IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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Disclaimer

Executive Summary

Objective of this deliverable is to provide a detailed overview of the preliminary results of the Utrecht demonstration. This deliverable is intended for the following audiences:

- Stakeholders in the Utrecht ecosystem as it should provide a detailed overview of the solutions that are implemented by each of the partners;
- Stakeholders in the demonstration districts as it should provide them with an overview of the solutions and on how local stakeholders are involved;
- Project partners in the other lighthouse and follower cities;
- Broader public, which is interested in the details of the demonstration.

This deliverable will facilitate the common understanding of the demonstration activities and the preliminary results. It will allow the Steering Committee of the project to assess the current status and compare with what is stated in the DoA and possibly provide feedback on the last period (M49-M66) of the IRIS project.

For the implementation of measures in TT#1, the fourth year of the IRIS project has proven to be the most productive, since we managed to start with NZEB refurbishment in the district Kanaleneiland-Zuid, along with implementing PV-panels and smart hybrid heat pumps. And we also have installed over 200 HEMS Eneco TOON in dwellings and successfully launched the DC-pilot by installing DC-equipment in a pilot house. Furthermore, the PEB refurbishment in the district Overvecht is successfully finished and has started with monitoring the energy performance aiming at creating an optimal building. In the district Lombok, the NZEB refurbishment is progressing steadily, having finished 200 out of 354 dwellings and aiming to finish the refurbishment by the end of 2022.

Finally, smart street lighting with 50 lampposts and a smart pedestrian crossing, creating a safer traffic situation, has been implemented. The results are taken into account for the city-wide street lighting program of 60 000 lamp posts.

In TT#2, the development and demonstration of the smart charging system for electric cars and the installation of a large stationary battery in the Kanaleneiland-Zuid demonstration district have enabled the rapid evolvement and growth of an energy management system at city level with currently almost 500 bidirectional charging stations and thousands more to come, which has made Utrecht a pioneer in bidirectional charging. IRIS has sped up that development and the focus now is to speed up further demonstration, expansion and replication. Interest from various parties in the Netherlands and the EU is rapidly increasing.

As part of TT#3, 68 e-buses are in operation In Utrecht with two large charging plazas just outside the city and several fast chargers along the route. As part of IRIS, bus company Qbuzz has fitted the buses with detailed monitoring and logging devices that are providing valuable data on battery behaviour, driving range, battery wear and state of charge over the day. Based on these data, QBuzz and Utrecht University are conducting research on the potential of smart charging and V2G operation of city e-buses in the Utrecht setting. First result show that smart charging of e-buses is promising, and implementation is on the way.

Within TT#4 various data services have been developed. The services are aimed at the monitoring of charging stations for electric cars, smart street lighting, making smart city applications visible in an AR application and fighting energy poverty through data-driven energy advice. These services run on datasets made available through the urban data platform CIP. The services contribute to solving social problems such as the increasing misuse of charging stations for electric cars, energy poverty, road safety and support the energy transition. The data services prove that services based on the use of open data sets available in the CIP can be used to solve societal challenges. The financial exploitation of the services and the translation into profitable business models is still quite challenging.

The continued presence and communication in the district Kanaleneiland-Zuid leads to better connections with the citizens and also more participants for the different measures (TT#5).

The personal approach with installing the Eneco TOON and personal connections with the social networks in the district have led to a good cooperation with the district. This also benefits the refurbishment actions in TT#1.

COVID-19 has hampered the progress because we have not been able to organise live meetings in the district and at schools for over a year. Currently, the corona situation in the Netherlands is developing positive because of a high vaccination grade amongst the Dutch inhabitants. This has led to national policy to slowly release COVID-measures and the possibility to organise events with citizens. Next steps include extending the local network and execution citizen engagement activities at schools and in the district.

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List of Abbreviations and Acronyms

Abbreviation	Definition
AC	Alternating current
CIP	City Innovation Platform
DC	Direct Current
DH(N)	District Heating (Network)
DoA	Description of Action
EMS	Energy Management System
EU	European Union
FC	Follower City
HEMS	Home Energy Management Systems
IS	IRIS Solution
KPI	Key Performance Indicator
LH	Lighthouse
LHCSM	Lighthouse City Site Manager
LT	Low Temperature
MaaS	Mobility as a Service
NZEB	Near Zero Energy Building
PEB	Positive Energy Building

PoR	Programme of Specification
PV	Photovoltaic
RES	Renewable Energy Sources
SoA	State Of the Art
TT	Transition Track(s)
WP	Work Package

1. Introduction

1.1 Scope and objectives

Objective of this deliverable is to provide a detailed overview of the preliminary results of the Utrecht demonstration. This deliverable is intended for the following audiences:

- Stakeholders in the Utrecht ecosystem as it should provide a detailed overview of the solutions that are implemented by each of the partners;
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- Project partners in the other lighthouse and follower cities;
- Broader public, which is interested in the details of the demonstration.

This deliverable will facilitate the common understanding of the demonstration activities and the preliminary results. It will allow the Steering Committee of the project to assess the current status and compare with what is stated in the DoA and possibly provide feedback on the last period (M49-M66) of the IRIS project.

1.2 Lighthouse demonstration project

Home to 340.000 inhabitants, Utrecht is the fourth municipality in the Netherlands. It is the fastest growing city in the country and expects to have 400.000 inhabitants in 2025. The city is characterized by its beautiful historical centre, its relatively highly educated population and its attractiveness to company headquarters, university, and research institutes thanks to its central position in the Netherlands.

Utrecht is very consistent in its sustainable energy policy. As of 2009, Utrecht takes part in the Covenant of Mayors. The city's 2008 Strategic Energy Action Plan (SEAP) was updated in the 2016 Strategic Energy Action Plan (SEAP), aiming at transforming the urban energy systems into sustainable, yet reliable and affordable systems. Core principle is that Utrecht wants to be a climate neutral and a climate robust city in 2030. It wants to become less fossil-fuel dependent and have buildings heated by renewables (power and waste heat) rather than by natural gas (the main heating system in the Netherlands since the 1960s). Although Utrecht is very densely populated, the city has the highest rate of PV-systems installed in the Netherlands (10 MWp, 2015). The city wants the number of PV-systems to grow from 4.000 in 2015 to 10.000 in 2020. The number of EV-charging stations should grow to 1.000 and the number of EVs to 10.000, both in 2020. These numbers illustrate the city's ardour to boost local production and use of renewables, and to adapt the urban energy system to accommodate high shares of both renewables and EVs.

In summary, the Utrecht lighthouse demonstration aims to address the following challenges:

1. To become energy neutral districts, a high penetration of renewables is necessary, in addition to low energy buildings and infrastructures. There is a clear need for integration of decentralized renewable energy systems in the district, making efficient use of space and infrastructure.

2. For high penetration of renewable electricity, increasing the flexibility of the electricity grid is essential. Therefore, demand response management as well as integrating storage capacity at district scale are necessary solutions.
3. The districts are characterised by a variety of energy infrastructure, the majority of which was installed decades ago and has become obsolete. The resulting need for renewal of the energy infrastructure is an opportunity for transforming the district into a Near Zero Energy district. The aim is to use renewable power for heating and cooking rather than natural gas, and to create an all-renewable electric district.
4. Kanaleneiland Zuid and Overvecht are low-income districts, asking for low and stable energy and mobility bills. Mobility bills can be reduced by means of a cost-effective car sharing system. A district-wide car sharing system deploying solar powered V2G e-cars is seen as a major chance, providing cost effective mobility, offering grid flexibility thanks to the storage capacity of the V2Gbatteries, as well as resulting in low emission and noise levels.
5. The diversity in stakeholders and the crucial role of citizens as enablers of the energy transition, especially in the lowincome and multicultural districts Kanaleneiland Zuid and Overvecht, require co-creation and attractive and inclusive services that support them in their own objectives to engage, express ownership, and behaviour change.
6. In order to integrate energy efficiency solutions and renewables with storage for grid flexibility and sustainable mobility, integrated urban planning methods and data sharing tools are essential. Data based services for integrated urban district planning, as well as an urban ICT platform based on open specifications can be major enablers to manage the successful transformation towards intelligent, user-driven and demand-oriented infrastructures and information services, at household, district and city level.

1.3 Structure of the deliverable

The preliminary results of activities in the five Transition Tracks of the Utrecht demonstration are described in chapters 2 to 6. Chapter 7 describes the impact of the Utrecht demonstration at city level.

2. Preliminary Results of Transition Track 1 - Smart renewables and closed-loop energy positive districts

The ambitions of this Transition Track #1 'Smart renewables and closed-loop energy positive districts' consists of: contributing to Near Zero Energy districts by integrating (1) a high share of locally produced and consumed renewable energy at district scale, (2) energy savings at building level, and (3) energy savings at district level.

KEY MESSAGE
The fourth year of the IRIS project has proven to be the most productive, since we managed to start with NZEB refurbishment in the district Kanaleneiland-Zuid, along with implementing PV-panels and smart hybrid heat pumps. And we also have installed over 200 HEMS Eneco TOON in dwellings and successfully launched the DC-pilot by installing DC-equipment in a pilot house. Furthermore, the PEB refurbishment in the district Overvecht is successfully finished and has started with monitoring the energy performance aiming at creating an optimal building. In the district Lombok, the NZEB refurbishment is progressing steadily, having finished 200 out of 354 dwellings and aiming to finish the refurbishment by the end of 2022.
Finally, smart street lighting with 50 lampposts and a smart pedestrian crossing, creating a safer traffic situation, has been implemented. The results are taken into account for the city-wide street lighting program of 60 000 lamp posts.

2.1 Overview

In this paragraph the designed Measures and activities are explained including the timeline over the past four years and a forecast for the last 1.5 year of the IRIS-project.

Measures:

This Transition Track consists of 8 Measures (initially 7 measures, due to an approved amendment changed to 8 measures):

- Measure 1 District wide PV
- Measure 2 LT district heating
- Measure 3 HEMS Eneco Toon
- Measure 4 NZEB refurbishment (Kanaleneiland-Zuid and Complex 507)
- Measure 5 Smart (hybrid) e-heating systems
- Measure 6 AC/DC home switchboxes
- Measure 7 Smart DC Street Lighting
- Measure 8: PEB refurbishment (Henriëttedreef)

These 8 Measures are executed in three districts in the city of Utrecht:

- District of Kanaleneiland-Zuid
  - Measure 1 District wide PV
  - Measure 2 LT district heating
  - Measure 3 HEMS Eneco Toon
  - Measure 4 NZEB refurbishment (Kanaleneiland-Zuid)
  - Measure 5 Smart (hybrid) e-heating systems
  - Measure 6 AC/DC home switchboxes
  - Measure 7 Smart Street Lighting
- District of Lombok
  - Measure 4 NZEB refurbishment (Complex 507)
- District of Overvecht
  - Measure 8: PEB refurbishment (Henriëttedreef)

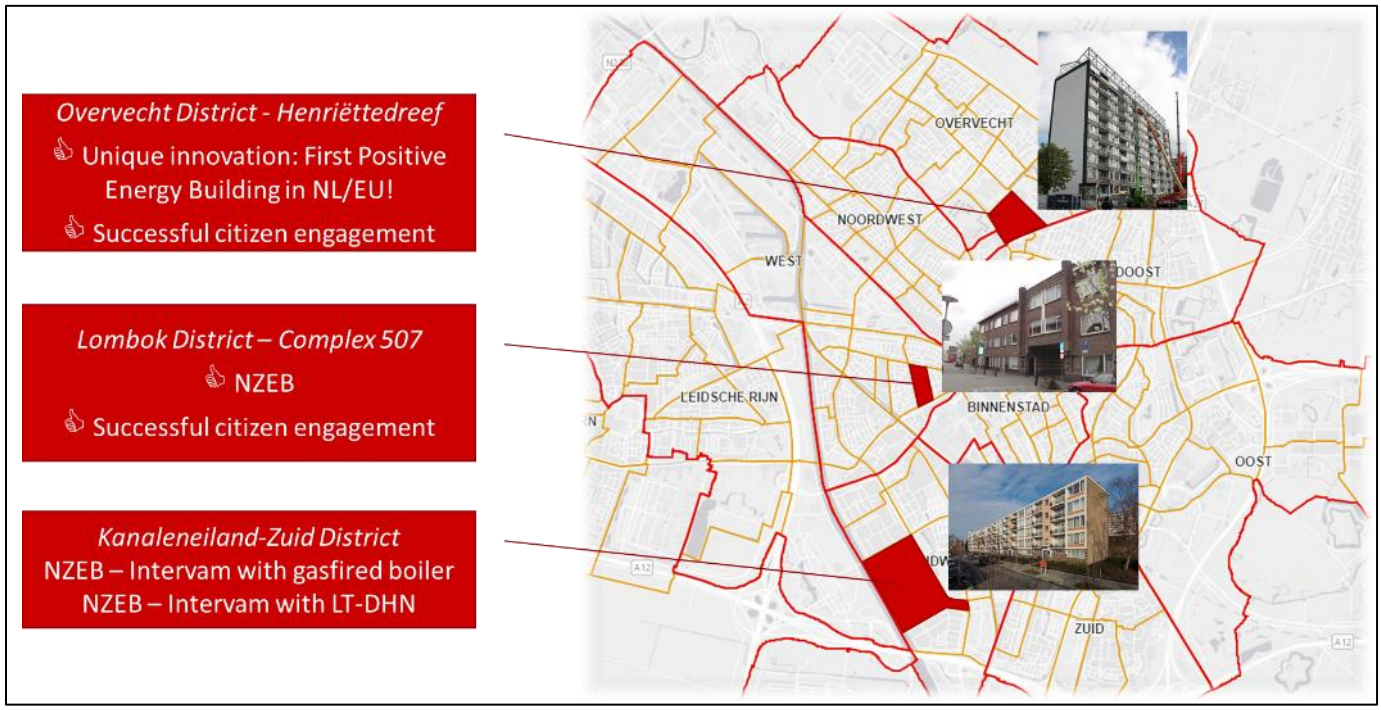


Figure 1. Overview of the demonstration areas in the city of Utrecht

Main activities and timeline:

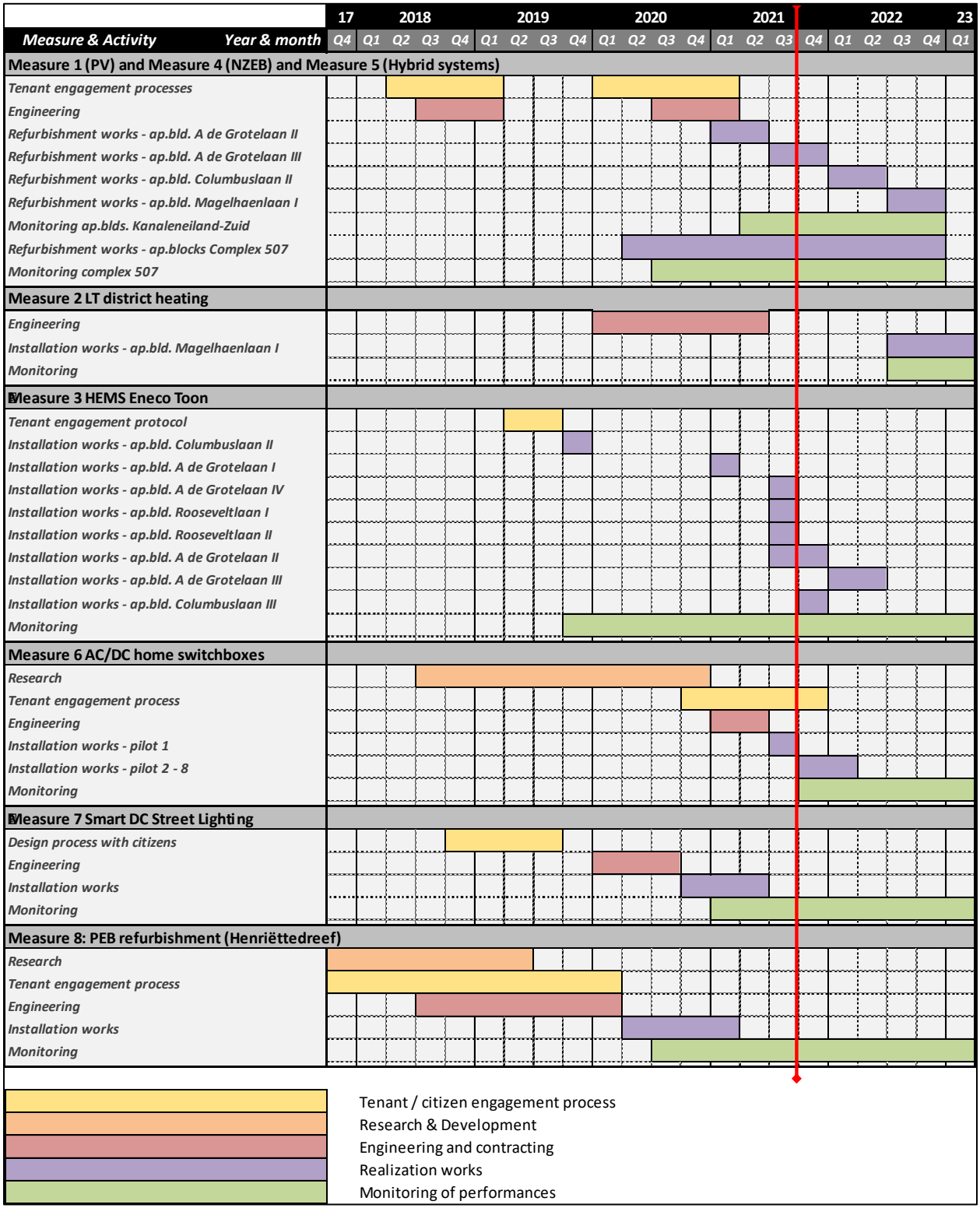
In the original schedule (DoA) most of the measures were linked directly to the schedule of the refurbishment works of the apartment buildings in the district of Kanaleneiland-Zuid. The measures 1 till 6 were dependent on the schedule of the refurbishment works. After two years it became clear that a substantial delay of the refurbishment works has exposed due to two main reasons:

- The process of tenant engagement for creating a refurbishment plan, which has been subject to the support measurement amongst tenants, took far more time than originally planned.

