: Lay-out of phase 1 of Bloemwijk project

3.1.2.4 PEB 1.4 InVesta Expertise Centre

InVesta is an expertise centre located in the replication area that stimulated 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#3 the following Innovative Elements will be installed or utilized:

Innovative Element 3.1	Partners involved
IE 3.1.7 - Solar Charging cars	InVesta

Table 4: ETT#3 Integrated Solutions at InVesta



Figure 6: InVesta centre of expertise.

3.1.2.5 PEB 1.5 Woonwaard Dillenburg

Dillenburgstraat apartments 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#3 no innovative Elements will be installed or utilized.

3.1.2.6 Other demonstration activities

All ETT#3 IEs within the POCITYF project are directly linked to a demonstration area. No other demonstration activities or sites are intended, installed, or used, at this moment in time.



4 Demonstrating ETT#3: E-Mobility Integration into Smart Grid and City Planning

The bases of POCITYF strategy are built around 4 multidisciplinary and complementary Energy Transitions Tracks (ETT). 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 (IS) taking the terms and focusses 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 (PEDs) by 2050. The figure below shows the integrated solutions within ETT#3.

Each of these integrated Solutions will be discussed in chapter 4.1; smart V2G EV charging and 4.2; E-mobility Services for Citizens and Auxiliary EV Technologies.



E-mobility integration into smart grid



Smart V2G EVs charging

- **Smart solar charging** of e-cars and e-buses through an **intelligent and optimal control algorithm** (supported by open ICT) that alternates the charging scheme based on the local energy supply and demand;
- Installation of bidirectional chargers for cars and buses to provide flexibility to the grid. This **Vehicle-to-Grid (V2G)** technology allows electric vehicles to store electricity during peak production and to provide electricity during peak demand;
- Innovative **lamppost integrated EV charging station** with charging units for electric cars and electric boats.



E-mobility services for citizens and auxiliary EV technologies

- To reduce the required number of parking space and create more space for a green neighborhood, **EVs will be shared** by residents at one of the demonstration sites. The shared electric vehicles will offer the V2G functionalities;
- A **hydrogen powered heavy duty vehicle** will be deployed for residential waste collection within the city of Alkmaar;
- A noise barrier alongside a ring road in Alkmaar will not only diminish noise pollution, it will also generate electricity with the integrated solar panels (**PV Noise Barriers**).

Figure 7: ETT#3 Integrated Solutions



4.1 IS 3.1: Smart V2G EV charging

Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions encapsules seven Innovative Elements for the city of Alkmaar. In the following chapters, an overview of each IE will be provided. To keep the overview of the IEs comprehensive and in line 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 3.1	Partners involved
IE 3.1.4 - V2G buses	Connexxion
IE 3.1.4 - V2G cars	Van Alckmaer
IE 3.1.6 - Charge control algorithm	TNO / Connexxion
IE 3.1.7 - Solar Charging buses	TNO / Connexxion
IE 3.1.7 - Solar Charging cars	InVesta
IE 3.1.7 - Solar Charging cars	Municipality Alkmaar
IE 3.1.9 - Lamppost integrated EV charger	Municipality Alkmaar

Table 5: Overview of Innovative Elements in IS 3.1

Each of these integrated Solutions will be discussed in chapters 4.1.1 to 4.1.7.

4.1.1 Demonstrating IE 3.1.4 - V2G buses

IE 3.1.4 - V2G (buses)
Goal and Description of IE at the PEB
This Innovative Element has been changed from its description in the original Grant Agreement (being the demonstration of a bus that provides V2G services by Connexxion in Alkmaar) and has been included in the Amendment with reference ... with an amended description. The background to the change is as follows. The buses of Connexxion currently in operation in Alkmaar (62) are not capable of operating V2G services. A study was done on how these buses could be retrofitted with hard and software. However, the development of this software and hardware relies on the roadmap of the original equipment manufacturer (OEM) which is VDL. The OEM does not expect to develop V2G services for already sold buses. Next to technical reasons, also legislation and communication between buses and chargers and grid connections are not standardised which makes that the location of the task at De Meent in the Westrand is not suited.



To summarize the issues:

- There are no communication standards applicable for V2G for buses
- The impact concerning guarantees by the OEM and battery supplier need clarification
- Legislation on V2G for buses is not available in the Netherlands
- Possible high risks on range vehicles in timetables
- No clear impact on effect on current governmental grants
- None of the buses in the current bus fleet of Connexxion in Alkmaar are suitable for V2G
- Retrofit solution depends on road map OEM

Based on the above, the IE and its implementation has been changed as follows (and agreed upon in the latest Amendment).

A test will be carried out with a bus suitable for V2G services as soon as it is available from the OEM, VDL. With this, a field test can be done at a certain time with one bus and one charger. This test could be done with an already installed V2G charger at the Connexxion depot on the Helderseweg in Alkmaar, within the Westrand area. The test is expected to last a couple of days. In this way a first feasibility of V2G services in the Netherlands could technically be tested. The OEM expects a first bus ready for testing in 2024. The OEM is not a partner in this consortium, which means that Connexxion is bound by the speed and developments within the OEM. As a result, Connexxion has less influence on the completion of this task.

As V2G is becoming more important within the energy transition Connexxion needs to mature in this field of expertise. Feasibility and opportunities still need to be studied to understand if and how V2G could lead to a viable business case for public transport operators. Connexxion will therefor use the POCITYF grant contribution to study further on feasibility, impacts, risks and opportunities when implementing V2G technology, strategy, algorithms and services into public transport operations.

The goal of this IE is to perform an operational V2G test with a Public Transport bus of Connexxion from the city of Alkmaar. To test and understand the alignment needed between Bus, V2G Charger, and grid. If electricity can be transferred from bus to grid and vice versa, this would help to balance the electricity need within the Westrand area. If electricity can be transferred from bus to grid other or new rules and regulations must be set to define business cases, and business rules at operators and energy- and grid providers.

The diagram below shows a basic V2G set-up.



Figure 8: Basic possible V2G Set up



Below one of the BYD E-buses currently operated by Connexxion.



Figure 9: Connexxion BYD electrical buses within the Lighthouse districts

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

Connexxion: PTO and owner of buses from the city of Alkmaar.

Municipality of Alkmaar: End user of bus transport services

Alliander: Grid operator/provider

Van Alckmaer: Linked to innovative element of 3.1.4 (V2G cars)

TNO: Linked to innovative element of 3.1.6 (charging algorithms)

Progress achieved to M38

The essence is that a test with (partial) preliminary research is done that focuses on the following aspects:

- Suitability of Connexxion's existing charging infrastructure at the depot on Helderseweg in Alkmaar for V2G
- Suitability of Connexxion's existing e-buses for using V2G
- Suitability of the existing software for Connexxion's charging infrastructure and e-buses at the depot on Helderseweg for V2G



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



- d. Test with a V2G bus to determine which hardware (particularly charging infrastructure) and software adjustments are required at Connexxion in Alkmaar and what the consequences are for the depot in Alkmaar, the charging regime, operational deployment of the buses (ride schedule), etc.

Preparation phase (research, design)

The topics 'a' and 'b' have already been investigated with the conclusion that the existing charging infrastructure, software, and e-buses are not suitable for V2G. The conclusion is also that the buses cannot simply be modified and that an ex-factory V2G bus must be made available for this purpose. The existing charging infrastructure can be adapted for V2G with the current insights, but the test with the bus will also have to show whether and how progressive software developments have an impact on the software versions in the chargers.

Topics 'c' and 'd' can and will be addressed when the V2G bus is available, which is not expected to be until 2024. With the availability of such a bus for a few days, a field test can be executed, and the investigation can be completed to answer the question whether V2G is feasible at the bus depot on the Helderseweg and what adjustments are needed to make it possible. A specific point for attention here is whether and, if so, to what extent the existing control and monitoring software of the Connexxion back offices is sufficiently suitable to allow V2G to work at the bus depot on Helderseweg in Alkmaar. The budgeted costs of € 10,500 as included in the Amendment are estimated for adjustments to the back-office software side (not being software for the charger or for the bus) to make this possible for the test.

There is no budget planned or available in POCITYF to upgrade buses and chargers with the needed hardware or software. Next to this the software and standards to communicate between bus and charger are not standardized within the bus markets, which withholds OEMs to implement their final solution or propositions. Now that we cannot perform a test, this action is completed.