- For the first IRIS apartment building, named Columbuslaan III, Bo-Ex did not obtain enough consent rate (support) amongst the tenants for the refurbishment plan. 67% of the tenants voted for, while the Dutch constitution law prescribes a minimum of 70% consent rate.

It was not possible to solve this delay within the runtime of the IRIS project. Therefore, we proposed to change the scope of works by introducing the projects in the district of Lombok and Overvecht in the city of Utrecht. Both these projects have a unique character and valuable outcomes. This change of scope has been approved by the EC.

Till the end of the IRIS-project in March 2023, the following schedule is followed:


17
2018
2019
2020
2021
2022
23
Measure & Activity
Year & month
Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1
Measure 1 (PV) and Measure 4 (NZEB) and Measure 5 (Hybrid systems)
Tenant engagement processes
Engineering
Refurbishment works - ap.bld. A de Grotelaan II
Refurbishment works - ap.bld. A de Grotelaan III
Refurbishment works - ap.bld. Columbuslaan II
Refurbishment works - ap.bld. Magelhaenlaan I
Monitoring ap.blds. Kanaleneiland-Zuid
Refurbishment works - ap.blocks Complex 507
Monitoring complex 507
Measure 2 LT district heating
Engineering
Installation works - ap.bld. Magelhaenlaan I
Monitoring
Measure 3 HEMS Eneco Toon
Tenant engagement protocol
Installation works - ap.bld. Columbuslaan II
Installation works - ap.bld. A de Grotelaan I
Installation works - ap.bld. A de Grotelaan IV
Installation works - ap.bld. Rooseveltlaan I
Installation works - ap.bld. Rooseveltlaan II
Installation works - ap.bld. A de Grotelaan II
Installation works - ap.bld. A de Grotelaan III
Installation works - ap.bld. Columbuslaan III
Monitoring
Measure 6 AC/DC home switchboxes
Research
Tenant engagement process
Engineering
Installation works - pilot 1
Installation works - pilot 2 - 8
Monitoring
Measure 7 Smart DC Street Lighting
Design process with citizens
Engineering
Installation works
Monitoring
Measure 8: PEB refurbishment (Henriëttedreef)
Research
Tenant engagement process
Engineering
Installation works
Monitoring
Tenant / citizen engagement process
Research & Development
Engineering and contracting
Realization works
Monitoring of performances

2.2 Implementations

In this paragraph the implementation results of each Measure are described:

Measure 1 District wide PV

- What has been implemented?: approximately 56 dwellings of the apartment buildings Alexander de Grotelaan II and III have been equipped with PV-panels on the roof (4 panels per household) as part of the total refurbishment works. Another 30 PV-panels have been realized on the roof of apartment building Columbuslaan I connected to the district battery (see Chapter 3 on TT#2 for more information). This results in 310 PV-panels of each 350WP.
- How has it been implemented?: the PV-panels for the tenants of Bo-Ex are part of the 'package deal' for the refurbishment of the apartment buildings. This package deal consists of a set of maintenance and improvement works and are gathered into a brochure. This brochure is sent to every tenant together with a vote form. When enough tenants vote 'for' the plan, the plan is by law considered to be acceptable and brings Bo-Ex to the decision to execute works. For the two apartment buildings Alexander de Grotelaan II and III there was enough support amongst tenants for the plan: 74% of the tenants voted yes in March 2021, where 70% is needed.

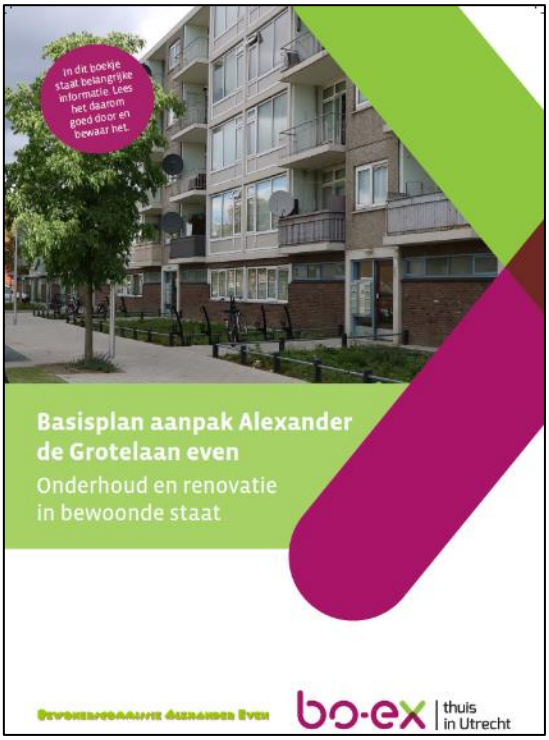


Figure 2 Brochure refurbishment plan A de Grotelaan II and III (Bo-Ex)

- What activities/implementations are still in planning?: in the period October 2021 till March 2022, another 26 apartments within the apartment building Alexander de Grotelaan II will get PV-panels (4 panels per household). On top of that, the 48 apartments of apartment building Columbuslaan II will get PV-panels (also 4 panels per household) en the 48 apartments of apartment building Magelhaenlaan II will be equipped with PV-panels. This results in 488 PV-panels of approximately 350WP.

Measure 2 LT district heating

- What has been implemented?: initially four of the twelve apartment buildings within the district of Kanaleneiland-Zuid were planned to be refurbished within the runtime of IRIS. These four

apartment buildings are located at the left side of the district map (figure 2). The change of scope has resulted in a decrease of the amount of apartment buildings in Kanaleneiland-Zuid within IRIS. At this moment it is planned to refurbish one apartment building which is connected to district

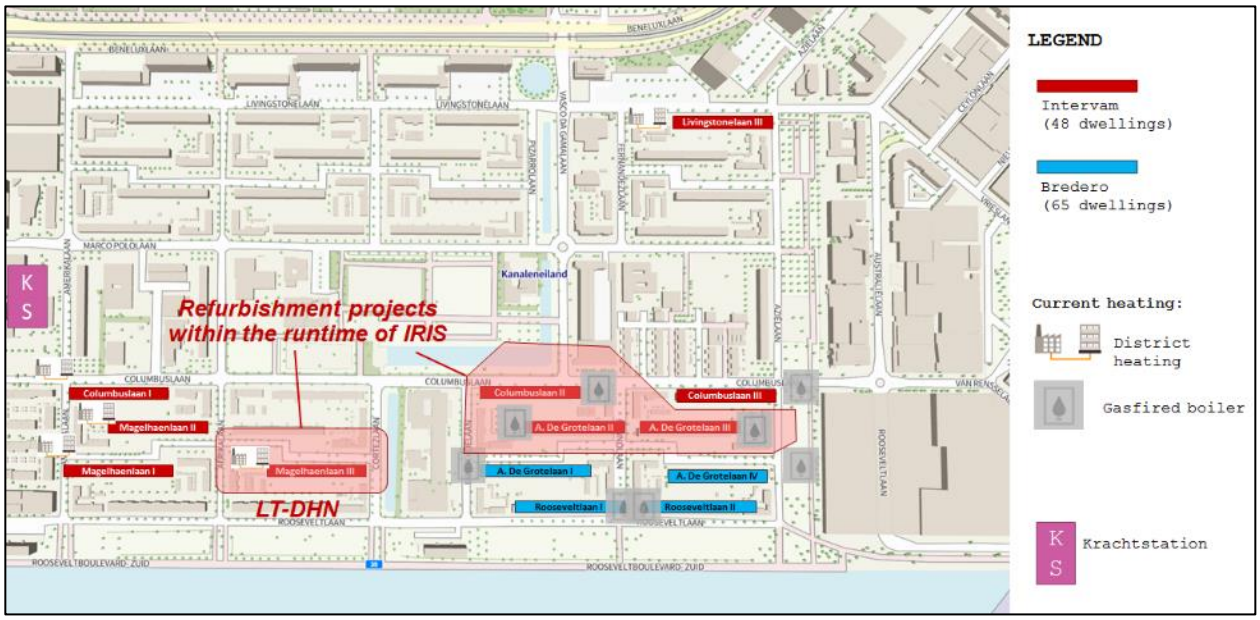


Figure 3 Overview apartment buildings to refurbish by Bo-Ex (Bo-Ex)

heating within the (revised) runtime of IRIS. Probably this will be apartment building Magelhaenlaan III, but it can also be one of the other three buildings mentioned in the map depending on the tenant engagement process and (expected) support amongst the tenants in every building. Bo-Ex together with the district heating owner Eneco have elaborated three feasible but different scenarios for the district heating:

- Baseline scenario: in this scenario, which has been realized in the pre-pilot building Livingstonelaan III, the incoming (90°C) and outgoing (70°C) temperatures are similar to the existing situation. The only change is the inner infrastructure: every dwelling will get an individual usage meter and main connection which feeds the heating network inside an apartment, instead of a collective system as it is now (central block heating). If the occasion arises not only the heating is provided by the district heating but also the hot tap water.
  In this scenario the calculated average energy usage per household per year is 17 GJ for comfort heating and 5 GJ for hot tap water (without the technical measurements, before the refurbishment works (e.g. the insulation of the shell of the building), the average energy usage per household per year is 21 GJ for comfort heating).
- Mid-temperate scenario: in this scenario the incoming (70°C) and outgoing (40°C) temperatures are decreased in comparison with the existing situation. Idem to the baseline scenario the district heating can also provide in hot tap water. The consequences for the technical requirements are manageable: this temperature does not require any additional techniques/installations in comparison with the baseline scenario.
  In this scenario the calculated average energy usage per household per year is 14 GJ for comfort heating and 5 GJ for hot tap water.

- Low-temperature scenario: in this scenario the incoming (50°C) and outgoing (40°C) temperatures are decreased substantially in comparison with the existing situation. The consequences for this scenario though are substantial: an additional (heat pump) booster for hot tap water is required, other types of radiators are needed due to a lower heat dissipation per m2, and an alternative ventilation circuit is necessary (mechanical feed and mechanical exhaust with heat recovery).
  In this scenario the calculated average energy usage per household per year is 12 GJ for comfort heating and 5 GJ for hot tap water.

All these three scenarios bring different investment costs for Bo-Ex and different revenues for the tenants. Besides, Bo-Ex can choose to outsource the realization of the inner infrastructure and administration to Eneco or realize the infrastructure themself for all three scenarios. In case of high investments by Bo-Ex and high revenues for the tenants, it is a fair deal to ask the tenants an increase of their rent.

Bo-Ex will discuss the different scenarios with the tenants in the tenant engagement process which will start end of 2021.

- What activities/implementations are still in planning?: in the period end of 2021 till Mid 2022, a refurbishment plan for one of the four apartment buildings is made by Bo-Ex. No big barriers in the engagement process to be taken, in Mid 2022 this plan is presented to all tenants and they are asked to vote for the plan. With enough support, the refurbishment works shall start in Autumn 2022 to finish End of 2022, just before(the end of the IRIS project).

Measure 3 HEMS Eneco Toon

- What has been implemented?: over the past three years, in the following apartment buildings a certain number of HEMS Eneco Toon has been installed:
  - Apartment buildings prior to the refurbishment:
    - Columbuslaan II: 22 of 48 households (46%)
    - A de Grotelaan I/IV: 55 of 130 households (42%)
    - Rooseveltlaan I/II: 42 of 130 households (32%)
      Exact number of installed HEMS Eneco Toon can increase due to late responders.
  - Apartment buildings which have been refurbished:
    - A de Grotelaan II 48 of 48 households
    - A de Grotelaan III 48 of 48 households
- How has it been implemented?: due to the delay of refurbishment works in the district of Kanaleneiland-Zuid, already in month 20 of the IRIS project another strategy for the implementation of the HEMS Eneco Toon has been implemented. This strategy consists of

installing the Eneco Toon in dwellings prior to the refurbishment works at tenants on a voluntary basis. So Bo-Ex together with Eneco call the tenants of an apartment building to sign-up for the installation of the Eneco Toon. This call consists of an individual letter to every tenant and posters in every staircase to inform the tenants and ask to sign-up. A couple of weeks after this moment, energy consultants call the tenants which have not signed-up already for this action and inform them about this action. With this strategy not only the tenants are introduced with the Eneco Toon on a special way, the tenants become also aware of their energy usage before the refurbishment and, last but not least, the tenants are activated in the coming engagement process linked to the refurbishment plan.

Figure 4 Posters for tenants for the Eneco Toon call (Bo-Ex)

- <u>What activities/implementations are still in planning?:</u>
  - Installing works: in the coming 1,5 year the HEMS Eneco Toon will be offered to tenants in the following apartment buildings:
    - Columbuslaan III (48 dwellings), prior to the refurbishment plan
    - Columbuslaan II (30 remaining dwellings) as part of the refurbishment plan.
    - Magelhaenlaan III (48 dwellings) as part of the refurbishment plan
  - Evaluation of the process and product: amongst the tenants of the following apartment buildings an inquiry will take place:
    - A de Grotelaan I/IV: 55 of 130 households (42%)
    - Rooseveltlaan I/II: 42 of 130 households (32%)
    - Columbuslaan III

Measure 4 NZEB refurbishment (Kanaleneiland-Zuid and Complex 507)

For this measure the refurbishment projects in Kanaleneiland-Zuid and Complex 507 are described separately.

<u>Kanaleneiland-Zuid Intervam apartment buildings:</u>

- <u>What has been implemented?:</u>
  - The support measurement of the apartment buildings A de Grotelaan II and III ended up in enough support: 74% of all the tenants voted For. With this outcome, Bo-Ex decided to execute the refurbishment works.

- The refurbishment works of the apartment building Alexander de Grotelaan III (48 dwellings) has been completed. The refurbishment works of the apartment building Alexander de Grotelaan III (48 dwellings) has started but is not fully completed yet. Begin of 2022, the last dwellings are finished and delivered back to the tenants.

Figure 5 Construction works of refurbishment A de Grotelaan II and III (Bo-Ex)

- How has it been implemented?:
  - After the failed support measurement amongst tenants of apartment building Columbuslaan III, a new tenants engagement process has been started with the tenants and tenants committee of both the apartment buildings A de Grotelaan II and III. Bo-Ex combined these two buildings because they are similar in a technical way and are located near to each other. Besides, it also saves time because Bo-Ex has to go through only one engagement process instead of two.
  - The preparation works mainly consists of (an intensive) tenants engagement process to set up a refurbishment plan for all the tenants and engineering process together with the contractor and consultants. The tenant engagement process consists of:
    - several meetings between Bo-Ex and the tenants committee about the scope of works, the offered options (free and paid options) to the tenants, the tenant's survey, possible rent increases and the brochure which is subject to the support measurement amongst all the tenants. These meetings have been chaired by an independent chairman, to prevent conflict of interests. The tenants committee has a right to give an advice at the end of the participation process. With this advice, Bo-Ex finalises the brochure for the tenants for the support measurement;
    - an individual survey amongst tenants, held by an independent consultancy firm. The outcomes of the survey – Bo-Ex tried to reach a high response to obtain a good overview – consists of what tenants like, what tenants don't like, what wishes the tenants have with the refurbishment and some specific questions about proposed activities;
    - the support measurement amongst the tenants, also held by an (other) independent consultancy firm to avoid a conflict of interest. In this measurements, all the tenants are requested to fill in a voting form: say Yes or No against the refurbishment plan as described in the brochure. At least 70% of all the tenants shall vote Yes, to consider a refurbishment plan as acceptable. A missing vote means a No, so it's necessary to obtain as much as possible filled voting forms.

- What activities/implementations are still in planning?: the remaining activities for the coming 1,5 year consist of:
    - Completion of works of the refurbishment of apartment building A de Grotelaan III.
    - Refurbishment of apartment building Columbuslaan II (48 dwellings), the heating is now provided by individual gas heating devices. For this apartment building the tenants engagement process has been started end of 2020. Basically, the refurbishment plan is a copy of the refurbishment plan of both the apartment buildings A de Grotelaan II and III. Some minor differences have been incorporated in the scope of works. At the end of 2021, the support measurement will be held amongst the tenants.
    - Refurbishment of apartment building Magelhaenlaan III (48 dwellings), the heating is now provided by district heating. The engagement process has been started just one month ago which will end up Summer 2021.

Complex 507 apartment blocks:

- What has been implemented?: fortunately the contractors have been able to realize the works continuously since the start of the Covid-19 disease (despite some infections amongst construction workers) and also almost all the tenants wanted to refurbish their dwelling immediately and did not request a postponement. Since April 2020, Bo-Ex together with their project partners have refurbished 200 dwellings of 354 dwellings in total. The completion of works is expected in Summer 2022.

Another aspect which has been implemented is to improve the communication and involvement process towards the tenants continuously: Bo-Ex started with the inquiries amongst tenants in June 2020. Every tenant where the refurbishment works has taken place, is asked to fill in two forms with questions about the product (refurbished dwelling) and process (involvement and communication). The outcomes of these inquiries are discussed with the tenants / tenants committee and the contractors and other involved parties to optimize the process. One of the main changes due to the received forms which has been incorporated, is the introduction of a so called 'sociale opname' (social intake). In this intake, held by tenant consultants, every household is implicated in the impact of the works for their situation. The consultants assist the tenants to prepare for the refurbishment works and explain where they can find information or who they can contact in case of problems/questions.

Figure 6 Refurbished apartment block in Complex 507 (Bo-Ex)

- How has it been implemented?: the refurbishment works of this project have started in April 2020. In March 2021 the project was supposed to start, but at that moment the Covid-19 disease appeared. Together with all involved parties including the tenants committee a dedicated project protocol for the Covid-19 disease has been set up. In this protocol the impact and procedures for the project organization and tenants are mentioned. This also affected the runtime of the refurbishment. Instead of starting every week 5 new dwellings and realize the works of a house block within 4 work weeks, Bo-Ex together with their project partners had to change the schedule substantially: every 1,5 week a start of 5 new dwellings and a runtime for every house block of 7 work weeks. Furthermore, the tenants had the opportunity to postpone the moment of refurbishment. Therefore, the Covid-19 disease made it more complex to realize the works within the project framework.
- What activities/implementations are still in planning?: in the next months the refurbishment works continue. In Summer 2022 Bo-Ex expects to complete the last dwellings and bring the total of refurbished dwellings to 354. Also, the tenants are asked actively to fill in inquiries to optimize the process and product.

Measure 5 Smart (hybrid) e-heating systems

Figure 7 Eneco Warmtewinner heat pump icw gas heated boiler (Bo-Ex)

- What has been implemented?: in the first two apartment buildings which are refurbished (A de Grotelaan II and III), the heat pump device Eneco Warmtewinner® is implemented. This device, as shown in the picture, will use the warmed ventilation air to heat up water for heating and top water. For peak demand, the existing gas heated device will supply additional heat.
- How has it been implemented?: the hybrid e-heating system is an installation consisting of a heat pump connected to the (existing) gas heated boiler. In the apartment buildings of Bo-Ex in the district of Kanaleneiland-Zuid, 50% of the Intervam type apartment buildings is equipped with a gas heated device. This device produces hot water for heating and hot tap water. By combining this device with an electrical heat pump, the amount of gas usage will decrease substantially. Most of the heat is supplied by the heat pump and only in cold conditions or a peak demand, the gas heated boiler is used. The exact amount of decreased gas and increased electricity usage differs per type heat pump and per household. Preliminary calculations show that combining the gas heated boiler with the Eneco Warmtewinner®, will decrease the gas usage by 300m^3 per year and increases the electricity usage of 700kWh per year. From a cost perspective, this is interesting for tenants since the price per m^3 gas in The Netherlands is almost four times higher than the price per kWh in the last years. Note: in 2021 the gas price has risen enormously in comparison with the gas price of 2020. Besides, it is expected that the gas prices will increase substantially in the coming years, while the prices of electricity will increase slowly.
  This calculation also convinced the tenants of the two mentioned apartment buildings to chose for this option and make it part of the refurbishment plan.
- What activities/implementations are still in planning?: in the coming period Bo-Ex will evaluate the working/impact and user experiences of the Eneco Warmtewinner®. Furthermore, for the apartment building Columbuslaan II further investigations take place for a hybrid solution. The Eneco Warmtewinner® is a product, but there are also other solutions which might be interesting. The outcomes of this investigations will be discussed with the tenants committee and incorporated in the refurbishment plan for Columbuslaan II.

Measure 6 AC/DC home switchboxes

- What has been implemented?: for the pilot with Direct Current, recently a pilot has been realized in one apartment. To create this pilot, two tenants have been contacted by Bo-Ex to participate in this pilot on a voluntary basis. Both tenants responded positive, but one has moved to another house in the meantime. For the other tenant, the pilot has been executed.
- How has it been implemented?: the implementation of Direct Current has been part of research. Based on researches held by students from University of Utrecht and further investigations by installation contractor BOS Installatiewerken, Bo-Ex has chosen for a partly direct current network solution. This means that a part of the apartment is equipped with a direct current network to supply in energy for dedicated devices such as mobile phones. In the first pilot, the apartment will get a DC-network which supplies five LED lamp bulbs, two USB sockets and outlets for Power Over Ethernet (POE++ protocol). The principle of this Direct Current pilot is to prevent energy waste from converting energy. That is why in the pilot energy from the PV-panels is distributed directly to these outlets or, if no energy is requested, saved in a small battery pack to provide at a later moment in time.
- What activities/implementations are still in planning?: in the coming period till Spring 2022, seven other tenants are requested to participate in the same pilot. This call is done by Bo-Ex amongst tenants from the refurbished apartment buildings A de Grotelaan II and III. Based on the response, the seven pilots will be executed by Bo-Ex.

Measure 7 Smart Street Lighting

In chapter 5.3 the demonstration of smart street lighting and a co-created smart pedestrian crossing is reported.

Measure 8: PEB refurbishment (Henriëttedreef)

- What has been implemented?: With a prefabricated renovation concept a ten storey high rise apartment building has been retrofitted to a Positive Energy Building. It is the first high rise apartment building in the EU that has been retrofitted in this way. Figure 8 provides an overview of the aspects of the renovation concept.

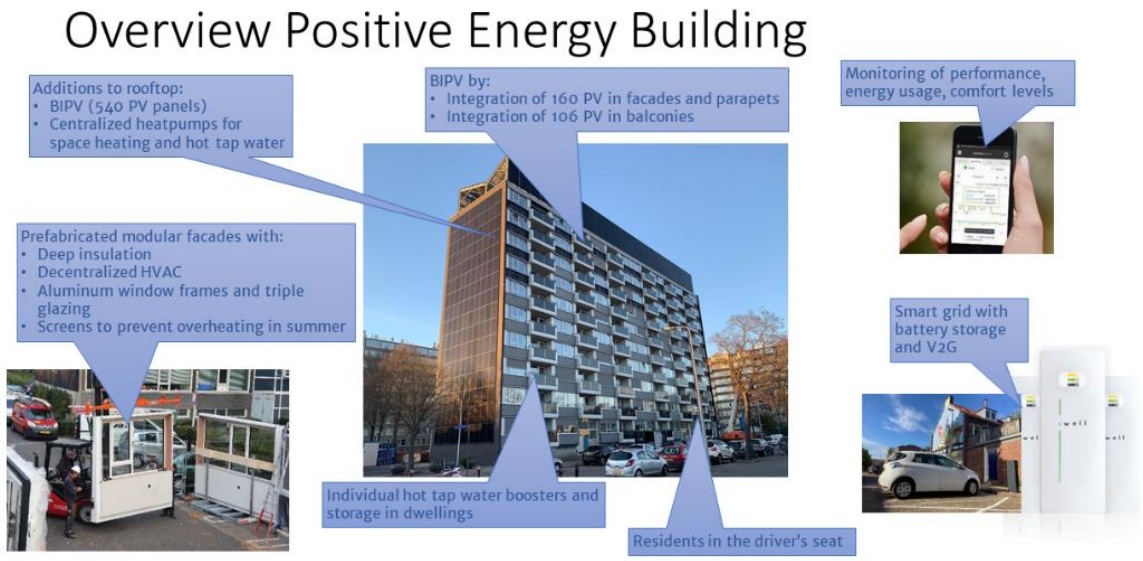


Figure 8. Overview of measures for Positive Energy Building in Overvecht

In Spring 2021 the last numbers of the 58 apartments have been completed by Bo-Ex. From that moment on, all the tenants live in their refurbished houses and pay a fixed fee for energy per month (a so-called energy service fee).

- How has it been implemented?: In 2017, a triple-helix consortium took up the challenge of demonstrating that it is possible to renovate a high-rise apartment block into a positive energy building. The consortium developed prefabricated façade elements with HVAC installations. The aim was to investigate the energy performance of these façade elements on a laboratory scale and to come up with a design to renovate one pilot house. As the results were promising, a pilot house was renovated into a positive energy dwelling in 2018. The results of the pilot house were then translated into a renovation concept for the entire apartment building. What is unique about this renovation concept is that the facades of the houses are demolished in one day, after which the prefabricated facades are assembled. This has made it possible to carry out the renovation in semi-inhabited state.

  After obtaining enough support from the tenants, Bo-Ex has started the refurbishment works in March 2020. Just like the refurbishment project Complex 507, also this project was suddenly confronted with the Covid-19 disease. With adjustments on the planning, facilities for the tenants (living rooms for tenants to spend time during the works in the daytime) and cooperation of the tenants, Bo-Ex was able to start and finish the project on time (finished in October 2020). Bo-Ex has concluded a performance contract with an installation company (Bos Group). Bos Group was the main contractor for the renovation and is also responsible for delivering the energy performance, a positive energy building, for a period of 20 years.
- What activities/implementations are still in planning?: in the coming period the energy usages and supplies are monitored intensively. With this data the tenants receive feedback on their use and will get tips about using their dwelling in an efficient way. Besides, the data is used to optimize the installation parts to increase the performance.

2.2.1 Preliminary results

With the executed activities within the described measures, several results have been gathered. Except for Measure 2, where only engineering and preparation works have been done, results in terms of feedback from the (end) users have been and are collected in the coming period. For most of the measures the monitoring data is not sufficient and representative. In the coming period Bo-Ex together with their partners will focus on gathering validated monitoring data.

Experiences and feedback

The following table contains a summary of the experiences, feedback per Measure:

Table 1. Summary of experiences and feedback per measure in TT#1

Measure	Experiences and feedback
Measure 1 District wide PV	End of October 2021, 7 out of 12 porches of the first two apartment buildings have been refurbished. This means that 56 out of 96 dwellings have been refurbished and have received 4 PV-panels per dwellings which results in 224 installed PV panels. Inquiries amongst tenants from the A de Grotelaan II and III are held in Autumn/Winter 2021.
Measure 2 LT district heating	*t.b.d. (no data is already available) The first showcase is planned for end of 2022 (refurbishment of one apartment building with district heating).*
Measure 3 HEMS Eneco Toon	Almost 200 HEMS Eneco Toon devices have been installed. From the approximately 200 end-users where a HEMS Eneco Toon has been installed, no complaints have been received so far. In the Autumn/Winter 2021 inquiries amongst all the people are held, also related to the objectives of TT#5.
Measure 4 NZEB refurbishment (Kanaleneiland-Zuid and Complex 507)	This means that 56 out of 96 dwellings have been refurbished. The energy performance of these refurbished dwellings has been increased from energy label D/C towards energy label A/A+. Inquiries amongst tenants from the A de Grotelaan II and III are held in Autumn/Winter 2021, also related to the objectives of TT#5. Inquiries amongst tenants from the Complex 507 (30 respondents) tells us that: - Tenants respond that they are happy with the process and product. The average score the tenants give to the refurbishment is 3,5 on a scale from 1-5 (Almost every tenant is happy with the realized measures to increase energy performance!).
Measure 5 Smart (hybrid) e-heating systems	Inquiries amongst tenants from the A de Grotelaan II and III are held in Autumn/Winter 2021, also related to the objectives of TT#5.
Measure 6 AC/DC home switchboxes	Inquiries amongst the tenant where the first pilot has been realized is held in Autumn 2021. The inquiries amongst the tenants for the other pilots will take place after the realization of these

	pilots (foreseen in Winter 2021/2022), also related to the objectives of TT#5.
Measure 7 Smart DC Street Lighting	The smart street lighting has been installed in Spring 2021. So far, no major problems occurred and complaints have been received. In Autumn 2021 inquiries amongst the participants and amongst citizens are held.
Measure 8: PEB refurbishment (Henriëttedreef)	All 58 dwellings have been refurbished and the apartment building generates electricity from PV and provides in heat and domestic hot water from the centralized heat pumps. Monitoring hardware in every dwelling measures the actual usages. The tenants pay a monthly fee, for this fee Bo-Ex supplies a certain amount of electricity, heat and domestic hot water.

Progress of the KPI's:

For all the KPI's within TT#1 it is clear what information is requested and who is responsible for the information supply. As mentioned, at this moment only a poor amount of data is gathered from several measures. In the coming months more and more valuable data is gathered. Because when we want to measure the energy savings for example, data from a whole year round is needed to compare the energy usage with a comparable period before the measures where implemented.

The following table contains an overview of the current state of each KPI within TT#1:

Table 2. Progress of KPIs in TT#1

KPI	Current state
General KPI's: 1. Energy savings for the tenants 2. CO_2 emission reduction 3. Reduced energy costs for tenants 4. CO_2 reduction cost efficiency	The data for these KPI's is collected from several sources. The energy usages are collected in the coming months/year and compared with a reference period: - Intervam apartment buildings Kanaleneiland-Zuid: information from the grid operator Stedin (average energy/gas usage and electricity generation per year) per apartment building and information from the HEMS Eneco Toon on an aggregated level. - Complex 507 Lombok: information from the grid operator Stedin (average energy/gas usage and generation per year) per street. - Henriëttedreef: information from the supplier of monitoring hardware BeNext (average energy/heat usage and electricity generation per year) Based on these information (including the construction cost related to a better energy performance), the reduced energy costs and CO_2-reduction cost efficiency can be calculated easily.
KPI's related to Measure 1 District scale PV:	The generated and used energy from the PV-panels in measured by the HEMS Eneco Toon which has been / is

1. Degree of local renewable energy production 2. Degree of energetic self-supply by RES 3. CO_2 emission reduction 4. Amount of renewable energy	installed in the refurbished dwellings. Based on these amounts, the KPI's can be calculated easily. The information from the HEMS Eneco Toon is collected in the City Innovation Platform (CIP).
KPI's related to Measure 3 HEMS Eneco Toon: 1. Increased awareness of energy usage	Every tenant where a HEMS Eneco Toon has been installed, is requested to fill in an inquiry with a couple of questions. For two apartment buildings where the Toon has been installed (Columbuslaan I and A de Grotelaan I) this data has been collected already.
KPI's related to Measure 6 AC/DC switchbox: 1. Increased awareness of energy usage	Every tenant who participates in the pilot for DC, is requested to fill in an inquiry with a couple of questions about the process, the product and the profit they gain.
KPI's related to Measure 7 Smart street lighting: 1. Reduction in annual final energy consumption by street lighting 2. CO_2 emission reduction	By comparing the energy usages of the old and new lamp bulbs, the reduction in energy consumption will be measured. Based on this amount, the CO_2-reduction is calculated easily.