- Delivery of the materials, equipment, and technology

The V2G bus with which the field test can be carried out is not expected to be available from supplier VDL until 2024. The test and the issues associated with the question of how V2G services can be applied at Connexxion in Alkmaar can and will then be tackled.

- Installation/implementation of the innovative element

The actual field test with a V2G bus at Connexxion is planned for 2024.

- Operationalization phase

The operationalization consists of a field test with a V2G bus during a few days (most likely to take place in 2024).

Monitoring phase

The results of the field test will be recorded, but a long-term demonstration and therefore monitoring will not take place.

- Reporting phase

The field test is expected to have been carried out in the next report (month 60), so that the results can also be reported.



Faced barriers and lessons learned (M0 to M38)

Below the barrier(s) that have been faced and the lessons that could be retrieved from circumventing/resolving the barrier(s). Also, it is described which potential changes in the to be demonstrated solutions as well as the reasoning for the change are applicable.

1. Buses of Connexxion in Alkmaar are not equipped with V2G hardware, software, and communications systems
2. Chargers of Connexxion in Alkmaar are not equipped with V2G hardware and communications systems
3. Communications between Charger en Bus is not standardized
4. A set-up cannot be made within the POCITYF project to perform the V2G test
5. Buses can be made V2G ready, but this requires additional soft- and hardware costs.
6. OEM's (no consortium partner) are not willing to invest in or pilot with upgrading V2G in sold vehicles
7. Chargers can be made V2G ready, but this requires additional soft- and hardware costs.
8. V2G of buses is less mature than V2G of cars

Next steps (what will be done/what still must be done - add dates if known)

OEMs are planning V2G services soon. And new buses are being built for the Dutch market. Discussions by Connexxion with several OEM's are ongoing and as soon as there is a V2G bus available Connexxion aims to test this bus in Alkmaar. However, this depends on the availability of other partners not the ones in the consortium. The understood timeline from Dutch OEM's seem to suggest that a first bus with V2G capability should be operational in Q4-2023.

Connected IEs with ETTs

Connections are seen to the other IEs of the Westrand area. Linked to innovative element of 3.1.4 (V2G cars) and linked to innovative element of 3.1.6 (charging algorithms).



4.1.2 Demonstrating IE 3.1.4 - V2G cars

IE 3.1.4 - V2G (cars)
Goal and Description of IE at the PEB
The aim of this Innovative Element is to realize the V2G concept in Bloemwijk, which makes it possible to charge and discharge the batteries of an electric car (shared car). Part of this IE is also the connection and realization of 2 charging stations to the electrical supply of an apartment complex in Bloemwijk. The use of V2G (and bidirectional charging posts) allows for a storage of electricity generated to be used at the time there is a need for more electricity than is being generated at that specific moment in time. The electric vehicles are in effect used as batteries and can be both charged as well as emptied depending on the demand and supply of energy. This enables Van Alckmaer to not only charge and discharge the vehicle batteries but also the balance the energy demand and supply. This creates a flexible storage capacity which can relieve the electricity grid and store energy for when the supply of renewable energy is lower.
Role of partners involved
Van Alckmaer is the sole partner responsible for the implementation of this IE. In the process of finding suitable parties that can offer and implement the V2G concept in combination with the shared vehicle concept, New Energy Coalition has provided support to Van Alckmaer. This has led to finding a developer and provider of V2G charging infrastructure for cars called Venema E-Mobility Charge Systems B.V. (Venema), and a shared vehicle provider called Fluctis B.V. The intended collaboration between Van Alckmaer, Venematech and Fluctis has been laid down in a Letter of Intent.
Progress achieved to M38
Van Alckmaer has been in contact with Venema and Fluctis. Venema is responsible for the delivery of 2 bi-directional charging posts. Fluctis is responsible for operation and the connection to the energy management system of the building. Within Van Alckmaer there are still some decisions to be made about how the 2 electric shared vehicles can be implemented in the neighbourhood in a responsible way. Questions about the exploitation for the coming years needs to be answered by the end of 2022 to make a feasible project.
Faced barriers and lessons learned (M0 to M38)
Making shared electric cars interesting for tenants in social housing is challenging for Van Alckmaer since the subject is new for the organization and requires extra effort to realize this because of the unfamiliarity with it. It is important that a viable business case can be realized with the implementation of this IE. The expected use of the vehicles, operating costs, management, and availability of the



hardware play an important role in this. Van Alckmaer is currently investigating the necessary data and insights to see whether realization is promising.

Next steps (what will be done/what still must be done - add dates if known)

Van Alckmaer's next step is to concretise the Lol with Venematech and Fluctis about the implementation of the V2G (dis)charging infrastructure and connection to an apartment complex in Bloemwijk, as well as the purchase/lease of (a) V2G shared car(s). The aim is to complete this during the first half of 2023.

Connected IEs with ETTs

This IE has a relationship with ETT#1 (PV panels on buildings) and ETT#2 (Energy storage and management) and ETT#3 (IE 3.2.1)

4.1.3 Demonstrating IE 3.1.6 - Charge control algorithms

IE 3.1.6 - Intelligent and optimal control algorithm

Goal and Description of IE at the PEB

The primary goal of developing the Intelligent and Optimal Control Algorithm is to take into consideration the production peaks of solar panels as well as the charging demand peaks for EV buses. Self-consumption is increased, and peak power demands decreased by changing when the buses charge to better match the consumption by buses to the production profile of the solar panels. The task for this work is as follows:

Public transport buses are increasingly being electrified to increase their sustainability. In Alkmaar, Connexxion is managing the electrical bus fleet and its charging infrastructure. To enhance the sustainability even further, the energy needed for charging will be matched in real time with a nearby PV installation to use as much renewable energy as possible.



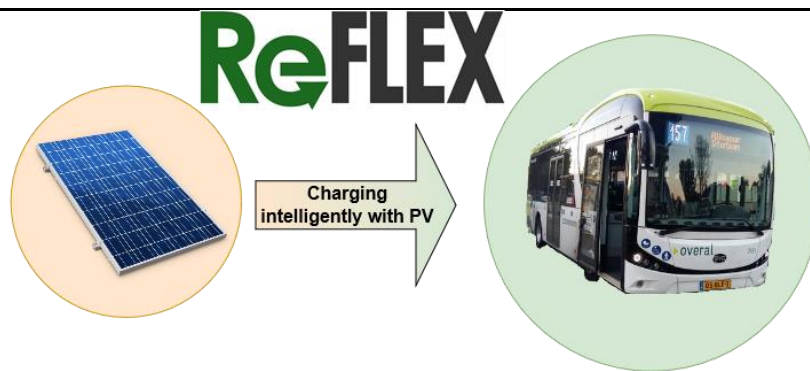


Figure 10: Positioning of the Reflex tooling

To provide a solution for the task posed, the tool ReFlex Insights has been used to show how much electricity from the PV installation may be utilized when the available energy flexibility in the EV bus charging sessions is used through simulation. To determine if ReFlex improves the matching, it was necessary to establish a baseline of how well the consumption and production matches. The baseline consists of the amount of electricity produced by the PV installation matched against the consumption of the EV buses without changing the charging behavior. By comparing the optimized results versus the baseline results it is possible to determine how much improvement is gained by utilizing energy flexibility.

This provided the following two research questions:

1. How much energy produced by De Meent PV can be used for charging the Connexxion buses without ReFlex (default behavior)?
2. How much energy produced by De Meent PV can be used for charging the Connexxion buses while charging is handled intelligently by ReFlex and energy flexibility is used?

The location of the Meent consists of many facilities including an ice rink and multiple gymnasiums. It facilitates a bike port and car port for visitors respectively park their bike and car. 'De Meent' has implemented multiple sustainability measures including 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).

Due to a lack of clean data, only the PV panels on the roof of the gymnasiums and the ice rink were considered. This is a total of 1726 PV panels with 275pW each. The PV installations on the roof of the carport and the bike port had significant gaps in the data due to maintenance and installation difficulties during which the installations did not record any data. Therefore, we have chosen to only use the PV panels on the roof of the gymnasiums and the ice rink.





Figure 11 :Top-down view of ‘De Meent’ sports centre (<https://sun-projects.nl/>)

The charging depot of Connexxion in Alkmaar is home to a 2MW electricity connection charging 44 buses. The drivers pick up the bus to start a ‘omloop’ or block which are several trips scheduled in succession. In between of the blocks, the bus is charged. During the night the buses charge their battery fully, so they are ready for the next day.