2.3 Business models and exploitation

The Measures in Transition Track 1 don't contain a Bankable Business model (financial nor societal) in the way these are executed by involved parties. Though there are Measures which might be considered as a Key Exploitable or Replicable Results:

- Measure 1 District wide PV: Key Exploitable Result: in the proposition for their tenants, Bo-Ex offers every tenant the investment of PV-panels. The pay back of this investment is created by a monthly fee from the tenants, which is equal to 50% of the generated energy. After 20-25 years, the investment of Bo-Ex will be paid back.
- Measure 2 LT district heating: Key Exploitable Result: a Low Temperature infra requires an investment and technical adjustments in a dwelling, but will also decrease the energy bill of a tenant. Considering an economical lifetime of 40 years, these investments can be paid back by an increase of the monthly rent.
- Measure 3 HEMS Eneco Toon: no business model opportunities acknowledged.
- Measure 4 NZEB refurbishment (Kanaleneiland-Zuid and Complex 507): Key Exploitable Result: for the improvement works, Bo-Ex ask their tenants to pay an additional rent. With this money, the improvement works can be paid back considering an economical lifetime of 40 years.
- Measure 5 Smart (hybrid) e-heating systems: a smart hybrid e-heating system requires an investment and technical adjustments in a dwelling, but will also decrease the energy bill of a tenant. The amount of energy saved by tenants (increase of electricity and a decrease of gas usage) is not a fact at this moment. Maybe this measure could lead to a Key Exploitable Result in analogy to the LT District Heating, but this requires more data.
- Measure 6 AC/DC home switchboxes: no business model opportunities acknowledged.
- Measure 7 Smart DC Street Lighting: no business model opportunities acknowledged.

- Measure 8 PEB refurbishment (Henriëttedreef): Key Exploitable Result: for the improvement works, Bo-Ex ask their tenants to pay an additional rent. With this money, the improvement works can be paid back considering an economical lifetime of 40 years. Besides, more insight and steering possibilities in energy usages amongst tenants, can lead to more freedom of movement.

2.4 Lessons learned and next steps

In the last period (from M36) a lot of activities in this Transition Track have been done and implemented. Looking back on this period, we conclude that this period was the most productive since the start of the IRIS project. The reason for this is that we managed to start with the refurbishment works of the two Intervam apartment buildings in Kanaleneiland-Zuid which include a couple of Measures. Also the amount of installations of the HEMS Eneco Toon was higher than before and the Smart street lighting has been realized and commissioned. Big steps in the execution of activities have been made!

In report D5.3 the reported major lessons learned for this Transition Track included the following two:

1. It's not easy to get in contact with our target group, because of language barriers, people have bigger problems to worry about and a natural distrust within a large part of the target group towards institutions such as the municipality and housing corporation.
2. The distrust in housing corporation Bo-Ex amongst tenants is high and it's hard to find reasonable solutions. The distrust is strengthened by the plans of the other housing corporation who act in the same area and offer their tenants more value for money according to the tenants of Bo-Ex. Some tenants thought that the money from the IRIS subsidy could also be spend on items they wish, such as new elevators.

Still these lessons learned are actual and the most important for TT1, but we have achieved improvements on these topics. With the approach we follow to install the HEMS Eneco Toon, we come into personal contact with more and more tenants in an earlier stage. This resulted in a wider group of tenants who want to participate in the plan formation for the refurbishment. Also, the engagement process held for the two apartment buildings at the Alexander de Grotelaan II and III resulted in enough support – though the ambition is to increase the consent rate towards 80-85%.

In the next (and last) period of the IRIS project, the main focus points are:

- Continue the refurbishment works in the project Complex 507 in the district of Lombok;
- Obtain enough support amongst tenants to refurbish two other apartment buildings in the district of Kanaleneiland-Zuid;
- Implement the DC-pilots in eight dwellings in cooperation with tenants;
- Monitor and analyse the results of all the measures.

3. Preliminary Results of Transition Tracks 2 and 3 – Charging stations, stationary battery, shared EVs, energy management system

KEY MESSAGE
The development and demonstration of the smart charging system for electric cars and the installation of a large stationary battery in the Kanaleneiland-Zuid demonstration district have enabled the rapid evolvement and growth of an energy management system at city level with currently almost 500 bidirectional charging stations and thousands more to come, which has made Utrecht a pioneer in bidirectional charging. IRIS has sped up that development and the focus now is to speed up further demonstration, expansion and replication. Interest from various parties in the Netherlands and the EU is rapidly increasing.

3.1 Overview

IRIS has sped up the development and upscaling of a unique innovation in the field of smart charging: *the bidirectional ecosystem in Utrecht*. A fast-growing network of bidirectional EV-charging points offer advanced V2G smart charging using open protocols, while being fully backwards compatible to (and hardly more expensive than) regular Type 2 charging points. This has allowed for fast upscaling to 500 V2G charging posts by the end of 2021. Part of these V2G charging points is used in conjunction with the fast-growing E-car sharing scheme of We Drive Solar, which by the end of 2021 will include the first V2G production e-cars in the world: the new Hyundai IONIQ5. With co-operations announced with Hyundai[1], Koolen Industries and Sono Motors, the innovating consortium led by We Drive Solar has a bright outlook towards fulfilling the ambition to realize the energy- and mobility system of the future: hundreds of electric shared cars that provide clean air, less cars on the road and the buffer for large scale application of solar and wind energy in the region.

In IRIS, this is combined with a large stationary battery to complement the flexibility potential of the V2G e-cars in the bidirectional ecosystem, to trade on the electricity markets, make the electricity grid flexible and with high penetrations of e-cars and variable renewable energy sources.

Since the solutions are connected with each other in the bidirectional ecosystem, this chapter describes the results booked per September 2021 in Transition Track #2 “Smart energy management and storage for flexibility” and #3 “Smart e-mobility” within the IRIS Utrecht demonstration project with respect to

[1] https://www.irissmartcities.eu/content/utrecht-first-bidirectional-city-world-due-collaboration-hyundai-and-we-drive-solar

EV charging stations, the stationary battery, shared EVs and the energy management system. These demonstration activities comprise the realisation and operation of:

- Smart solar V2G chargers in the Kanaleneiland district, Lombok and Henriettedreef, at district scale interconnected with PV-systems;
- District-wide additional stationary storage, interconnected to primary V2G-storage and PV-systems by green ICT;
- District EMS, the district ICT platform providing interconnection and monitoring at district scale;
- Deployment of V2G E-cars and e-vans;

In the next chapter, preliminary results of Transition Tracks 2 and Track 3 with respect to E-buses and e-bus charging stations will be discussed.

Location of the measures in the city area

The original focus of IRIS was on the district of Kanaleneiland-Zuid in the city of Utrecht. This is a residential area of 64 hectares situated in the Utrecht Centre-West area, just southwest of the historic city centre and the Utrecht Central Station. The district is surrounded by two large canals (hence 'canal island'), one of which is used intensively for freight transport (Amsterdam-Rhine Canal)

Figure 9 provides an aerial view of the district depicting the location of the first V2G-chargers, V2G-cars and the stationary battery.

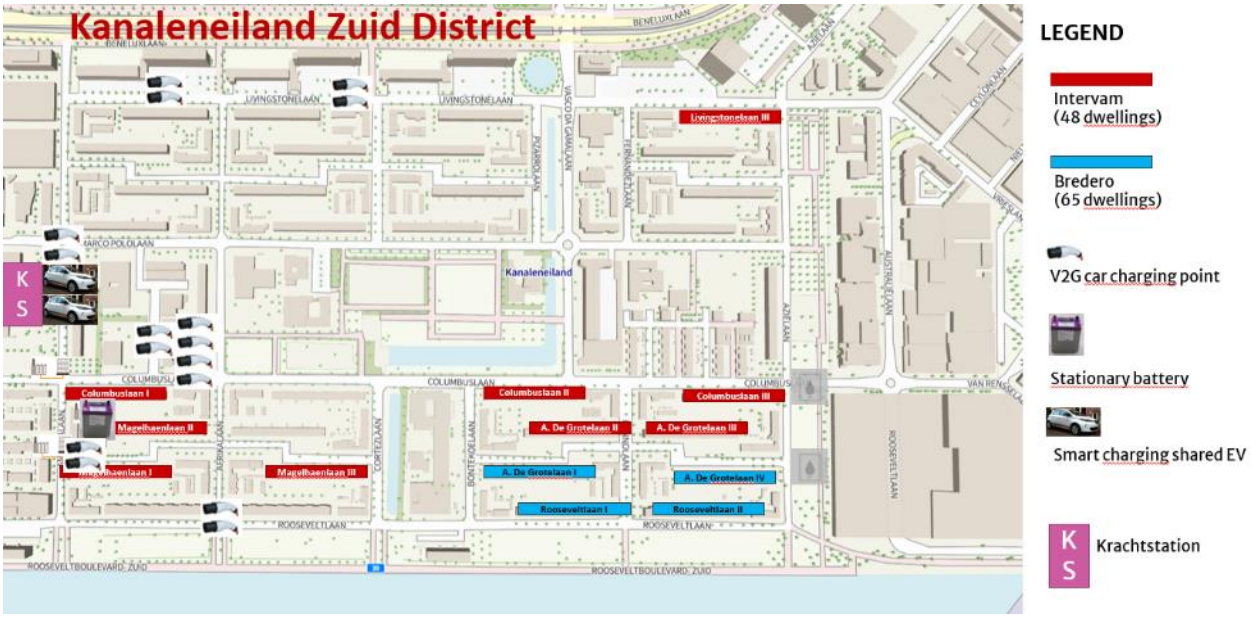


Figure 9. Map of Kanaleneiland-Zuid with IRIS demonstration measures for TT#2 and TT#3: V2G charging points, stationary battery and smart charging shared EV

The implementation of V2G charging stations and smart charged shared EV's is growing rapidly and is depicted in **Fout! Verwijzingsbron niet gevonden.**.

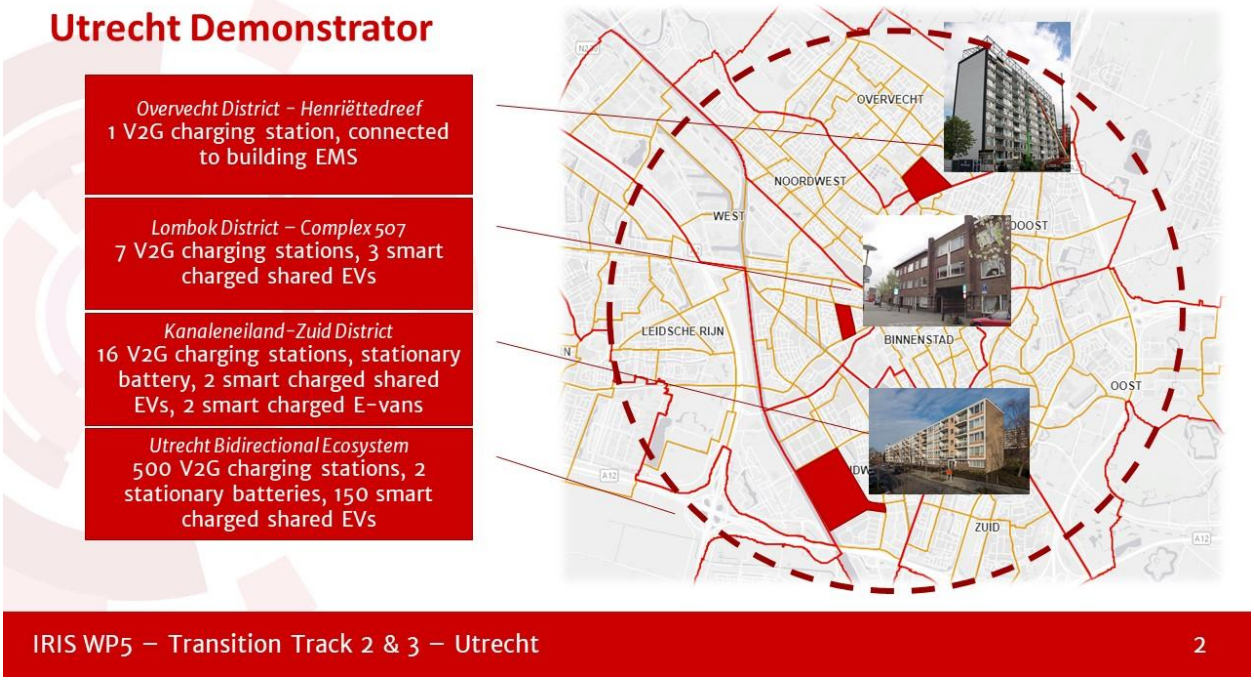


Figure 10. IRIS TT#2/3 activities in Utrecht

An overview of main activities and timeline

The main activities have been:

Since the start of the project, eight **Solar V2G charging posts** (16 charging points) for e-cars/e-vans have been realised in the Kanaleneiland Zuid district. That number is expected to grow in the remaining running time of the project, following actual demand, towards or possibly surpassing the planned total of 18 charging points in Kanaleneiland Zuid. At the Henriettedreef location, a V2G charging post is being realised that will be directly connected to the advanced energy management system for in the energy positive building. In the city-wide development of the bidirectional ecosystem, the number of V2G charging post is growing steeply and is expected to reach 500 in 2021, as mentioned above.

Until now, two shared **V2G e-cars** and two e-vans are in operation in Kanaleneiland Zuid. The demand for shared e-cars in Kanaleneiland-Zuid turns out to be low, apparently this is connected to the demographics of this district. The plan to place V2G e-cars in the district has been delayed, because while car manufacturer Renault has developed and supplied prototype V2G e-cars to the project, due to external conditions, series production of V2G cars at Renault has been delayed by several years. However, this year, Hyundai has announced that it is planning to launch the world's first series produced V2G car on the market, with a worldwide first in Utrecht. This means that from end 2021, V2G e-cars will become available to the project and complete the Utrecht bidirectional ecosystem.

This autumn, an 845 kWh and 590 kW / 630 kVA **Stationary storage battery** is installed in a shared area between IRIS housing blocks at the Columbuslaan and the Magelhaeslaan, see **Fout! Verwijzingsbron niet gevonden.**.

The stationary battery, connected PV panels (in TT #1) and the V2G e-car charging posts are combined into a **Smart Energy Management System** that will bundle the flexibility and help with congestion management of the grid in the city. The energy management system is being scaled up to the level of the whole city, as part of the establishment of the Utrecht bidirectional ecosystem. Bundling all flexibility assets (the 500 V2G charging posts, the soon-to-arrive V2G shared cars, the stationary battery and another stationary battery already in operation in the city, and the PV systems will result in a powerful network congestion management and flexibility system that will profit from the laws of numbers and have far more impact than when these assets were managed separately.

3.2 Implementations

Regarding **Solar V2G charging points for e-cars/e-vans** (Measure 1 of TT#2)**,** 16 V2G charging points have been realised in the Kanaleneiland Zuid district:

- One charging post (2 charging points) near the Local Innovation Hub “Krachtstation” (former school building that now hosts start-ups and functions as a meeting place).
- One charging post (2 charging points) near the corner Afrikalaan – Rooseveltlaan.
- Two charging posts (4 charging points) at the parking place of the office of Bo-Ex in Kanaleneiland.
- One charging post (2 charging points) near the corner Amerikalaan – Magelhaenlaan.
- One charging post (2 charging points) on the Maylaan.
- Two charging posts (4 charging points) on the Livingstonelaan.

The plan is to have this number increase to the planned 18 V2G charging points in Kanaleneiland, following actual demand. Active citizen engagement activities have taken place. The growth of the V2G charging network is connected to the growth of the city-wide charging network as part of the Utrecht bidirectional ecosystem, with an expected total number of 500 V2G charging posts in Utrecht (1000 charging points) in 2021 and foreseen rapid further growth in the next years.

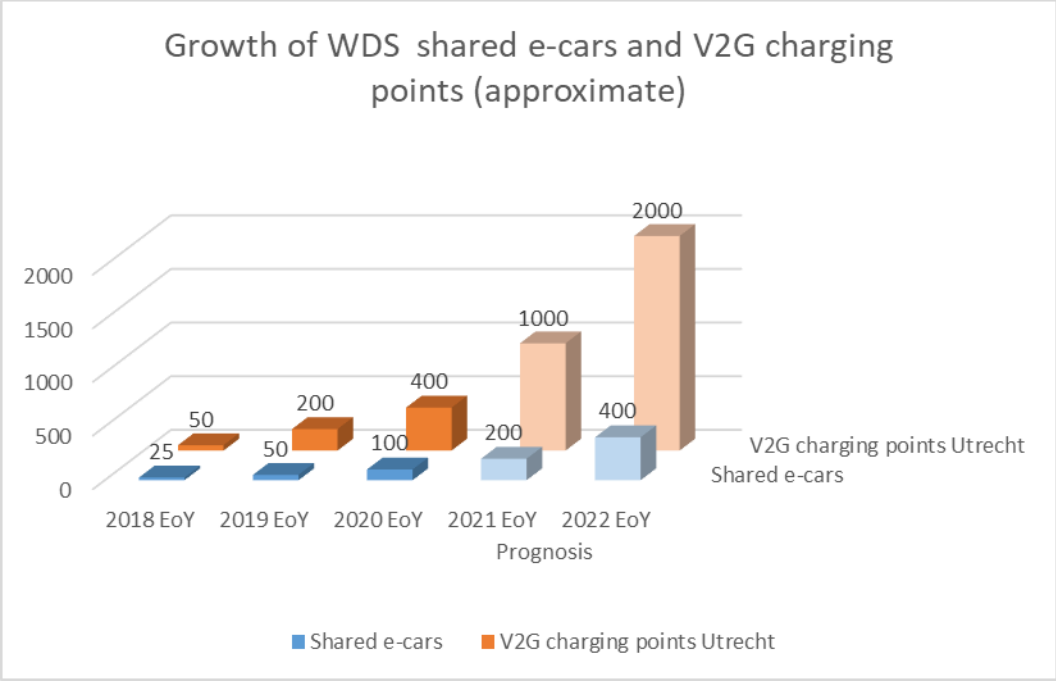


Figure 11 Growth of shared e-cars and V2G charging points in the Utrecht Bidirectional Ecosystem

In the Kanaleneiland Zuid district, **V2G e-cars and e-vans** (Measure 1 of TT#3), have been placed. Two shared e-cars are providing MAAS mobility services in the district. Also, two e-vans have been procured by housing association Bo-Ex to replace its existing vans for maintenance and service use. The number of e-cars is foreseen to slowly increase, following demand. The demand for shared e-cars in Kanaleneiland Zuid was promoted with online and offline publicity, information sessions and other citizen engagement activities[2]. The relatively low response in this district is associated with the demographics and economical situation of the citizens.

[2] Report on Utrecht citizen engagement activities by Labyrinth, May 2019

Figure 12 Public information session at Kanaleneiland Zuid, 2019

The plan to implement bidirectional, V2G e-cars in the demonstrator was delayed because despite earlier expectations, V2G production cars were not available. Car manufacturer Renault had developed and supplied two prototype V2G e-cars to the project, but due to external conditions, Renault was forced to postpone series production of their V2G cars.
In Spring 2021, Hyundai has signed with We Drive Solar the intention to have the world's first series produced V2G car (the model IONIQ5) on the market, with a launch in Utrecht. This means that from end 2021, the first V2G e-cars will become available to the project. The plan is to introduce and demonstrate the first 15 IONIQ5 cars in Utrecht this year. A project amendment has been requested in order to be able to realise this development. Also, the German car maker Sono is now developing production V2G e-cars and it is proposed to also connect these to the bidirectional ecosystem in Utrecht. These cars will be connected to the Utrecht Bidirectional Ecosystem using the new international ISO 15118 standard and demonstrated in the IRIS demonstrator. From that moment, the bidirectional ecosystem is in full operation and will fulfil its ambitions on the energy field (use the EV batteries as a virtual battery to reduce electricity network congestion and maximise renewable electricity use) as well as on the mobility field (reduce air pollution, increase healthy mobility, reduce the claim of cars on urban (parking) space).

Figure 13 On September 8, 2021, the first IONIQ5 V2G car was received by We Drive Solar from Hyundai. In the coming months, this car will be used to test the bidirectional charging of in the Utrecht Bidirectional Ecosystem.

Secondly, a **Stationary storage battery** (Measure 3 of TT#2) is installed in a shared area between IRIS housing blocks at the Columbuslaan and the Magelhaenlaan, see **Fout! Verwijzingsbron niet gevonden.**. Realising this battery proved to be challenging, as an earlier tender to realise 2nd life batteries installed in garage boxes of buildings did not result in viable options. There were serious concerns on fire safety issues connected to installing such batteries in garage boxes under houses, and the second life batteries on the market were too tall to be installed in the relatively low garage boxes. Also, the prices quoted were very high – even higher than prices of new batteries. This was probably due to the steep decrease in stationary battery prices at the time.

A second tender for a new battery energy storage system to be placed outside, proved successful and cost-effective. The offer of Tesla was selected and, after a further delay due to permission procedures, a Tesla PowerPack with a capacity of 845 kWh and a power of 590 kW / 630 kVA is now installed in a shared area between the apartment buildings. The battery will be interconnected with a PV-system and the V2G EV-sharing system.

This stationary battery will provide flexibility services to the electricity grid by trading on the TSO electricity markets. This will be bundled with the other assets of the growing Utrecht Bidirectional Ecosystem, especially the other stationary battery already in operation at the site of the Jaarbeurs trade fair and the V2G smart charging stations throughout the city. At the same time, the stationary will be used by Utrecht University, Utrecht Sustainability Institute and Stedin to analyse in what amount it can contribute to reduction of network congestion, and what value it could create when delivering these network congestion services. These results will be used to determine the business case for the parties that deliver flexibility (the battery will be operated on behalf of Bo-Ex by an aggregating party) and for DSO Stedin as future customer for these services. Stedin will thus be able to investigate how much flexibility would be available and at what price that flexibility would become available for local

congestion management, at the desired moments, in comparison to the costs saved by postponing grid reinforcements. The research questions to be answered are:

- At what price will the battery deliver flexibility on the TSO markets at the moments when there would be flexibility because of high load at the transformer stations?
- From what level of cost would the DSO be able to get access to the battery flexibility for capacity / congestion management, as compared to alternatives (grid reinforcement)?
- In what way would the business case of the battery for the owner be influenced when Stedin would use the available flexibility of the battery for congestion management – would it improve the business case for the battery owner?
- Would operation of a stationary battery in a residential area in this situation lead to unforeseen / undesirable effects on the network load in relation to the demand profile in the area?

To deliver these services and to generate these data, the battery will use monitoring equipment that is delivered as part of the battery management software, electricity measurements on the connected PV panels and measurement data of the electricity connection meter. Measured data will include the charging/discharging patterns, control signals from the aggregator to the battery, the price paid to the battery owner for the delivered flexibility, solar panels output, load patterns on quarterly base, transformer limits, electricity load data from apartment complexes. The congestion will be simulated using historic data from relevant transformer stations.

Figure 14 Stationary battery being installed in Kanaleneiland (source: LomboXnet)

Citizen engagement activities were started, in which children and citizens have been asked to suggest decorations to be applied to the stationary battery enclosure so that it will become a more attractive element in the shared area. If the battery can generate net positive cash flow from the above services to the electricity grid, these proceedings will be used to improve / refurbish the small park in which the battery is located, so that the surrounding citizens also have direct profit in that respect.

Figure 15 Citizens of Kanaleiland being involved in designing improvement of the park where the stationary battery is located

Further, a **Smart Energy Management System** (Measure 4 of TT#2) is being realised. The district energy system will interconnect energy consumers, energy producers and energy storage providers including the following components:

- PV panels and hybrid heat pumps (in TT#1)
- Solar V2G charged e-cars and charging points
- Stationary battery

The local electricity grid in the demonstration area was designed in the sixties and has been reinforced to fit in all elements as summarized above. Three additional transformer stations, transforming the voltage from medium voltage to low voltage have been added to the existing three stations in the local low voltage grid. These additional transformer stations were necessary due to the foreseen feed-in of large amounts of solar power produced on the apartment buildings, additional electricity demand due to the hybrid heat pumps replacing natural gas boilers and charging of electric vehicles. The locations of all 6 transformer-stations are indicated on the map in Figure 16.

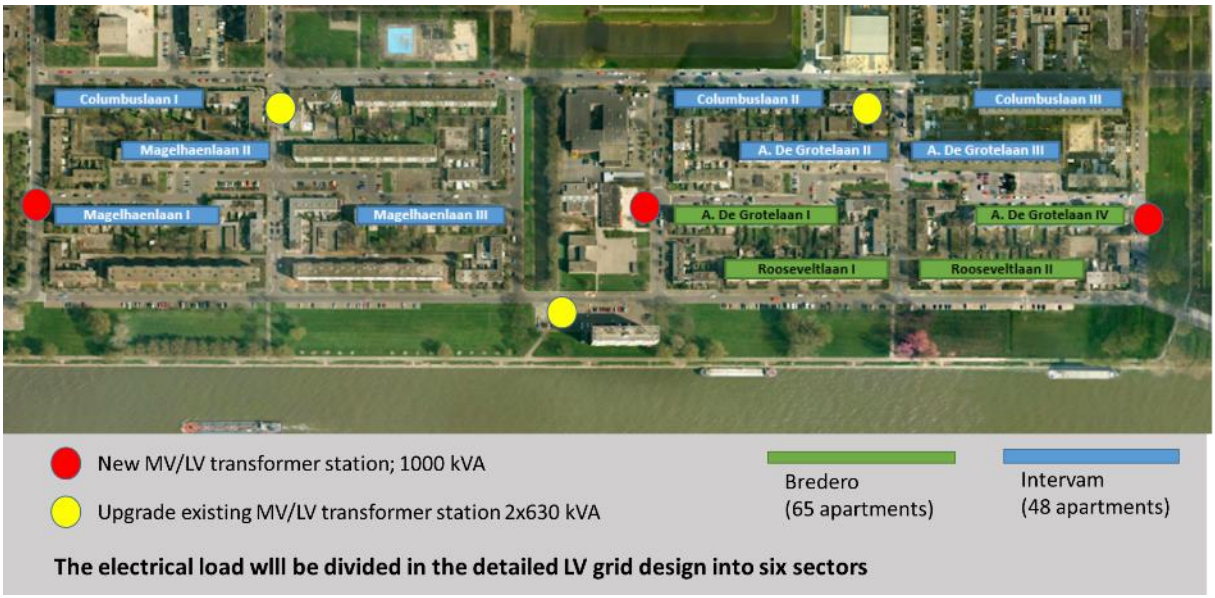


Figure 16. Location behind of the 6 medium voltage stations in the IRIS area to solve foreseen congestion points.

The district energy management system will have a double function:

- During the transformation of the apartment buildings, including installing solar panels, and the introduction of the charging points for electrical vehicles the changes in energy flows will be measured and analysed to also estimate the effect on the electricity system when, due to replication, the solutions in the demonstration area are duplicated on a large scale at other places.
- The real time measurements of the electricity flows will be essential input for the aggregator for using flexibility to help Stedin keep the maximum flow within acceptable values and monitor the status of the grid.

The IRIS project has brought about a rapid development in Utrecht city - the growth of what is called the Utrecht Bidirectional Ecosystem. This bi-directional ecosystem had its world premiere in May 2019 in the presence of King Willem-Alexander of the Netherlands and top executives of Groupe Renault; at the same event the new ISO15118 open standard for V2G charging was launched by ElaadNL and the Open Charge Alliance. The main elements at this moment are:

- The same district energy management system that was foreseen to be used as DEMS in the Kanaleneiland demonstrator, has spread over Utrecht. Spread over the whole city, there are now almost 500 bidirectional charging points in operation; this number is still increasing because of an active municipal program.
- The company We Drive Solar (affiliated to LomboXnet) is operating a network of over 100 smart charging electric shared cars in the whole city, including the first prototype AC-bidirectional Renault Zoe cars worldwide. In the near future, fast further growth is foreseen, as well as the implementation of bidirectional cars at larger scale in Utrecht.
- A new strategic cooperation between Hyundai and We Drive Solar has been announced spring 2021. This is expected to result in the worldwide launch of the first V2G production car as part of the Utrecht bidirectional ecosystem in 2021.

- At the time of writing of this report, also a strategic cooperation between the German car maker Sono Motors and We Drive Solar was announced, with the intention to bring 100 Sono Motors cars to Utrecht as V2G shared EV's.
- Solar power installations on a number of schools are delivering electricity that (partly) feeds the charging stations. Also, a second stationary Battery Energy Storage System is in operation on the premises of the Jaarbeurs trade fair as mentioned above.

Therefore, a project amendment request has been formulated to broaden the District Energy Management System for the Utrecht demonstration site to a City Energy Management System in which flexibility is exchanged between the IRIS demonstration sites in Utrecht and other flexibility assets throughout the city. This will enable the Utrecht demonstration partners to increase the impact of the IRIS innovations greatly, as the three demonstration district areas Kanaleneiland, Lombok and Overvecht as well as a fast-growing number of other new assets in the whole city could be connected into one city-wide energy flexibility network.

3.3 Preliminary results

Regarding end-user experiences until now, the public interest in shared EV's is low in Kanaleneiland, but the demand for charging stations has increased in the past years. In the rest of the city, the demand for charging stations and shared EV's is soaring. A research action was conducted to gain more insight amongst the inhabitants of the Kanaleneiland district in the demand for shared mobility. Main results were that about half of the interviewed people owned a car and most of those car owners used it less than once a week. Half of the car owners reported having parking problems occasionally. People that expressed interest in electrical shared cars were young and mostly did not have a car or shared a car. The interest was connected to environmental aspects and location. Reasons for not being interested in shared electrical cars were the wish to have an own car, appearance/luxury, the wish to choose the car brand and fear that sharing cars with unknown others might cause conflicts.

An action to mobilise central key persons to approach other citizens turned out to be hard to realize, with the observation that many residents are in a constant struggle regarding health, food security and safety.

The stakeholder experience on the installation of the stationary battery has been that integration of such batteries into the built environment is still a challenging task, with fire safety and physical integration as attention points. The stakeholder experience with the charging stations has been very positive – the demand-driven growth in Kanaleneiland Zuid has been promising, just like in the rest of the city. The district energy management system is awaiting the battery to become operational.

The progress of the related KPI's has been summarized in the below table.

Table 3. Progress of KPIs in TT#2/3 for charging stations, stationary battery, shared EVs, energy management system

KPI	Target (as described in DoW or declared)	Progress
Peak Load Reduction	No target specified, because this KPI was formulated for research purposes. We hope to achieve a peak load reduction of over 10%.	First peak load calculation expected end 2021
Storage capacity installed	845 kWh	845 kWh battery being installed
NOx emissions	0.2 ton/year (1 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 0.04 ton/year in district, 1.1 ton/year in the whole city
FPM emissions	0.004 ton/year (0.2 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 0.0009 ton/year in district, 0.03 ton/year in the whole city
CO emissions	0.6 ton/year (3 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 0.13 ton/year in district, 5 ton/year in the whole city
CO_2 emissions	62 ton/year (308 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 14 ton/year in district, 300 ton/year in the whole city
Access to vehicle sharing solutions for city travel	18 cars	Estimated 2021: 4 cars in district, 150 cars in whole city
Yearly km driven in e-car sharing system	270,000 km/year	Estimated 2021: 60,000 in district, 1.8 million in whole city

As described above, the IRIS demonstrator is presently serving as a living lab and a catalyst for fast upscaling of smart energy and mobility management for the whole city of Utrecht. LomboXnet is rolling out the technology in the whole city and even in the region around Utrecht city. Presently, the total number of V2G charging points is approaching 1,000 and the number of shared E-cars in Utrecht is growing towards 150.