Connexxion currently exploits two types of EV buses at the charging depot in Alkmaar: the VDL and the BYD. The name for these types corresponds with the suppliers. More details can be found in the in table below:

Bus Type	Battery capacity	Battery max. charging power	# Of busses
VDL	180 kWh	60 kW (30 kW at night)	25
BYD	170 kWh	80 kW	19

Table 6 : Connexxion EV bus characteristics per type.

At TNO we have developed the intelligent supply & demand matcher called ReFlex. The advantage of ReFlex is that it enables the utilization of energy flexibility in a cluster of devices while optimizing towards an energy target or using the current electricity prices. ReFlex allows to both analyze the amount of energy flexibility through simulation while also creating plans in a real-time, operational setting. For this work, we have used the simulation mode of ReFlex which is called ReFlex Insights.

To use ReFlex Insights, we have modelled both the PV production and the Connexxion EV buses as a cluster of devices. We then let ReFlex Insights create a plan which will plan all EV bus charging sessions while utilizing the available energy flexibility. The PV production is non-flexible but still accounted for in the plan. ReFlex Insights will optimize the plan, so the EV bus charging sessions use as much of the PV production as possible.



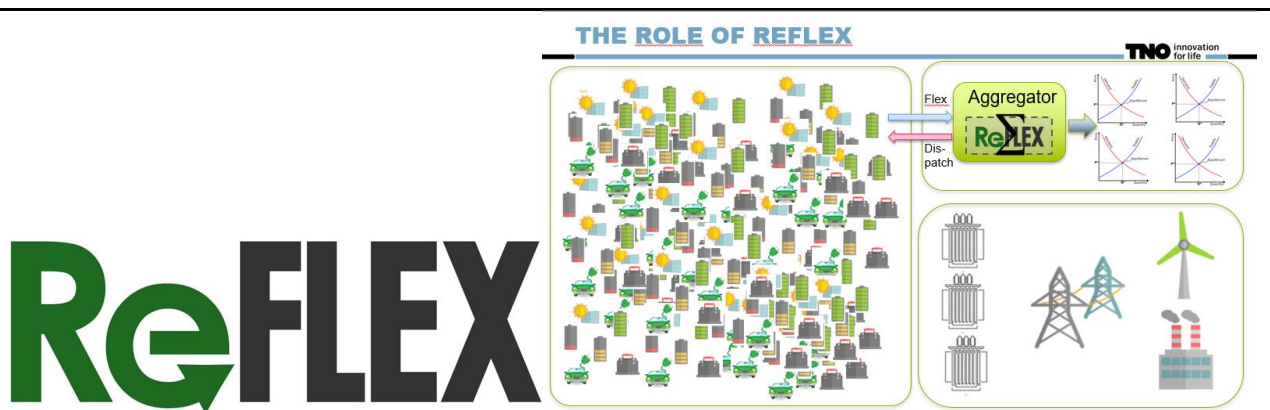


Figure 12: Reflex brand label and role

ReFlex Insights may be used for other, similar questions e.g.:

How many batteries and PV panels are necessary to solve a congestion issue caused by several heat pumps?

How much OPEX costs may be saved if tariff optimization is used?

How may charging of several EV's be influenced to shave the peak and lower the needed capacity on the grid connection?

The algorithmic core used for simulation purposes with ReFlex Insights can also be used in an operational setting.

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

TNO - Has developed the innovative algorithm and run the simulation.

Connexxion - Has provided domain knowledge and data for the EV bus charging depot in Alkmaar.

Alkmaar Sport - Has provided domain knowledge and data for the solar panels deployed at the "De Meent" building.

Progress achieved to M38

The demonstration of the algorithm has been completed. A simulation was developed and performed using a summer (July 2020) and winter week (January 2020) of PV data and the winter Connexxion charging schedule for Alkmaar 2021.

- Preparation phase (research, design)

Q4 2021: Received the charging schedule for the EV busses and conducted initial data analysis to understand the dataset. Also, creation of the simulation design including the integration of the ReFlex tool.



- **Delivery of the materials, equipment, and technology**

Q4 2021 - Q2 2022: Receipt of the solar panels production data and a translation key on how to interpret the data. Specifically, the translation key took a significant time to find.

- **Installation/implementation of the innovative element**

Q2 - Q3 2022: ReFlex tool was extended to fit the EV bus charging schedules and the solar panel production data. The baseline models for the EV bus charging and the PV production were created. The simulation results were gathered, analysed, and disseminated to the various project partners and at the SSPCR 2022 conference. With these steps this task has been completed.

- **Operationalization phase**

- N/A

- **Monitoring phase**

- N/A

- **Reporting phase**

Q4 2022: The necessary reporting steps have been completed including this report.

Faced barriers and lessons learned (M0 to M38)

The improvement of matching between solar panels production and EV bus demand by introducing the ReFlex tool to utilize the energy flexibility is minimal. This is due to the high amount of PV produced energy that is already matched to the demand of the EV buses with default behaviour and the minimal amount of energy flexibility available in the EV bus charging schedule. Results show the bus consumption against the PV production during the chosen summer week. We have shown that only if the PV installation system is scaled, will the matching between consumption and production improve as there is an overproduction of the PV installation compared to the demand of the EV buses. Examples of the scaled results have been built to highlights where we detail the bus consumption against the PV production scaled five times during the chosen summer week.

During the winter the PV production is low to nil. Similarly, this holds during the summer evenings, night, and mornings. An example of the winter week results may be seen in the graph 'Attachment C' where we detail the consumption against the PV production during the chosen winter week. In other words, the PV production was only significant during the daytime in summer. Therefore, the night demand of the EV buses will not be satisfiable by PV production no matter the scaling of the PV installation.

In conclusion, the energy produced by the PV installation of De Meent matches fully with the demand of the Connexxion Alkmaar EV buses, but the demand of the EV buses matches poorly with the production of the PV installation. More types of renewable energy sources need to be added to the mix to satisfy the demand of the EV buses when the PV production is low and so improve self-consumption.



Next steps (what will be done/what still must be done - add dates if known)

None, the task has been completed by developing the algorithm and demonstrating its use.

Connected IEs with ETTs

The algorithm developed and the simulations executed show how energy flexibility may be utilized to optimize towards a target or KPI such as self-consumption. This fits well with the other tasks in ETT3 / Task 7.5 where various innovative producers and consumers of energy are demonstrated. In other words, a future step outside of the scope of POCITYF based on the work in ETT 3 / task 7.5 would be to investigate the use of energy flexibility with the other IE's such as the Smart Solar Charging subtask.

4.1.4 Demonstrating IE 3.1.7 - Solar Charging Buses

IE 3.1.7 - Smart Solar Charging buses

Goal and Description of IE at the PEB

This innovative element is about the use case of the renewable solar energy of ice stadium The Meent to charge the buses. The Meent is generating Solar energy. The remaining solar, after the need of The Meent, can be used to charge Buses. The buses will be directly charged with the Solar of the Meent and will use the energy directly without interference of the grid operator. Using a DC/DC connection. This will lower the dependencies on the grid. It will increase the dependencies on renewable sourcing. Energy produced within the Westrand will be directly used within the Westrand, upgrading the local effect of energy systems.