Thus, on the level of the whole city the flexibility provided by smart charging vehicles, stationary batteries and smart district energy systems provides an amplification of the benefits. The municipality of Utrecht is embracing these developments, triggered by the IRIS demonstration it is now scaling up the technology in the whole city, driven by its ambitions to become energy-neutral by 2030 and to have

25,000 e-cars in the city by 2023. In a tender by the municipality for new EV charging stations, V2G compatibility has been included.

Figure 17 Smart charged shared We Drive Solar e-cars at the Krachtstation, Kanaleneiland Zuid

3.4 Business models and exploitation

The Smart Solar Charging (SSC) approach comprises of a complex set of bankable and societal business models with multiple value propositions. It is the combination of these business models that describes the full value of the approach. The most prominent business models are briefly described here.

3.4.1 Bankable business models

Value Proposition: Shared EV solutions provide competitive, green, clean mobility as a full alternative to owning one or two cars.

Customer:	Households, especially urban
Channels:	Internet, press exposure, social marketing
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	Participants in the sharing scheme pay a fixed amount per month for the possibility to use a car for a certain number of days per month; there are several tiers. On top of that fixed amount, an amount is charged per km driven, which includes charging costs.

Value Proposition:	SSC provides flexibility services to electricity markets
Customer:	TSO (in the Netherlands, there is currently no market model for DSO's to procure flexibility)
Channels:	Electricity markets such as day-ahead, FCR, aFFR
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	Electricity price variations on markets

Value Proposition:	SSC offers advanced energy management as well as a mobility solution which requires far less parking space to urban, zero energy new housing districts.
Customer:	Project developers developing urban zero housing districts
Channels:	Professional publications and symposia
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	Participation fees in new housing projects. For instance, the new housing district Cartesius in Utrecht, for which the construction will start in 2022, will have very few parking places, relying on V2G charging shared e-cars to not only provide green mobility but also energy management for its all-electric, zero fossil energy system.

3.4.2 Societal business models

Several business cases for upscaling of the stationary battery and smart energy management system are at this moment hampered by regulations and taxation; lobbying activities are going on at different levels to influence this, but at this moment the following business cases are societal:

Value Proposition:	SSC provides a solution to the challenges that a sustainable energy supply brings to the electricity grid, avoiding costly grid reinforcement.

Customer:	DSO's, TSO
Channels:	To be established (apart from the above-mentioned energy markets)
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	The potential avoided costs for grid reinforcement, as estimated by DSO's and TSO, are in the range of billions in the Netherlands alone.
Value Proposition:	SSC provides a solution to the challenges that a sustainable energy supply brings to the electricity grid, avoiding impact on the built environment.
Customer:	Municipalities, especially of cities
Channels:	To be established
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	The potential avoided costs for spatial planning of grid reinforcement measures in cities (cables, low and medium voltage power stations) are significant.
Value Proposition:	SSC enhances the business case for electric mobility, thus providing societal value in terms of air pollution and health.
Customer:	Municipalities, especially of cities
Channels:	To be established. The municipality of Utrecht plays an important role with 500 smart charging stations expected in autumn of 2021 throughout the city, based on local demand and the expected steep growth of the number of electric vehicles in the city.
Costs:	V2G charging infrastructure, V2G cars, car sharing solution
Revenue:	The potential avoided societal costs connected to air pollution in cities are high.

3.4.3 Key Exploitable Result

In the Annex, an update is given of the Key Exploitable Result table, which was generated last year in the Exploitation Strategy Seminar. The update illustrates that the business model development is in progress and that new propositions are being tested in the market.

The upscaling and replication of the We Drive Solar / Smart Solar Charging approach has taken off in 2021 with as major highlights:

- In April 2021, car manufacturer Hyundai has signed a Letter of Intent with We Drive Solar to deliver the world's first AC V2G production car to the Utrecht bidirectional ecosystem. The first cars are expected by end of 2021, with 150 cars to follow in 2022.
- In June 2021, Koolen Industries, an investment company targeting sustainable innovations, has announced a large investment in We Drive Solar so that scaling up will now be carried more by private investment.
- Large insurance company ASR is currently establishing the world's largest V2G parking garage with 250 V2G charging point at its headquarters complex on the East side of Utrecht city.
- In September 2021, a LOI is signed between We Drive Solar and the innovative start up car manufacturer Sono Motors in Germany, to deliver a first prototype and later 100 V2G Sono Zion cars to the Utrecht bidirectional ecosystem.

Replication and upscaling is taking place in a number of other ways:

- IRIS partner Gothenburg has shown interest in several IRIS workshops, in which there was attention for the replication of the data driven approach in rolling out the charging stations.
- We Drive Solar has won a concession to roll out V2G charging points in Rotterdam and Arnhem.
- In the innovation project ROBUST, the Utrecht Bidirectional System will be replicated to Arnhem and further upscaled.
- The ISO 15118 standard is due for publishing end 2021 and is an open standard with the goal to further stimulate replication of ISO 15118 compatible smart charging systems. As mentioned above, not only Renault but in particular Hyundai and Sono Motors are adopting the standard in their product. This is being taken up in several initiatives, including the European Horizon Europe project INCIT-EV.
- The consulting and management company Moneypenny has researched the opportunities for upscaling the V2G shared e-car approach in sustainable new housing districts in Utrecht. First results indicate that in urban settings, where sustainability ambitions are high and parking requirements are strict, V2G shared e-cars can provide an attractive solution for smart e-mobility as well as energy management.

3.5 Lessons learned and next steps

IRIS has catalysed the development of the Utrecht Bidirectional Ecosystem, which is based on the V2G charging stations and shared e-cars, the stationary battery in Kanaleneiland and the city-wide energy management system. The V2G charging stations are compatible with public charging of private EV's which has enabled their fast growth to 500 stations in Utrecht in 2021. This year, the 150th smart charged, shared EV will be taken in operation by We Drive Solar, with V2G cars from Hyundai expected by end 2021 and from Sono Motors later. In general, activities are progressing according to plan, with the replication / upscaling on city level running ahead of earlier schedules.

Important lessons learned include:

- Energy and flexibility systems are developing on city level, as well as e-bus and V2G shared e-car roll-out. IRIS is a main driver towards the quick development of a city-wide flexibility and e-mobility ecosystem.

- In low-income districts with a lot of social housing like Kanaleneiland Zuid and Overvecht, the adoption of shared e-cars lags behind the fast-growing demand in the city of Utrecht as a whole.
- The realisation of stationary batteries in garage boxes has proven to be more difficult, with respect to spatial restrictions and electrical / fire safety concerns, than expected. For this reason, the stationary battery was placed outside.
- Second life batteries proved (in 2019) significantly more expensive than new batteries, which appears to be due to quick price drops and production growth, and the low number of used e-car batteries available. This is expected to change in the next years.
- The interest in the demonstration of smart energy management from related parties such as authorities, DSO and other power network parties is large, but because developments in the field of flexibility management are fast in the Netherlands, the interest of partners and external parties in the innovative solutions in the project also changes. An example is the intention to use USEF – in the meanwhile the newer Gopacs platform has started to develop which means that it is now intended to use the two platforms together to establish the flexibility mechanisms.

Next steps are:

- Continue fast expansion of the network of V2G chargers in a demand-driven way, with support of citizen engagement activities and the involvement of local entrepreneurs.
- Realisation and exploitation of the stationary battery and develop the flexibility request handling systems so that the actual value of local flexibility services on the Dutch market can be investigated
- Realisation of the smart energy management system and quick extension towards virtual power plant and a city-wide ecosystem of green mobility and sustainable energy management.

4. Preliminary Results of Transition Tracks 2 and Track 3 – E-buses and e-bus charging stations

In Utrecht, 68 e-buses are in operation with two large charging plazas just outside the city and several fast chargers along the route. As part of IRIS, bus company Qbuzz has fitted the buses with detailed monitoring and logging devices that are providing valuable data on battery behaviour, driving range, battery wear and state of charge over the day. Based on these data, QBuzz and Utrecht University are conducting research on the potential of smart charging and V2G operation of city e-buses in the Utrecht setting. First result show that smart charging of e-buses is promising, and implementation is on the way.

4.1 Overview

This chapter describes the results booked so far (September 2021) in Transition Track #2 and #3 regarding e-buses in Utrecht. The specific measures are:

- Smart charging spots for e-buses in Westraven (Measure 2 of TT#2)
- Smart charged e-buses (Measure 2 of TT#3).

The location of the measures in the city area;

The two large charging plazas are situated in the district of Kanaleneiland-Zuid in the city of Utrecht, in two locations: Westraven and Remiseweg (see Figure 18). The 68 e-buses that are parked and charged in these plazas have routes in the city of Utrecht and partially in the region.

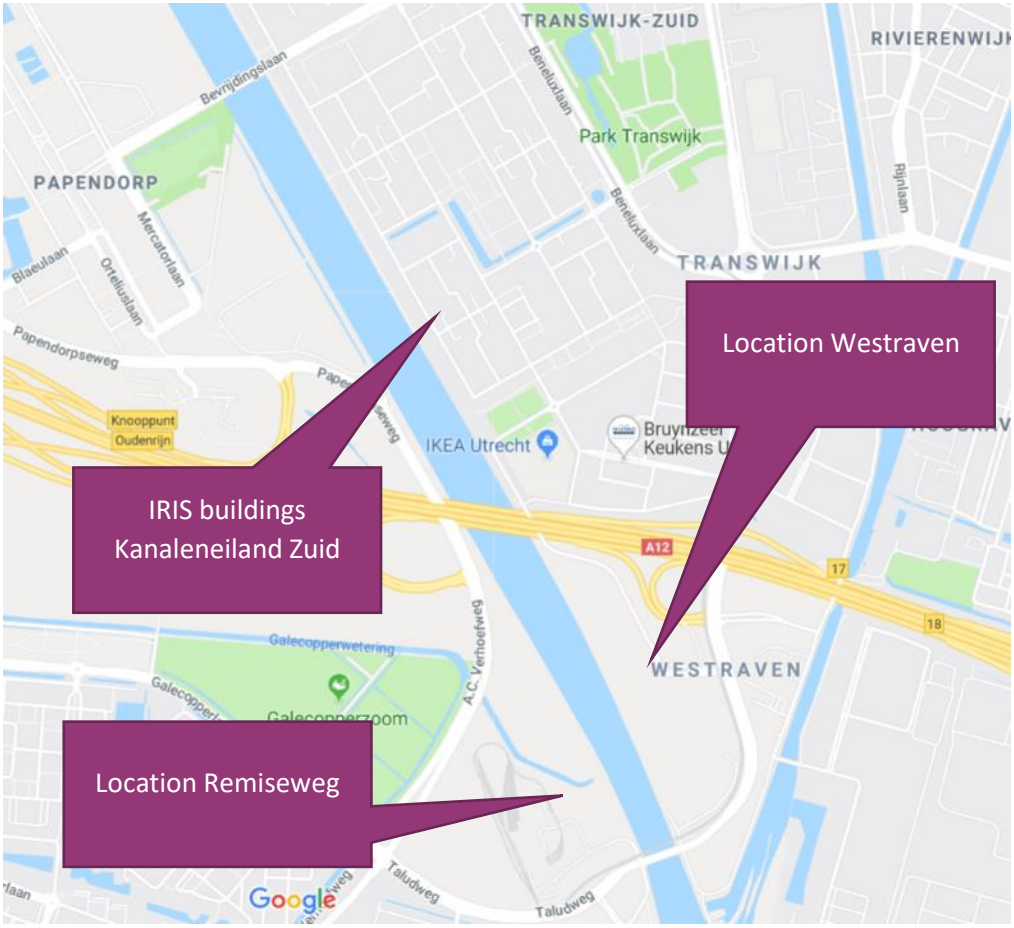


Figure 18: New e-bus charging locations of QBuzz

In the two **charging plazas for 68 e-buses** (Measure 2 of TT#2), the buses are charged during the night with renewable electricity (Dutch wind power). Research is ongoing on the benefits of adopting smart charging strategies at the two e-bus charging plazas.

Since 2020, **68 e-buses** (Measure 2 of TT#3) of Qbuzz are providing public transport to the city and region.

4.2 Implementations

In the two **charging plazas for 68 e-buses** (Measure 2 of TT#2), the buses are charged during the night with renewable electricity (Dutch wind power). Research is ongoing on the benefits of adopting smart charging strategies at the two e-bus charging plazas. This research has been performed by Utrecht University together with LomboXnet, Utrecht Sustainability Institute and QBuzz. In October 2021, one of the Utrecht University students will start an employment at Qbuzz and continue her research on smart and V2G charging options there. The research cooperation with Utrecht University and Utrecht Sustainability Institute will be continued in 2022 and will also include connection of the charging plazas

to the Utrecht Bidirectional Ecosystem. The latter research will be coupled to the research project ROBUST, where the Utrecht Bidirectional Ecosystem will be further developed.

Since 2020, **68 E-buses** (Measure 2 of TT#3) are now in operation by partner Qbuzz to provide public transport to the Province of Utrecht. The e-buses are charged in two new large depots with in total 68 bus charging stations. The e-buses provide their services to the region; the charging stations at the bus depots have an own medium-voltage connections and thus act on city level rather than district level.

4.3 Preliminary results

The e-buses and their chargers are in operation for more than a year now. The detailed monitoring gear in the buses is delivering large amounts of detailed data which is being analysed.

First results from investigations by Utrecht University together with Qbuzz, Utrecht Sustainability and LomboXnet resulted in for smart charging of the e-buses being identified as promising, with the goal to reduce network capacity load and future trading on the electricity markets of the TSO. These are being investigated further by the above-mentioned partners. Also, the possibility of V2G charging of the e-buses is researched in more detail as a possible next step.

A preliminary estimate gives the following progress on KPIs:

Table 4. Progress of KPIs of TT#2/3 for e-buses

KPI	Target (as described in DoW or declared)	Progress
NOx emissions	0.2 ton/year (1 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 7 ton/year in the whole city
FPM emissions	0.004 ton/year (0.2 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 0.09 ton/year in the whole city
CO emissions	0.6 ton/year (3 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 3 ton/year in the whole city
CO_2 emissions	62 ton/year (308 ton in 5 years) in district Kanaleneiland Zuid	Estimated 2021: 1100 ton/year in the whole city

4.3.1 Bankable business models

As described above, QBuzz has strongly expanded its e-bus fleet in Utrecht. QBuzz is intent on winning the next concession which will be tendered around 2023 and further expand the e-bus fleet and services. The business case for smart charging of e-buses is being researched by University of Utrecht together with Utrecht Sustainability Institute and QBuzz; first results indicate a positive business case for smart charging for peak load reduction and also for electricity cost reduction by purchasing electricity on the TSO markets. The potential for V2G charging of buses is also being researched.

Value Proposition:	Smart E-bus charging provides flexibility services to electricity markets
Customer:	TSO (in the Netherlands, there is currently no market model for DSO's to procure flexibility)
Channels:	Electricity markets such as day-ahead, FCR, aFFR
Costs:	Smart e-bus charging infrastructure, e-buses
Revenue:	Electricity price variations on markets and/or savings on capacity tarriffs.

4.3.2 Societal business models

The business case of e-buses is strongly driven by municipal concessions and policies.

Value Proposition:	Smart / V2G e-bus charging contributes to the challenges that a sustainable energy supply brings to the electricity grid, avoiding impact on the built environment.
Customer:	Municipalities, especially of cities and DSO's and TSO's
Channels:	To be established
Costs:	Smart e-bus charging infrastructure, e-buses
Revenue:	Potential avoided costs for spatial planning of grid reinforcement measures in cities (cables, low and medium voltage power stations).

Important lessons learned include:

- E-buses are developing strongly on city level and further expansion is expected.
- Smart e-mobility systems and V2G charging are quickly developing on city level (and buses and V2G) and IRIS is a main driver of these developments in Utrecht.

5. Preliminary Results of Transition Track 4 – City Innovation Platform and data services

Objective of this deliverable is to provide a detailed overview of the activities for Transition Track #4 within the Utrecht demonstration. The Grand Agreement states the objective as: "Through cross-cutting open ICT (1) enable the integration of the IRIS solutions, maximising cost-effectiveness of the integrated infrastructure, (2) provide the City Innovation Platform (CIP) and (3) develop meaningful information services for households, municipality and other stakeholders, (4) together allowing for new business models." The document is aimed at giving insight into de progress made on the diverse data services developed within the IRIS project in the demonstration area Kanaleneiland-Zuid in Utrecht. It helps other lighthouse cities and following cities within the IRIS project to see and learn what possibilities for services are and how they can be replicated.

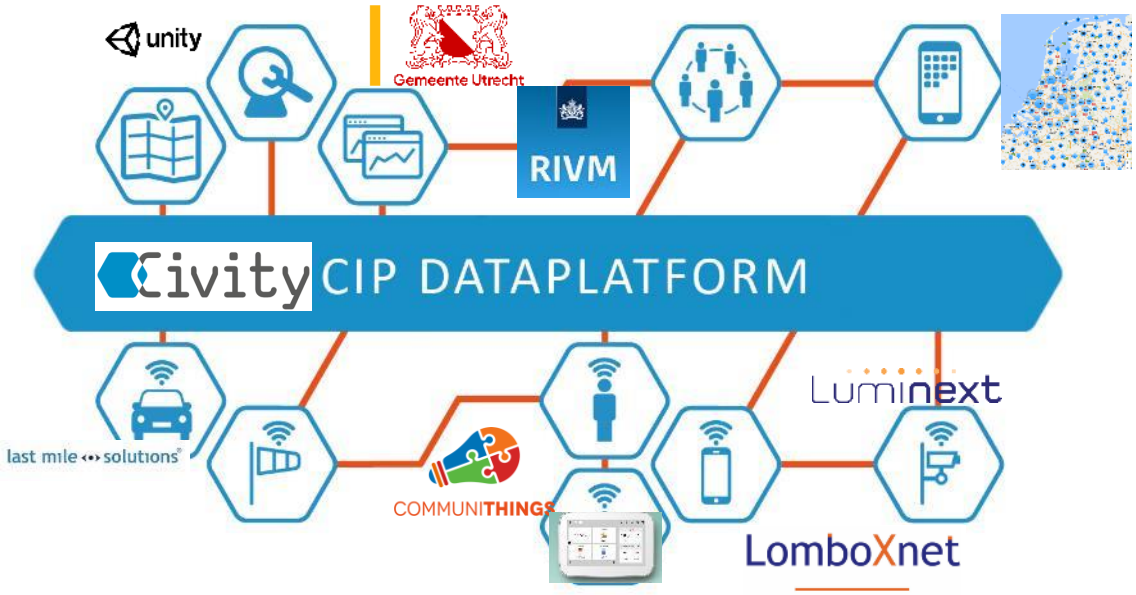
KEY MESSAGE
Within Transition Track 4 various data services have been developed. The services are aimed at the monitoring of charging stations for electric cars, smart street lighting, making smart city applications visible in an AR application and fighting energy poverty through data-driven energy advice. These services run on datasets made available through the urban data platform CIP. The services contribute to solving social problems such as the increasing misuse of charging stations for electric cars, energy poverty, road safety and support the energy transition. The data services prove that services based on the use of open data sets available in the CIP can be used to solve societal challenges. The financial exploitation of the services and the translation into profitable business models is still quite challenging.

5.1 Overview

The activities in the since the last report in month 24 months includes the implementation of the data services. Most services have been implemented and some preliminary results can be shared. Within TT#4 the following services have been developed:

- Data service 1: Monitoring E-Mobility with LoRa network
- Data service 2: Smart Street Lighting with multi-sensoring
- Data service 3: 3D Utrecht City Innovation Model
- Data service 4: Monitoring Grid Flexibility
- Data service 5: Fighting Energy Poverty

The results of data service 4: Monitoring Grid Flexibility is done in chapter 3 on tracks 2 and 3.



City Innovation Platform (CIP)

The CIP is a data platform that can host different static a dynamic data sets through witch integrated data services can be developed. CIP is used for the measures 1, 2, 3 and 5 connecting different data set and thereby enabling new information and data services. The CIP collects the data from different data sources (charge points, sensors, HEMS, etc.) and processes the data into usable data sets. The datasets are then offered to third parties in a data marketplace though witch (commercial) arrangements are made between the data suppliers and the data users. TT4 is aimed at developing data services based on this principle and aims data users to develop valuable data services on with the available data sets in the CIP, proving the value of public urban data platforms like the CIP.

Different data connections have been established (charge point data, parking sensor data, energy usage data TOON data, cabal capacity data, shared car data) other connections can be established in the future. More information on the development of the CIP can be found in the report of Deliverable D4.6

5.2 Data service 1: Monitoring E-Mobility with LoRa network

5.2.1 Implementations

Deploying and operating EV charging bays is a substantial investment, which requires the most optimal and efficient use for a feasible business case. In the current situation it is not possible to provide EV-car users and charging pole operators with information about rightful or illegal usage of the parking bay. The aim for this *use case* within the IRIS-project is to create insight in the (in-efficient) usage of parking bays and charging infrastructure by measuring the illegal use of EV charging bays by ICE-cars with the use of parking sensors.

A second objective was to research the effectiveness of traffic signs reserving parking bays for EV-charging. The aim is to investigate if the city can put public chargers into place without making a specific traffic rule for each charging bay by monitoring false usage. This potentially safes investments in time and money for taking 2.500 traffic rules and still have efficient usage of the chargers. Parking sensors have been installed at the 40 parking bays spread over town for EV charging to measure usage. 20 locations had a parking sign, and 20 had only cross markings (Figure 19).

With parking sign

Without parking sign

Figure 19: Charging bay with and without trafic sign

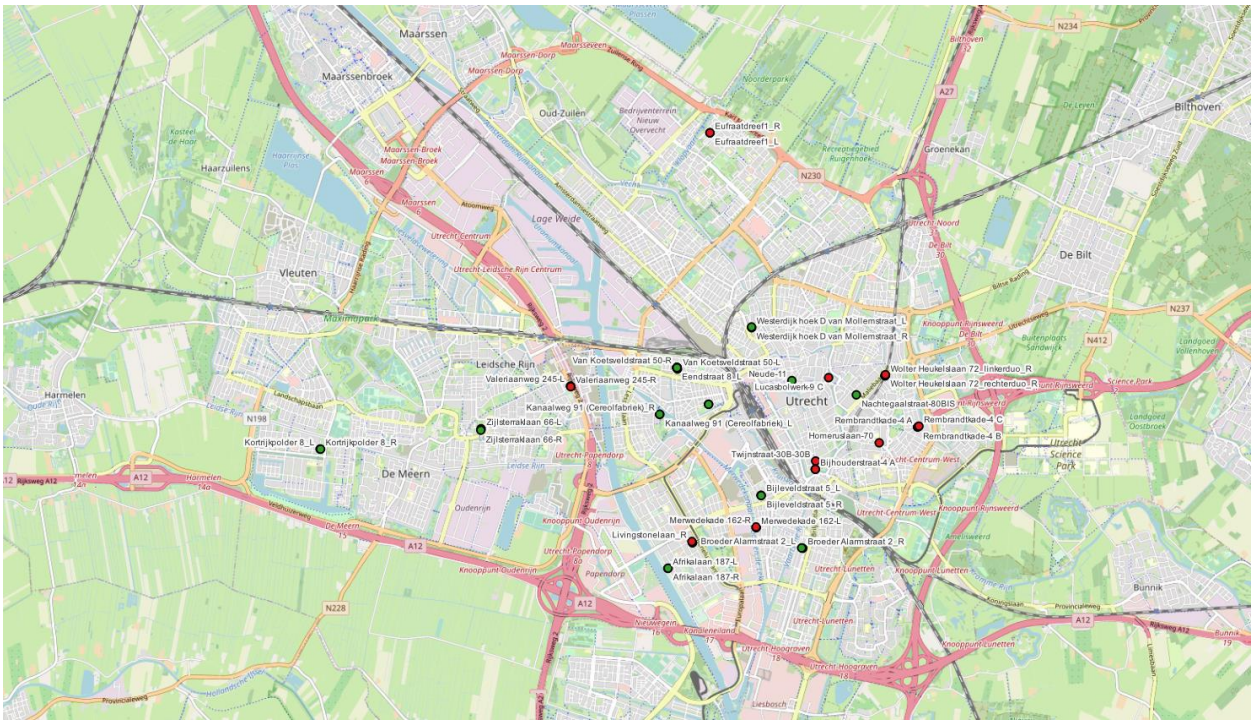


Figure 20. Location of parking sensors (red dot = occupied EV parking place; green dot = free EV parking place)

By combining the data from the parking sensor with the data from the charging pole an information service emerges, monitoring the rightful use of the charging bay(Figure 21).

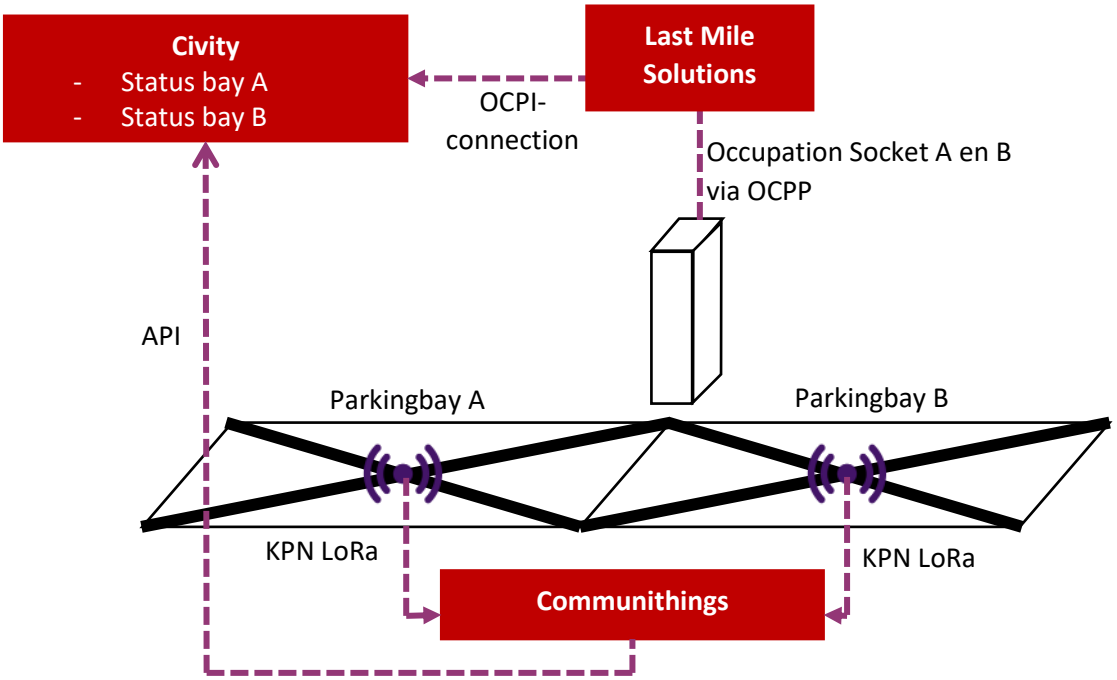


Figure 21: setup data service

5.2.2 Preliminary results

The main results are shared in **Fout! Verwijzingsbron niet gevonden.**. The results show that no significant difference between 'sign' or 'no sign' parking bays has been found.

A more shocking and less expected result is that about 60% of moments and time parking bays are misused. That is a figure that is much higher than we expected. About 10% of this percentage can be explained by a period of snow cover in February. But even if figures are corrected for that period, the misuse amounts about 50% of time and moments.

Table 5. Results monitoring mis-use EV parking bays

	Parking moments	Parking time
With parking sign	61%	54%
Without parking sign	62%	60%

Looking closer at the detailed figures (Table 6) shows that lots of variation between locations This probably has to due to lack of law enforcement misuse by EV-drivers plugging but not charging.

Another explanation might be there is flaws in de the data collection or a mismatch between sensor locations and charge points. An extra check on the data is executed at the time of writing of this report.

With parking sign

Laadlocatie		Parkeermomenten (aantal)		Parkeertijd (in uren)		Percentage onjuist (%)	
Adres	Project opstelling	Aantal totaal	Aantal onjuist	Uren totaal	Uren onjuist	Parkeermomenten	Parkeertijd
Bekkerstraat (hoek Griftkade15)	Zonder bord	518	355	7.498,85	5.329,97	69%	71%
Broeder Alarmstraat 2	Zonder bord	598	395	6.286,60	3.048,61	66%	48%
Eufraatdreef1	Zonder bord	491	221	7.303,94	3.759,07	45%	51%
Kortrijkpolder 8	Zonder bord	476	141	6.211,94	2.687,85	30%	43%
Livingstonelaan	Zonder bord	622	341	12.837,18	9.687,47	55%	75%
Nieuwe Koekoekstraat 102 (J Bekastraat)	Zonder bord	478	313	4.273,31	1.907,31	65%	45%
Nieuwe Pijlsweerdstraat 61	Zonder bord	527	511	773,34	656,33	97%	85%
Van der Duijnstraat 1	Zonder bord	528	379	4.693,81	2.754,03	72%	59%
Westerdijk hoek D van Mollemstraat	Zonder bord	670	300	8.780,54	3.795,45	45%	43%
Wolter Heukelslaan 72_linkerduo	Zonder bord	639	502	9.053,49	6.748,27	79%	75%

Without parking sign

Laadlocatie		Parkeermomenten (aantal)		Parkeertijd (in uren)		Percentage onjuist (%)	
Adres	Project opstelling	Aantal totaal	Aantal onjuist	Uren totaal	Uren onjuist	Parkeermomenten	Parkeertijd
Afrikalaan 187	Met bord	496	435	4.118,43	3.364,90	88%	82%
Bijleveldstraat 5	Met bord	230	112	5.314,84	2.399,61	49%	45%
Eendstraat 8	Met bord	54	46	619,92	576,46	85%	93%
Floresstraat, hoek van Riebeeckstraat 10	Met bord	956	575	7.192,50	3.159,48	60%	44%
Kanaalweg (Cereolfabriek)	Met bord	420	223	4.239,50	1.875,12	53%	44%
Merwedekade 162	Met bord	607	429	8.996,77	6.696,85	71%	74%
Valeriaanweg 245	Met bord	758	297	9.142,30	3.765,62	39%	41%
Van Koetsveldstraat 50	Met bord	1004	764	5.228,09	2.579,01	76%	49%
Wolter Heukelslaan 72_rechterduo	Met bord	491	333	6.409,02	3.801,25	68%	59%
Zijlsterraklaan 66	Met bord	460	150	6.358,89	2.816,04	33%	44%

Table 6: full figures monitoring misuse EV parking bays

5.2.3 Business models and exploitation

Business model

The aim of de current experiment is to investigate if a specific parking decree/rule is needed which enables the municipality to reserve public parking bays specific for the charging of electric vehicles. For every charger currently put into place such a rule costs about € 300 - € 400 per rule. Additional cost is € 150 for the traffic sign. Investment in the senor is approx. € 250. The societal business case for the service is € 200 to € 300 positive in this case.

The counter effect of putting no sign up is that in some cases the charge pole might be uses less effective. Although the preliminary results show there is no difference, the operator of the chargers is a little bit hesitant to let go of the traffic sign. The operator has two main objections:

1. If car drivers find out they can not be finned without a sign, then misuse will increase.
2. The sign also helps user/e-drivers to locating the charge pole.

These issues might be mitigated by:

1. If many complains about misuse at a certain location arise a traffic rule can be implemented at that specific location;
2. Another, unofficial traffic sign can be installed to help findability of the charge pole.

Exploitable results

The research done in this measure is not designed as an exploitable service. One could think of another setup of the measure that could be exploitable. Examples are:

- *Law enforcement:* When a traffic rule is implemented, the sensor data can be used for informing officers about a vehicle using the parking space without a charging activity that took or has taken place. This service is aimed at avoiding fossil fuelled cars using the parking bays, or EV's parking without connection to the charging pole or no ongoing charging for a configurable time.
- *Authentication*: authentication of the user with the parking sensor to check for eligible use of the parking/charging facility. Non-eligible use can also trigger the officer for control and/or fine.

These services were not in scope of this research. Further research is needed to find out if and how these potential services are exploitable and bankable.