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

Connexion: Buyer and user of the renewable solar energy

Municipality of Alkmaar; Producer and seller of renewable solar energy



Progress achieved to M38

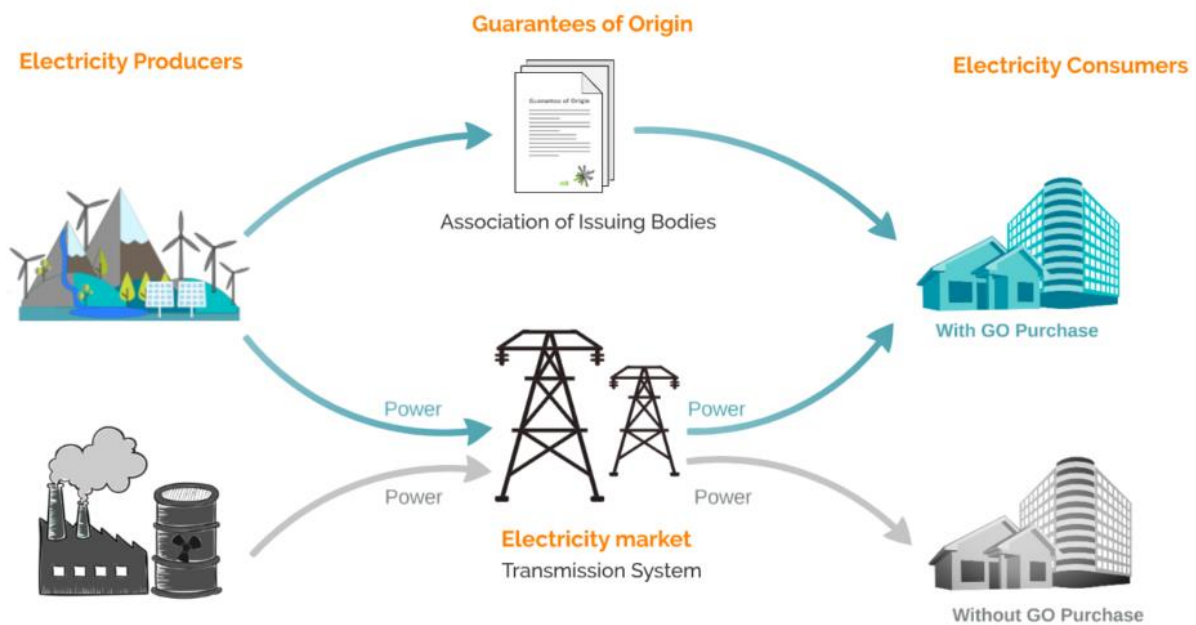


Figure 13: High-level conceptual mapping of Goo's

- **Preparation phase (research, design)**

The municipality (owner The Meent) agreed in 2022-H1 on a contract (solar of the years 2023-2024-2025) with Connexion. This was completed after a study by the municipality to understand volume of the GVO's and the understanding of the process

- **Delivery of the materials, equipment, and technology**

Q4 2021 - Q3 2022: Contract discussions including prices/periods are settled between the Meent, the GoO broker and Connexion. The quote and the proposal are awaiting the final agreement by the Municipality of Alkmaar. Meent delivers 2,268 Goo's for 3 years.

- **Installation/implementation of the innovative element**

The renewable solar energy generated by the Meent is virtually, via certificates/guarantees of origin (GoO), used to charge the buses in the depot on the Helderseweg. In this process the current grey energy used for charging the buses is transferred into green energy via certificates/guarantees of origin. The certificates of origin are from the solar energy generation plant of the Meent.

- **Operationalization phase**

The forecast is that The Meent delivers 2,268 Goo's for 3 years. This is based on the 756 Annual Expected Production, as 1 GoO equals 1 MWh of solar power. This applies to the full capacity of optimal solar production from the solar panels.



- **Monitoring phase**

Monitoring will be done outside of the POCITYF project. POCITYF can assume that the full amount of GoO will be delivered to Connexxion. If needed, GA can supply a yearly overview of the GoO's.

- **Reporting phase**

Q4 2022: The necessary reporting steps have been completed. With this action the task is completed.

Faced barriers and lessons learned (M0 to M38)

For Solar charging the issue is technical. Currently 1.750 PV panels are available at the Meent. However, there is no charging or storage facility at the Meent. The 42 chargers now available in Alkmaar at Connexxion are not able to utilize the solar directly from solar panels. However, these chargers support DC to AC solar transferal. At the Connexxion depot no PV panels are available.

In the POCITYF budget of connexxion solar panels or chargers are not budgeted. The needed DC to DC chargers are not available in Alkmaar at this moment. Furthermore, the proposed charge location of the Meent is not suitable, is not planned to be developed for this task.

To summarize what is inventoried the past months as issues:

No stations or storage available at de Meent,

High investments needed, not budgeted in POCITYF.

No DC-DC chargers at de depot Connexxion or at the Meent

No charging location at the Meent in timetable, not intended as well.

No restricted area for testing available.

Bus batteries need high power charging, too much for direct current solar charging.

Possible time issues when slow charging buses.

Therefore, solar charging as stated in the grant agreement cannot be technically realized this information was not known at local level when writing the grant agreement in the beginning of the project. Because of the technical issues, a mitigation was planned; via a virtual transferal of the solar energy from the Meent to the buses.

Next steps (what will be done/what still must be done - add dates if known)

The quote and the proposal are awaiting the final agreement by the Municipality of Alkmaar. Final steps are to perform the formal signing of the contract between Alkmaar and Connexxion which is expected before 2023-H1. And to yearly transfer the GoO towards Connexxion.



Connected IEs with ETTs

The Meent cannot use the, with Connexxion, contracted Solar energy for other usages. This could impact other IEs at the Meent, such as 1.1.14 and 3.1.7.

4.1.5 Demonstrating IE 3.1.7 - Solar Charging Cars at InVesta

IE 3.1.7 - Smart Solar Charging (cars) (the InVesta case)

Goal and Description of IE at the PEB

Due to the intermittent nature of Renewable Energy Sources (RES) and highly fluctuating pattern of electricity consumption there often is a mismatch between electricity supply and demand. Zooming in on mobility, this is also the case with the charging pattern of battery electric vehicles compared to the production profile of solar panels. The goal of IE 3.1.7 - Smart Solar Charging is to better match the charging pattern of an EV charger to the electricity availability on site. The innovative element (IE) is being demonstrated at the center of expertise of InVesta (PEB 1.4).

InVesta's center of expertise provides a suitable use case due to the presence RES in the form of various solar panels (IE 1.1.14) and a stationary battery (IE 2.1.8) to temporarily store energy during peak production. The smart EV charging unit that will be demonstrated at InVesta will optimize the charging scheme based on 1) the preferred charging duration and vehicle range of the user, 2) the electricity production profile of the solar panels, and 3) the availability of stored energy by the stationary battery. Also, the three components - solar panels, stationary battery, and smart EV charger - will be linked via an internal direct current (DC) grid (IE 2.1.11) to mitigate energy losses. More information on the demonstration of the internal DC grid at InVesta can be retrieved from the dedicated section in D7.7 (ETT#2).

The specifications of the smart DC/DC EV charger cannot be provided yet as no final decision has been made on the purchase of a final charging unit. New Energy Coalition is in close contact with Venematech that seems to offer a suitable solution that matches the description above. Venematech develops a 10kW unidirectional DC/DC charging unit that will be capable to be connected to an internal DC grid and battery as well as the solar panels. Venematech expects to need three more months of technology development before the solution can be delivered.

It should be noted that Venematech is also involved in the demonstration of V2G and EV sharing at Bloemwijk in which Venematech will provide the bidirectional EV charger. New Energy Coalition will organize a meeting with InVesta, Venematech and Indutecc (who provides the DC grid and battery) in the month of December. Hopefully, an order for the smart DC/DC EV charger will then follow quickly after the meeting.

Next to the smart DC/DC EV charger, InVesta also installed a more standard 'EV Box dual charge Business-line 32 Ampere (2x16A)' with two charging points. The installed EV Box is depicted below:





Figure 14: Installed EV boxes at InVesta

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

As of November 2022, the regular EV Box with two (AC) charging units has been installed. Regarding the implementation of the smart DC EV charger, a meeting with Venematech, Indutecc, and InVesta will be initiated by New Energy Coalition to discuss the possibility further.

-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 technology provider that offer a DC/DC smart charging solution that can be connected to the energy management system and stationary battery. It is intended to conclude the preparation phase by the end of January 2023 with the order of the Venematech solution.

-Delivery of the materials, equipment, and technology

No exact delivery date can be given for the potential smart DC EV Charging solution provided by Venematech. However, Venematech did communicate that it will take approximately three months of technology development before the solution can be delivered to InVesta.

-Installation/implementation of the innovative element

Despite the uncertainty on the exact delivery date of the smart DC EV charging solution it is intended by InVesta to install the solution by the end of spring 2023.

-Operationalization phase

The solution is intended be operationalized by the summer of 2023. It should be noted that InVesta first must establish a connection to electricity grid before the charging solution to become operational (see faced barriers). Also, its final configuration, with the integration of the stationary battery, might be established a few months after the operationalization of the charger.

-Monitoring phase

The monitoring period is expected to start shortly after the smart DC EV charger is operationalized and thereby expected to start in the summer of 2023.

Faced barriers and lessons learned

The first phased barrier was the identification of a suitable solution (and technology provider) that matches the described scope of the intended solution. Since AC/DC is still considered to be the standard not many EV charger developers and providers offer a DC/DC solution that can directly be connected to the solar panels and stationary battery via an energy management system. A promising technology provider that develops the intended solution seems to be found in the company of Venematech.

Secondly, there is the issue of grid congestion. As a result of growing demand and supply of renewable electricity, the grid capacity has reached its limits. As a result, a growing number of regions within the Netherlands, including the Boekelermeester in Alkmaar where InVesta is situated, cannot connect new premises with a relatively high electricity demand and/or electricity production 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, and one potential solution has been identified that has the potential to solve this issue by the end of spring 2022. Once this solution is realized, multiple energy related installations, such as the smart DC EV charger, will be operationalized.



Next steps

The most pressing next step is to come to an agreement on the to be ordered smart DC EV charger. Hopefully, and expectedly, this agreement will shortly be finalized after the upcoming meeting in December between NEC, InVesta, Venematech and Indutecc. Afterwards, the solution is intended to be implemented and operational in the summer of 2023.

Key requirement for the operationalization phase is the establishment of a grid connection. As a result of the grid congestion, InVesta is currently still operating on construction power. It is expected that by the end of spring of 2023 a grid connection will be established that will also allow the EV charger to become operational. After that, the focus will be put on monitoring the performance of this innovative element which is also expected to start by the summer of 2023.

Connected IEs with ETTs

As indicated earlier, the Smart Solar Charging (IE 3.1.7) is directly connected to the solar roofs and facades (IE 1.1.14) and stationary battery (IE 2.1.8). These elements are all DC/DC connected by the Ferroamp EnergyHub XL; the energy management system (IE 1.1.8) provided by Indutecc that optimizes the energy flows.

4.1.6 Demonstrating IE 3.1.7 - Solar Charging Cars at de Meent

IE 3.1.7 - Smart Solar Charging cars

Goal and Description of IE at the PEB

Within Sport complex de Meent the goal is to replace a fossil source (natural gas) with a renewable source (using residual heat from the ice rink and heat-cold storage) which results in CO2 reduction. Electricity though is still needed; this is then generated locally with solar panels. The solar panels and e-charging points will be connected to a battery to create a smart electrical grid. With this smart grid we want to achieve an efficient and flexible use and control of the supply and demand of electricity. the result is minimal grid stress and curtailment due to power peaks in offer (solar) or demand (electric vehicles), and maximal profits of the installed interconnected energy, mobility, and ICT infrastructures.





Figure 15: Solar panels at the Meent charging points

It is not a vehicle 2 grid solution but PV to battery - battery to vehicle. PV will be used directly at the charging point using converters (DC/AC en AC/DC).

This IE includes 8 charging stations for cars with 2 charging points each (= 16 charging points) and 20 charging stations for bicycles. The model charging point is Public Line 3P 16A 2xT2. The solar panels have a 355-Watt peak power per panel and a positive power tolerance between 0 and +10W. In total the power capacity is 475kWp. The charging stations for bicycles will not be connected to the smart grid due to the low supply and demand. The bike port has 72 bifacial solar panels.



Figure 16: Charging stations for cars and bicycles



Role of partners involved
POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are: Municipality of Alkmaar: Owner of the assets Firan (Alliander) with the smart grid (BEMS) de Meent
Progress achieved to M38
Preparation end of 2019, tender published in January 2020, awarded in June 2020. Carport has been realized December 2020, bike port in June 2021. Is fully operational now. Monitoring is already possible, done via battery by Firan. But at this moment Firan is still working on the smart grid.
Faced barriers and lessons learned (M0 to M38)
First tender yielded no results due to specifications of the issued permit. And due to the specifications of the permit, the installation of the solar roof it is not vandalism proof. Which means that we have had several issues when there was no possibility of charging cars. Although the traffic decision has not yet been made for the parking spaces at the charging stations, spots remain empty for electric cars. Ownership, management, maintenance, and operation of the solar roof and charging poles are separated. This was complex in the realization of this IE due to some confusion of who is doing what. All wanted data about the charging poles must come from Sun Projects and is not delivered directly to the owner, the municipality. But the data is handed over monthly. Due to Covid we had less cars parked and charged than expected. So, we still must see in what way the charging poles are used
Next steps (what will be done/what still must be done - add dates if known)
This IE is operational and can be monitored.
Connected IEs with ETTs
Connected with solar roofs (1.1.14), battery (2.1.8) en 3.1.7



4.1.7 Demonstrating IE 3.1.9 - Lamppost integrated EV charger

IE 3.1.9 - Lamppost integrated EV charger

Goal and Description of IE at the PEB

It is favorable to reduce the number of objects within the monumental street view in the city center of Alkmaar. Nowadays, several infrastructural objects are present in the narrow monumental streets of the beautiful city center of Alkmaar:

1. Electrical charging station for cars
2. Electrical charging station for boats, incl. electrical feeding (connection) box
3. Regular lampposts

Besides the disturbing view of these objects in the vicinity of the monumental buildings, the separate objects cause space in the narrow streets and thus reducing the available parking space and/or space in the streets. By applying a combined charging lamppost there will be one object instead of three different objects. After long research we had to conclude that, for now, it is not feasible to have a smart lamppost with charging stations for cars and boats integrated in a historic designed lamppost. But we have found a good alternative, we will “transform” a nostalgic designed lamppost into a smart lamppost. An existing “nostalgic looking” lamppost (see next photo) will be replaced by a Nedal lamppost with integrated charging points. The top part with the LED Luminaire will be reused. The two techniques will be combined in one object.

The aimed configuration is a master/satellite construction which consists of one ‘master’ charging station with 2 sockets and ‘satellite’ lamppost-charger with 2 sockets. The master-station is the feeder of the lamppost charger. This ‘master’ charging station has an increased grid connection (3x35A instead of the regular 3x25A) to be able to feed 4 sockets. Due to regulations in The Netherlands, the sizing of the grid connection including the required Smart Energy Meter from the DSO/Grid Operator, does not fit in a lamp-post column. Therefore, power must come from an external source like a grid connection box or, in this case, another charging station.

The power output per socket is 11 kW maximum (3x16A), and all 4 sockets are balanced within the limits of the 3x35A grid connection. This means that when all 4 sockets are occupied, the available capacity from the grid connection is divided via a smart algorithm. This algorithm considers the connection time, the actual required power by the vehicle and the number of phases (EV’s can charge on 1, 2 or 3 phases). The algorithm is based on the Open Charge Point Protocol, which allows a Charge Point Operator to balance power over different brands and types of charging stations.

The general specifications can be found below:



Master charging station

Brand: Enovates

Type: Pro-series public

EVSE's (sockets): 2, Type 2

Grid connection: 3x35A (24kW)

Output: 3x16A (11kW) per EVSE/socket

Communication protocol: OCPP v1.6

Smart Charging Technology: Cloud Based Smart Charging via OCPP with proprietary algorithm from green flux

Operator: Total Energies

Lamppost Charger

Brand: Nedal/City Charge

Type: LaadTaarn

Size: 4-8 meter (to be determined)

EVSE's (sockets): 1 or 2, Type 2

Connection: fed by external power source (master charging station), 3x32A

Output: 3x16A (11kW) per EVSE/socket, + power for LED-light from lamppost (accessible via separate door in the column)

Communication protocol: OCPP v1.6

Smart Charging Technology: Cloud Based Smart Charging via OCPP with proprietary algorithm from green flux

Operator: Total Energies

Color is RAL 8012.



The location is just outside the historical center, but at the canal that is surrounding the city center.

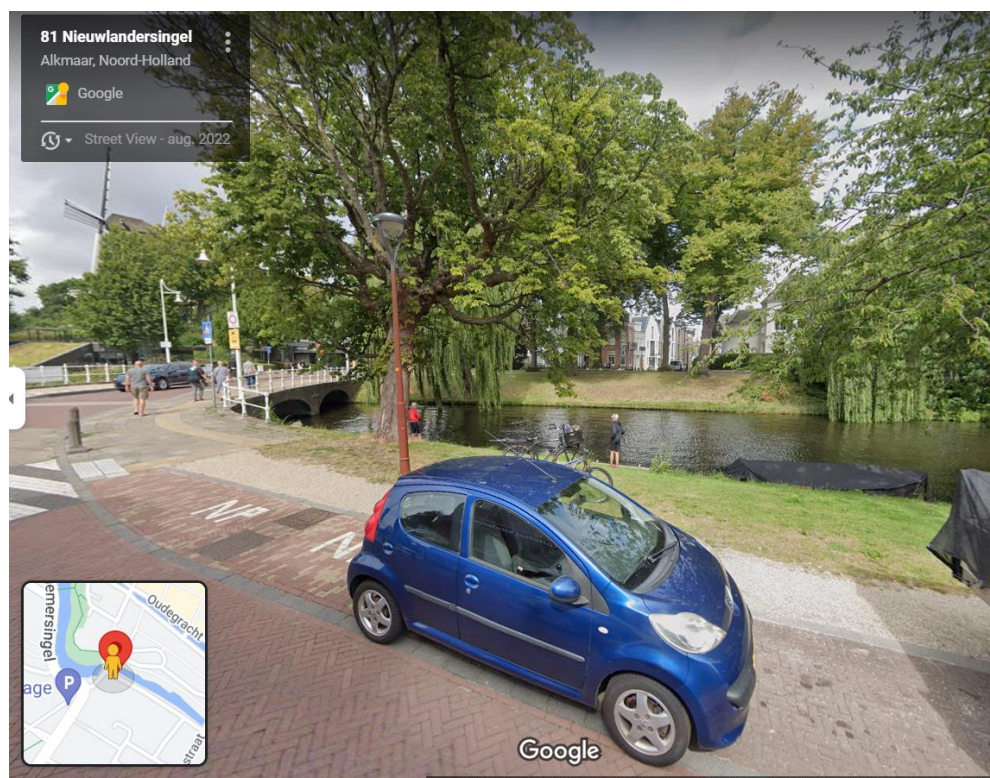


Figure 17: Positioning of the lamppost

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

Municipality of Alkmaar: End user

Alliander: Grid operator/provider

Progress achieved to M38

This innovative element has been thoroughly researched. Since this lamppost had to be realized in public space and within a historical city centre, we encountered quite some challenges / a lot of regulation. The existing equipment, in particular the meters were not small enough to fit in the existing historical lamppost.

We have investigated several possibilities:

Cutting the armature in half: the top part with the LED Lumiere and the slender pole will be reused. The bottom part will be a modified charging station was not possible, not safe, and not certified

Researching the possibilities in changing the prescribed materials for historical design (not possible, not allowed by local regulation)



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



If the producer of the cast iron historical lamppost could make it slightly slimmer so equipment could fit not possible, is a mold too difficult to adjust

Other producer of charging poles that can fit in historical designed cast iron lamppost: not existing

Historical lamppost with only 1 charging point: even that was too difficult to realize.

Existing smart lamppost: would be a possibility, but not in the historical center (lamppost is too big and modern). And then we had to change our supplier which would create difficulties in implementing the charging unit.

After a year of looking at all the possibilities we finally have found the solution as mentioned above. Expected status end of November:

- Application for (parent) charging station already approved, permit granted and traffic decree irrevocable
- Application for (parent) charging station is already in suppliers' system, but date of placement has yet to be determined

Faced barriers and lessons learned (M0 to M38)

The existing equipment is too big (meters) to be put in the existing historical design.

Adjustment of a meter is not easily done. Design, production, and certification of meters takes a very long time. And especially since in Alkmaar (at this moment) it had to be done for 1 smart lamppost.

Other materials may not be used because of regulations and safety reasons

Cutting the pole in half and adjusting the armature was not possible for safety and certification reasons

Existing smart lampposts are big and have a very different (modern) design for historic center

You must deal with regulations for charging poles as well as for public lightning.

Responsibilities for liability and maintenance must be very clear (different ownership of charging and lightning)

Next steps (what will be done/what still must be done - add dates if known)

GA must send the fixture data of the nostalgic lamppost to the supplier who will check whether Nedal charging lamp can be coated in Ral 8012. Then charging lamp will be ordered. Planning as far as currently understood is that the charging station will be installed this year. Should be possible together with this nostalgic smart lamppost.

Monitoring can start in Q1 2023.

Details of monitoring must be discussed between GA and supplier. There is one possible threshold: this charging pole must be able to be integrated into their system, platform. These tests are currently being carried out; we expect start of November 2022 the green light.



Connected IEs with ETTs

Not connected to other IE's.

4.2 IS 3.2: E-mobility services for Citizens and auxiliary EV technologies

Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions encapsules seven Innovative Elements for the city of Alkmaar. In the following chapters, an overview of each IE will be provided. To keep the overview of the IEs comprehensive and in line 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 3.2	Partners involved
IE 3.2.1 - EV Sharing	Van Alckmaer
IE 3.2.2 - Hydrogen powered HD vehicles	Municipality Alkmaar
IE 3.2.3 - Noise screen	Municipality Alkmaar

Table 7: Overview of Innovative Elements in IS 3.2

Each of these integrated Solutions will be discussed in chapters 4.2.1 to 4.2.3.

4.2.1 Demonstrating IE 3.2.1 - EV Sharing

The IE 3.2.1 EV sharing relates to IE 3.1.4 V2G cars. The progress of IE 3.2.1 is described in IE 3.1.4. Van Alckmaer has been in contact with Venema E-Mobility Charge Systems B.V. and Fluctis BV. Venema is responsible for the delivery of 2 bi-directional charging posts.

Fluctis is responsible for operation and the connection to the energy management system of the building. Within Van Alckmaer there are still some decisions to be made about how the 2 electric share vehicles can be implemented in the neighbourhood in a responsible way. Questions about the exploitation for the coming years needs to be answered by the end of this year to make a feasible project.

Van Alckmaer's next step is to concretise the Letter of Intent with Venematech and Fluctis about the implementation of the V2G (dis)charging infrastructure and connection to an apartment complex in Bloemwijk, as well as the purchase/lease of (a) V2G shared car(s). The aim is to complete this during the first half of 2023.



4.2.2 Demonstrating IE 3.2.2 - Hydrogen powered HD vehicles

IE 3.2.2 - Hydrogen Powered HD Vehicles

Goal and Description of IE at the PEB

The municipality of Alkmaar aims to utilize sustainable vehicles for the collection of waste. The use of battery electric vehicles (BEVs) is not suitable as the required battery pack will be extremely heavy. Instead, fuel cell electric vehicles (FCEVs) are more suitable for heavy transport because of the lower weight and longer driving ranges.

When comparing a regular diesel-based truck to a hydrogen powered truck through a back-of-the-envelope calculation, the saved CO₂ emissions can be determined. A hydrogen powered truck uses 4,6 kg per 100 km covered, meaning that with a storage tank of 15 kg, a total distance of 326 can be covered. Which results in a Co₂ Emission of 11Kg. Meanwhile, a diesel fueled truck uses 31 liter per 100 km covered meaning that it burns 101 liters to cover the same distance. With a CO₂ emissions factor of 3,23 kg CO₂ per liter diesel (well-to-wheel), which results in a Co₂ Emission of 329Kg. A total amount of (329kg-11kg=) 318kg CO₂ is saved each time the hydrogen powered HD vehicle is fueled instead of diesel fueled truck.

A DAF CF FAN (6x2 truck) will be used for the demonstration of this innovative element. Hyzon Motors will transform this diesel fueled truck into a hydrogen powered heavy duty (HD) vehicle. The diesel fuel engine will be replaced by a 40-kW proton exchange membrane (PEM) fuel cell, 150 kW PEM electric motor and a 15 kg hydrogen storage tank to move the HD vehicle. Besides these components a 136-kWh fuel pack will serve as a small buffer.

Next to the hydrogen fueled truck, a waste collection body developed by Olympus and offered by Terberg Matec will be used for the collection of waste in the city of Alkmaar.

The demonstration will make use of a DAF CF FAN with a wheelbase of 3.80 meter. About the waste collection body, the plan is to incorporate the OL21W (volume = 21 m³) with an OmniMax container loading system. MX-11- motor, 6 cilinderdieselmotor, 10,8 liters. Power 220KW (299pk) at 1675 revs per min. Max.torque 1350 Nm at 900 - 1400 revs per min.

The loading of the OmniMax is a multifunctional load which can empty fully automatic and separate 2-wheel containers from 60 to 330 litre (in accordance with EN 840.1), semi-automatic 4-wheel entertainers of 660 liters - 1200 liters (in accordance with EN 840.2 and EN 840.3), manual carrying containers of 25 and 40 liters, Bammens containers from 500 to 1600 liters in accordance with EN 840-4.



OLYMPUS OMNIMAX



Figure 18: OmniMax container loading system

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

Municipality of Alkmaar: End user of garbage services

HVC (as the municipality has outsourced garbage collection since July 2022 to HVC)

Progress achieved to M38

The purchase of the truck was depending on the arrival of a hydrogen filling station in Alkmaar. Because the costs of both investments (hydrogen filling station and garbage truck) are substantially higher than the purchase of a conventional diesel-powered garbage truck, a subsidy has been requested and granted through a Dutch subsidy scheme (DKTI). It took some time, but the hydrogen filling station will be ready for use between April and June 2022.

Due to delivery problems at Hyzon Motors, the garbage truck is not yet transformed and unknown when this will be realized.

Faced barriers and lessons learned (M0 to M38)

The dependency on a filling station was quite an obstacle.

Next steps (what will be done/what still must be done)

The most important next step is the installing of the innovative element and getting it ready. The final steps are of course the monitoring of the performance.

Connected IEs with ETTs

Not connected to other IE's.



4.2.3 Demonstrating IE 3.2.3 - Noise Screen

IE 3.2.3 - PV Noise Screen (Alternative solar road)

Goal and Description of IE at the PEB

The municipality of Alkmaar commissioned the construction of a so called ‘Energieleverend Geluidsscherm’ which can be defined as solar energy producing noise barrier (‘PV noise barrier’) on the side of a road. On the one hand, the technology serves the purpose of regular sound barriers that mitigates noise pollution for residents living in the vicinity of the road, and on the other hand, the technology produces renewable energy to create a more sustainable energy system. This first PV noise barrier with 5.000 solar panels will be constructed alongside the Schagerweg (N245), Huiswaarderweg (N245) and Nollenweg (N508). The technology is scalable, and the municipality of Alkmaar aims to support the realisation at least 10 PV noise barriers in the upcoming years.

The advantages of the solar screens are:

Minimal pollution of the landscape, which is the case with large fields of solar panels. Some citizens object to this “sight” pollution.

Solar screens have a noise reduction function for neighbouring districts, which offers advantages for the citizens.

High visibility of this innovative element, emphasizing the effort which is done towards the goal of an energy neutral Europe by the Dutch government and European Union.



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



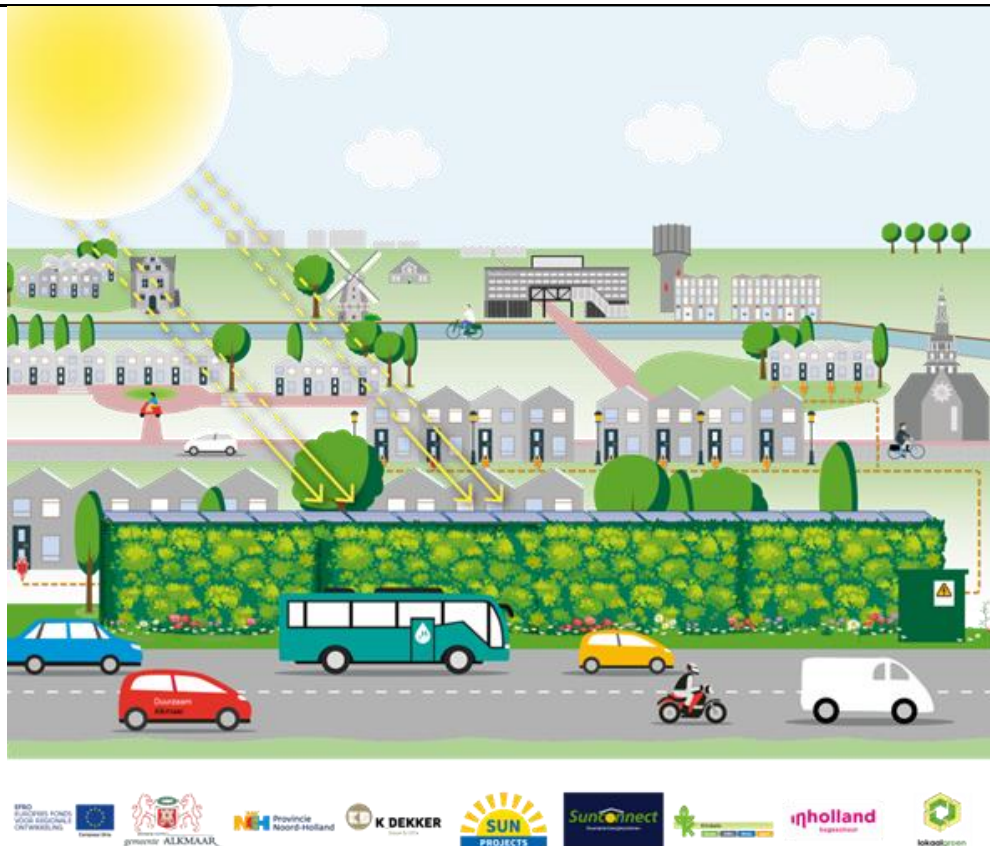


Figure 19: Noise Screen designs

Specifications:

The targeted output of this to be demonstrated solutions are electricity production, avoided CO2 emissions and reduced noise pollution:

Electricity production: +/-1.000 MWh/y (1,875 MW - sufficient for 420 households)

Avoided CO2 emissions: 1.000 tons per year

Reduced noise pollutions: > 55 dB

Revenue: minimum of €80.000 per year

Cost: Investment cost: € 7,3 million. Partly subsidised through EFRO and SDE++

Dimension: Size: 2,5 km length x 5,7 m high. Total number of solar panels: 4.463



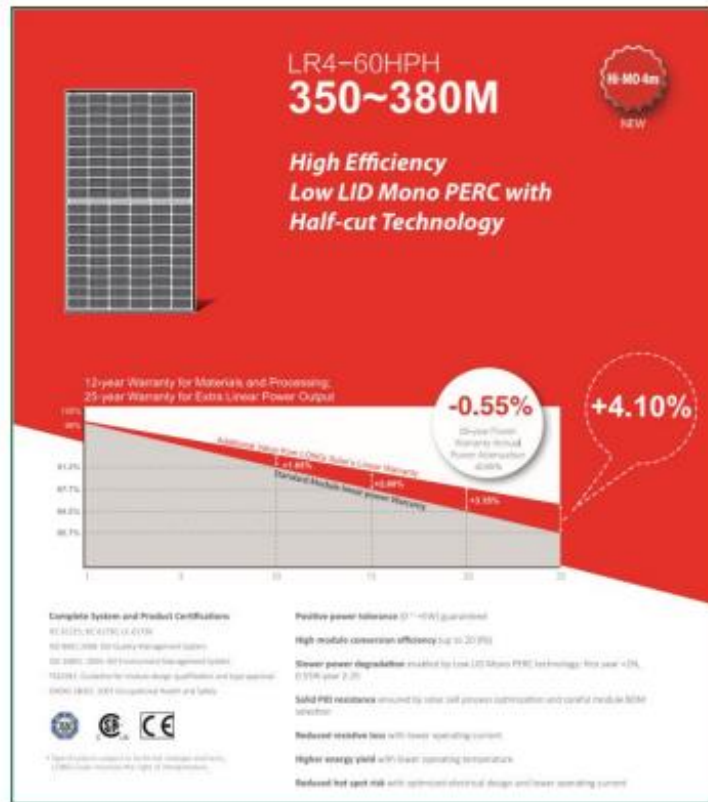


Figure 20: Noise Screen PV panel characteristics

Role of partners involved

POCITYF partner(s) involved and their role with the demonstration of this specific innovative element are:

Municipality of Alkmaar: End user of the noise barrier

Progress achieved to M38

The location of these innovative solar screens is outside PED area; they are in the area north of Alkmaar, next to the PED area, but within the Alkmaar city boundaries.



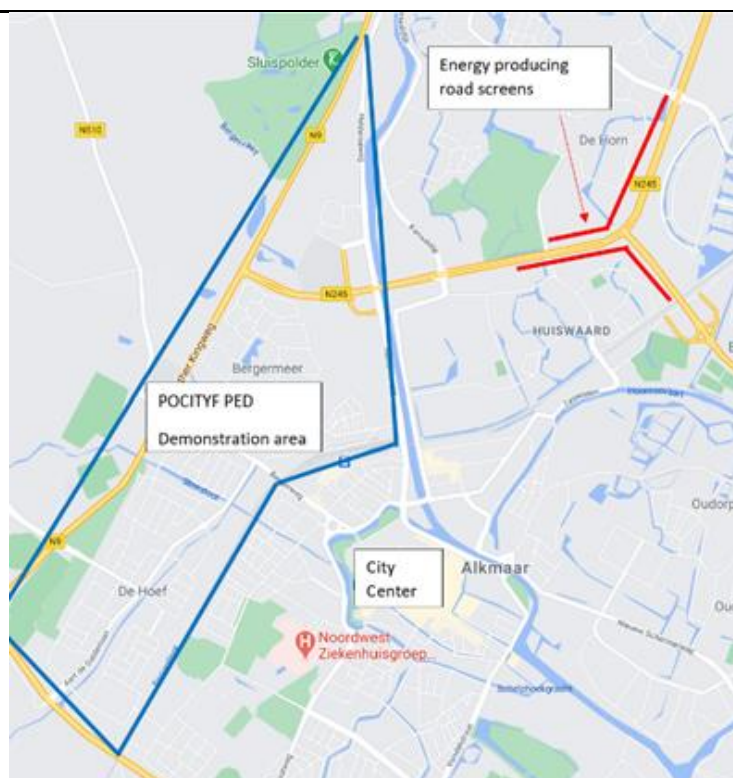


Figure 21: Positioning of the Noise Screens within the Lighthouse districts

- **Preparation phase (research, design)**

May 2020: Council decision

August 2020: SDE and EFRO subsidy

November 2020: Contract reached

Spring/autumn 2021: several research to flora and fauna, input for final design

September 2021: information meeting citizens and stakeholders, input for final design

End 2021: Final Design approved, environmental permit and contract realization

July 2022: Additional costs approved by city council

September 2022: information session citizens and stakeholders

- **Delivery of the materials, equipment, and technology**

November 2022: start build

Construction has just started first week of October 2022

- **Installation/implementation of the innovative element**

Construction is expected to be finalized in June 2023

- **Operationalization phase**

- N/A



- **Monitoring phase**
 - o N/A
- **Reporting phase**
 - o N/A

Faced barriers and lessons learned (M0 to M38)

Key requirements for the deployment this solution are the required areas to construct this solution and the solar irradiation gradient. Another key requirement is the opportunity to feed-in the produced renewable electricity into the electricity grid. Other factors that must be considered are:

- 1) the potential impact on flora & fauna,
- 2) law & regulations,
- 3) rigidity of the frame construction and solar panels, and
- 4) fire hazards.

Lessons learned:

First: a lot of research had to be done.

Check Nature Protection Act

Measurement of the terrain

Performing CPTs (sondering)

Test noise calculation

Inventory of flora & fauna.

Engineering of main structure / profiles

Yield calculation of PV panels

Technical and financial feasibility route-shift Huiswaarderweg

Resulting in adjustment of planning and design. But due to the research and the involvement of local groups of citizens and nature protection groups the design was improved. And less trees need to be cut. The changes were causing some delay. So, take the time for preparation of this project.

Intensive Citizen engagement: we had highly involved citizens, communication was and is essential with these engaged stakeholders. Difficulty was that they had conflicting interests. The residents wanted as soon as possible noise reduction, the nature protection group no trees cut and good care for flora and fauna. We tried to give them a say in this project, as much as possible. But that was not always possible. That creates frustration. And due to so many partners and stakeholders, it is a complex project.

In the realization phase you need to prepare the construction very well due to traffic. A lot of permits had to be applied for environmental permit, logging permit, permit for underground work and the permit for placing a construction sign. And in the realization phase you need to prepare the construction very well due to traffic. And make good arrangements in management and



maintenance. Finally: land transfer must be arranged - part of the trail is on the PNH's land. The PNH will transfer this land to the municipality.

And next phase we expect the management, monitoring, and maintenance to be very important

Barriers

High increase of costs: during the preparation of the project, there was an immense increase in costs. This caused a delay in the execution. We had to ask the city council for more budget and looked for additional funding at the province.

Net congestions issues: Alkmaar has a very large issue with net congestion. It seemed quite a long time that the feed in of the produced renewable electricity into the electricity grid would not be possible in 2023. Even although a contract was already signed with the DSO. Due to negotiations on high level management it seems to be solved.

Financial participation was not feasible: due to legal and administrative issues the costs of financial participation of the surrounding residents was not feasible.

Breeding season: since this IE has an impact on nature (flora and fauna) we are not able to realize construction work during breeding season. Starting the building phase in November is necessary, no later than that to avoid problems.

Environmental permit: an objection was made. The objection was rejected after investigation by mutual agreement.

Permit for underground work: the DO had to be modified several times.

Next steps (what will be done/what still must be done - add dates if known)

November 2022: visible work begins. The area will be prepared for construction.

June 2023: PV noise barrier ready, operationalization

July 2023: monitoring starts.

Connected IEs with ETTs

Not connected to other IE's



5 Conclusions

The previous chapters discussed the goals and descriptions of each innovative element. Including the role of the partners involved. In this chapters the progress of each innovative element was described including faced barriers and lessons learned. Also, it was described which next steps need to be taken. Below we conclude the status and the next steps for each of the Innovative elements.

- **IE 3.1.4 V2G buses: Not completed**

This IE has been completed, finalizing the demonstrating V2G buses before the end of the project is next. OEMs are planning V2G services soon. And new buses are being built for the Dutch market. Discussions by Connexxion with several OEM's are ongoing and as soon as there is a V2G bus available Connexxion aims to test this bus in Alkmaar to finalize the feasibility study. Connexxion will, if an V2G bus will be available, test in Alkmaar.

- **IE 3.1.4 - V2G cars: Not completed**

This IE is not completed. Van Alckmaer's next step is to concretise the Lol with Venematech and Fluctis about the implementation of the V2G (dis)charging infrastructure and connection to an apartment complex in Bloemwijk, as well as the purchase/lease of (a) V2G shared car(s). The aim is to complete this during the first half of 2023.

- **IE 3.1.6 - Charge control algorithms: Completed**

The IE has been completed by developing the algorithm and demonstrating its use within LH Alkmaar.

- **IE 3.1.7 - Solar Charging Buses: Not completed**

This IE has been completed by developing the process and demonstrating its use within LH Alkmaar. The quote and the proposal are awaiting the final agreement by the Municipality of Alkmaar. Final steps are to perform the formal signing of the contract between Alkmaar and Connexxion which is expected before 2023-H1.

- **IE 3.1.7 - Solar Charging Cars at InVesta: Not completed**

This IE is not completed. The most pressing next step is to come to an agreement on the to be ordered smart DC EV charger. Hopefully, and expectedly, this agreement will shortly be finalized after the upcoming meeting in December between NEC, InVesta, Venematech and Indutec. The solution is intended to be implemented and operational in the summer of 2023.

- **IE 3.1.7 - Solar Charging Cars at de Meent: Completed**

This IE has been completed apart from handing over the GoO's, the processes are operational.

- **IE 3.1.9 - Lamppost integrated EV charger: Not completed**

This IE is not completed. Development is ongoing. GA must send the fixture data of the nostalgic lamppost to the supplier who will check whether Nedal charging lamp can be coated in Ral 8012. Then charging lamp will be ordered. Planning as far as currently understood is that the charging station will be installed this year. Should be possible together with this nostalgic smart lamppost.



- **IE 3.2.1 - EV Sharing: Not completed**

This IE is not completed. Van Alckmaer's next step is to concretise the Lol with Venematech and Fluctis about the implementation of the V2G (dis)charging infrastructure and connection to an apartment complex in Bloemwijk, as well as the purchase/lease of (a) V2G shared car(s). The aim is to complete this during the first half of 2023.

- **IE 3.2.2 - Hydrogen powered HD vehicles: Not completed**

This IE is not completed. Development is ongoing, the garbage truck is not yet transformed and unknown when this will be realized. There are dependencies which are outside of the Alkmaar consortium. Demonstrating the hydrogen powered heavy Duty Vehicle before the end of the project is a plus.

- **IE 3.2.3 - Noise Screen: Not completed**

This IE is not completed. Development is ongoing, visible work begins. The area for installing the Noise Screen will be prepared for construction. Demonstrating the noise screen is expected after Q2- 2023.



6 References

POCITYF - A positive Energy City Transformation framework, H2020 - European Commission. Available online: <https://pocityf.eu> (assessed 28/11/2022)

POCITYF - Grant Agreement AMD 864400-15



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