5.2.4 Lessons learned and next steps

Conclusions

The averages are almost the same in both setups. Also, based on a statistical analysis we can conclude that there is no significant difference between the two setups (p = .3262). Based on this outcome, it can be concluded that it is possible to realize charging locations without an associated traffic sign, without this being at the expense of the availability of the charging locations for electric drivers.

The important but unexpected conclusion is that a relatively large amount of incorrect use is made of charging locations, both in the number of parking moments and in the total parking time. An average percentage of 62% for all charging locations in the trial and 59% of the total parking time. In practice it is

known that there is hardly any enforcement on incorrect parking at charging locations and it seems that motorists are aware of this. The IOT platform offers the option of an automated reporting function to the enforcers. A possible follow-up study would be to apply enforcement to the signposted locations to see if parking behaviour changes.

Another explanation may be that a correct connection between the car and charging station is not established more often than expected, because of which the charging transaction does not start. In a follow-up study, it would be interesting to compare registration actions at the charging station with the incorrect parking moments. If a connection can be found between this, a possible solution is to send a push message to the user that the car is parked but no charging transactions are taking place. This prevents a disappointed user and provides the CPO with extra revenue.

Another conclusion is that the percentage of parking moments is higher than the percentage of the parking time. This mainly applies to the locations with a sign. This could possibly be explained by the fact that loading locations are often free and are then used for short-term parking, for example for loading and unloading. Environmental factors such as parking pressure have not yet been included in this study and could explain such actions.

Lessons learned

Applying IOT applications in public space is relatively new. During the design and implementation of this trial, we encountered various obstacles. Two lessons learned have been distilled from this:

- Jointly formulate good principles for interpreting the data: Establishing principles and KPIs at the start of the project is an important phase. We have had to adjust the definition of an 'incorrect parking moment' several times. For example, there is time between the arrival of the vehicle (sensor detects vehicle) and the start of the charging transaction. As a result, the same parking moment goes from incorrect to correct and can cause pollution of the data. Draw out the process flows of the use cases and ensure that all data is available and clear. For example, we ran into the fact that it was not clear from the charging data which socket belongs to which parking space. Only start building a data dashboard after working out the use cases. This ensures that you interpret all the data correctly.
- Take enough time for the realization: Public space is constantly changing, which means that the realization encounters all kinds of problems. When the sensors were installed, for example, despite a parking ban, cars were still parked at the intended locations, or there was a heap of sand on one of the locations. As a result, no sensor could be installed at that time. Take enough time, plan several installation rounds and make good agreements between the parties involved.

5.3 Data service 2: Smart Street Lighting with multi-sensoring

5.3.1 Implementations

The GA stated the objective to introduce Smart Street Lighting in Kanaleneiland-Zuid, which encompasses equipping lamp posts with smart multi-sensors and connectivity. Data collected through these sensors should be used to enhance data driven district policies aimed at reducing/minimizing problems faced by the citizens in public space. The connected lamppost can pave the way for using city lampposts for IoT services.

The municipality of Utrecht is currently facing the procurement for replacement of 60.000 lamp posts within the city. A tender will be put into the market. The municipality of Utrecht wants sensor and connectivity services to be a part of this procurement. The city aims at deriving lessons from the IRIS project to put a successful tender into the market for the 60.000 lampposts.

The implementation exists of two projects.

Connected lampposts

One is focused on connectivity. In a city block in the demonstration area Kanaleneiland-Zuid all lampposts are equipped with a new LED fixture containing a standard Zhaga connector providing room for a smart plug connecting all fixtures with de Luminizer backend of Luminext.

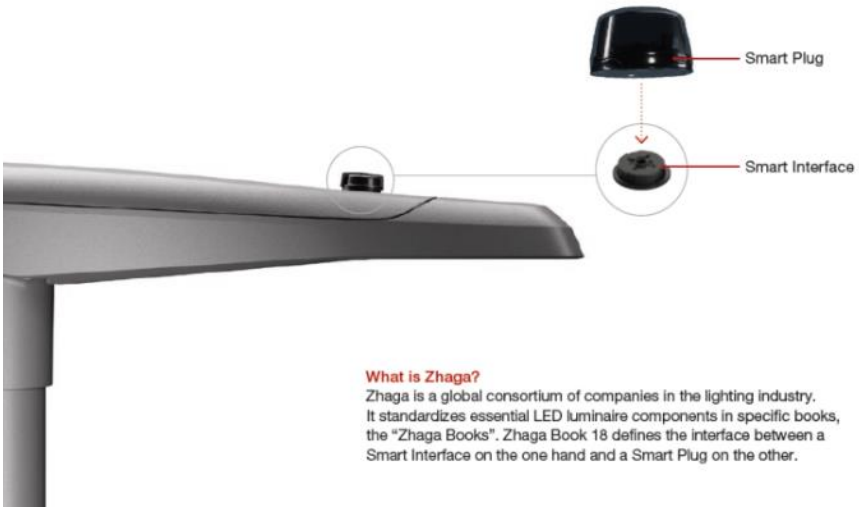


Figure 22: Lamppost fixture with Zhaga connector en smart plug

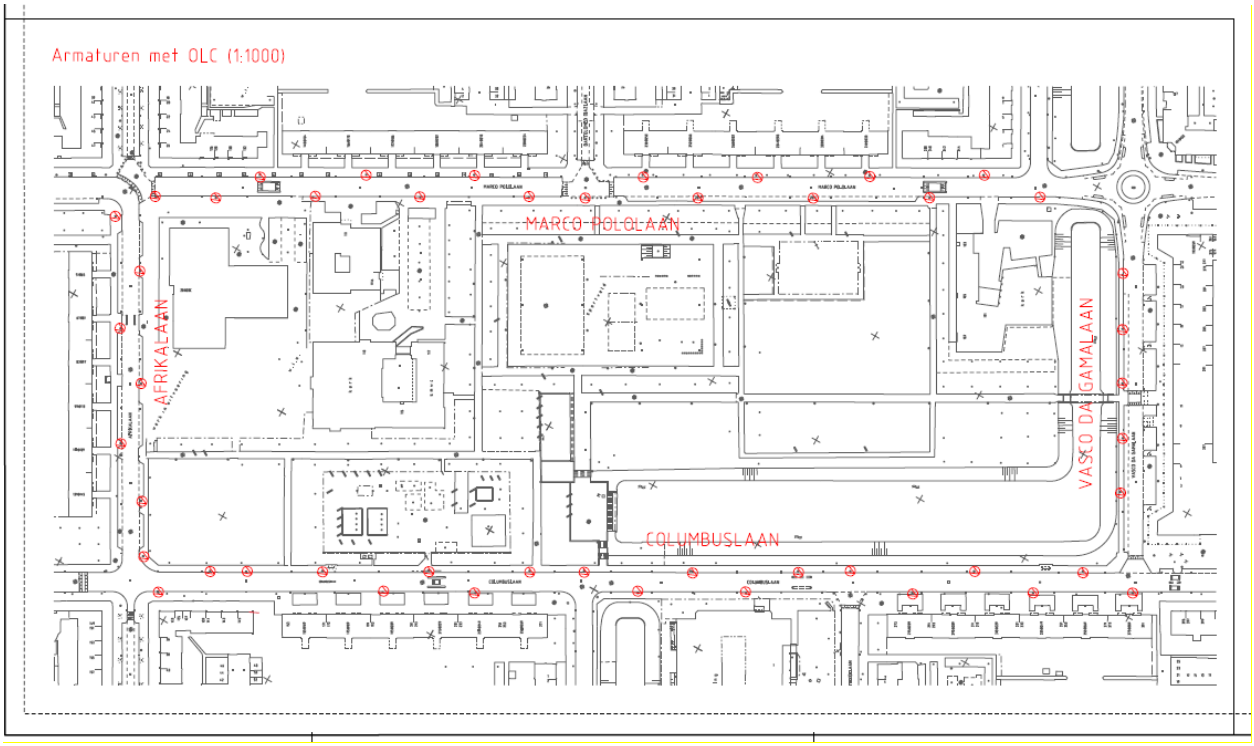


Figure 23: map showing locations of the connected lampposts

Currently in Utrecht lampposts are switched from a central street cabinet using 3G messaging. Historically in other municipalities lamppost are switched using a so-called Toon Frequent (TF-)signal via de grid. The downside of these systems is that power in the lampposts is switched of during daytime. This limits the possibilities for implementing smart city solutions that require permanent power.

The implementation of connected fixtures can also be helpful for more effective asset management by providing real time data on malfunctions and energy usage. Energy saving is possible by dimming the light in more quiet hours of the night.

Smart pedestrian crossing and smart poles

A successful first citizen engagement and co-creation process around the development of smart street lighting solutions was carried out in June 2018. With a diverse group of stakeholders including residents, entrepreneurs, and market parties several concepts were developed. In this workshop a design thinking approach was followed.

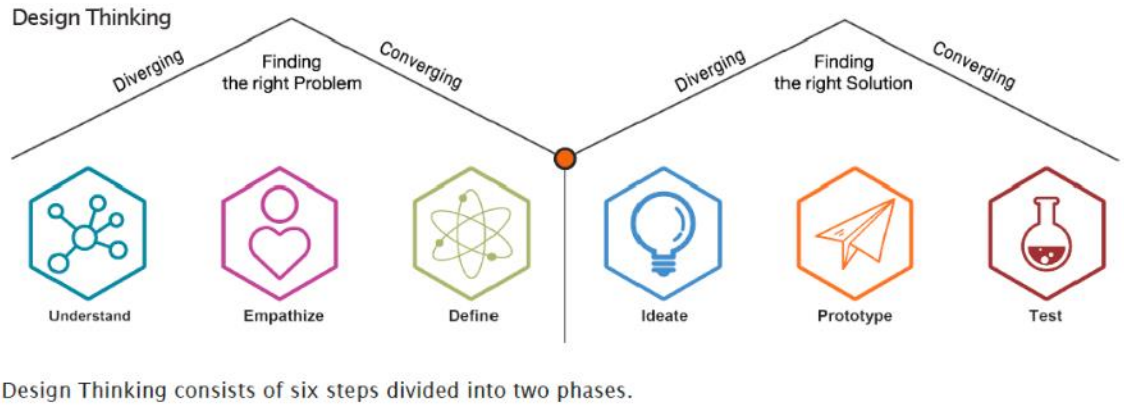


Figure 24 Design thinking approach

The idea that received most support was a smart pedestrian crossing. Next the municipality of Utrecht and Luminext assessed the concept of a "smart pedestrian crossing" regarding feasibility, costs and sustainability. This concept was further discussed and detailed (co-creation) during a follow up workshop with stakeholder before the summer of 2018. Now the "smart pedestrian crossing" is implemented, it will be tested and monitored together with end-users.

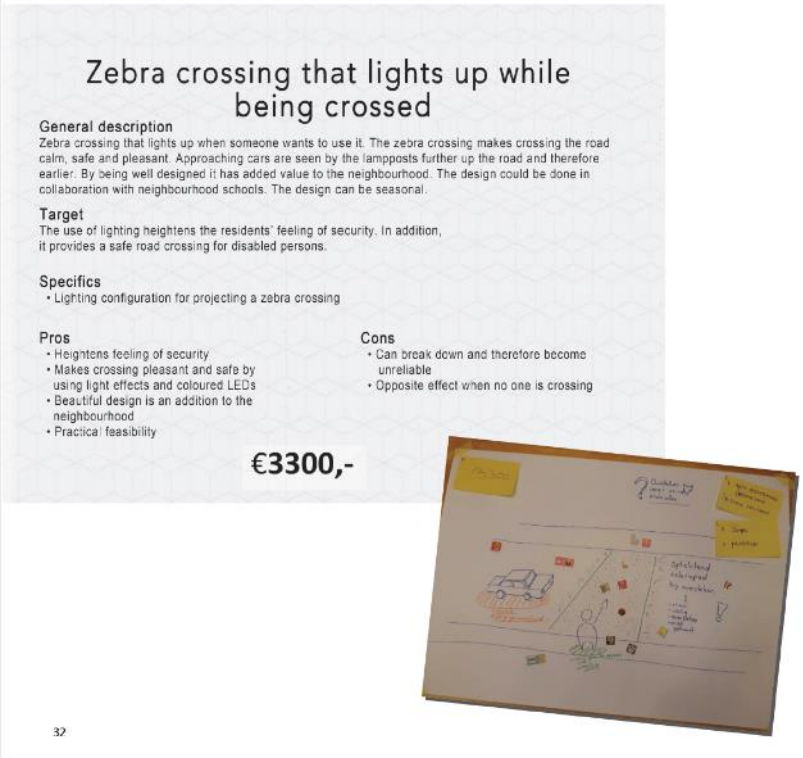


Figure 25: Posed idea of smart pedestrian crossing

In June 2019, a second co-creations session was organised together with citizens. In this session the city of Utrecht presented its first design of the "smart pedestrian crossing" and together with citizens functionalities (pictured right) and location (pictured left) of the crossing were determined.

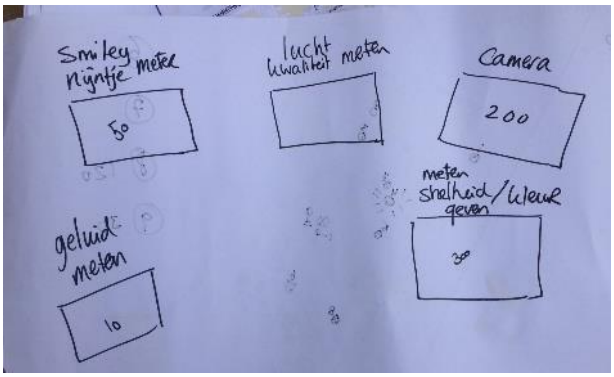


Figure 26: Results of the second co-creation session

The result of the co-creation session is shown in the pictures below. The following functions have been installed:

- A smart pedestrian crossing with luminous white strips with LED lighting. Sensors that detect the proximity of traffic and pedestrian control the light.
- Multiple sensors attached to a Smart Pole on one side of the crossing. The smart pole is a light column in which various functions, such as cameras, measurement sensors for noise levels and air pollution, dynamic lighting, and also traffic detection. The sensors can distinguish between traffic type and speed.
- Collection and assessment of data is done via the Luminext management system via WiFi and LoRa connections. The following data sets are uploaded into the CIP:
    - Power usage (kWh)
    - Burntime (hours)
    - Malfunctions
    - Air quality (to be implemented)
    - Noise (to be implemented)

The data collected with the sensor attached to the smart pole will be transferred and disclosed on the CIP. The main purpose of this stage is to learn what it means to implement sensors, connectivity and smart lighting in public space. The municipality needs these lessons to be able to implement third party (commercial) services in the second stage.

Figure 27: luminous smart pedestrian crossing and smart poles

5.3.2 Preliminary results

The smart street lighting has been installed and activated in June 2021 and was launched with an information video that can be found on the Utrecht IRIS website[3]. The evaluation on stakeholder end-user experience is to be done over the next months by doing interviews with stakeholders and surveys and interviews with users (pedestrians, car-drivers) in the neighbourhood. Results are expected early 2022.

[3] https://iris-utrecht.nl/met-slimme-straatverlichting-naar-een-duurzamer-en-veiliger-kanaleneiland-zuid/

5.3.3 Business models and exploitation

Commercial business model

For analysing the business potential of the developed smart pedestrian crossing and smart poles the exploitable result is outlined in annex II. The market to be targeted with this solution are municipalities and other local governmental organisations responsible for traffic safety.

Exploitation model

Concession model for the exploitation of sensor and connectivity services offers in the long run possibilities for a profitable business model and exploitation. We learned this from the exploitation of public EV-chargers. The city of Utrecht started granting concessions for public charging services from 2013 onwards. A charging point operator is selected based on price and quality and wins the right to operate public chargers for a certain amount of time. The first year the operation had a negative financial result and public subsidies were needed to develop the market. Over a few years scaling effects reduced cost and the demand for charging services grew. Now the market is mature and in the most recent concession the city earns 6 cent per kWh charged on public chargers contributing to a total of € 2 to € 6 million in 10 years.

On the long-term similar exploitation models can be implemented for smart street lighting. Expected revenues for sensor services are difficult to predict. Expected is that sensor services will mainly be used for policy making and public management information services therefor giving social value.

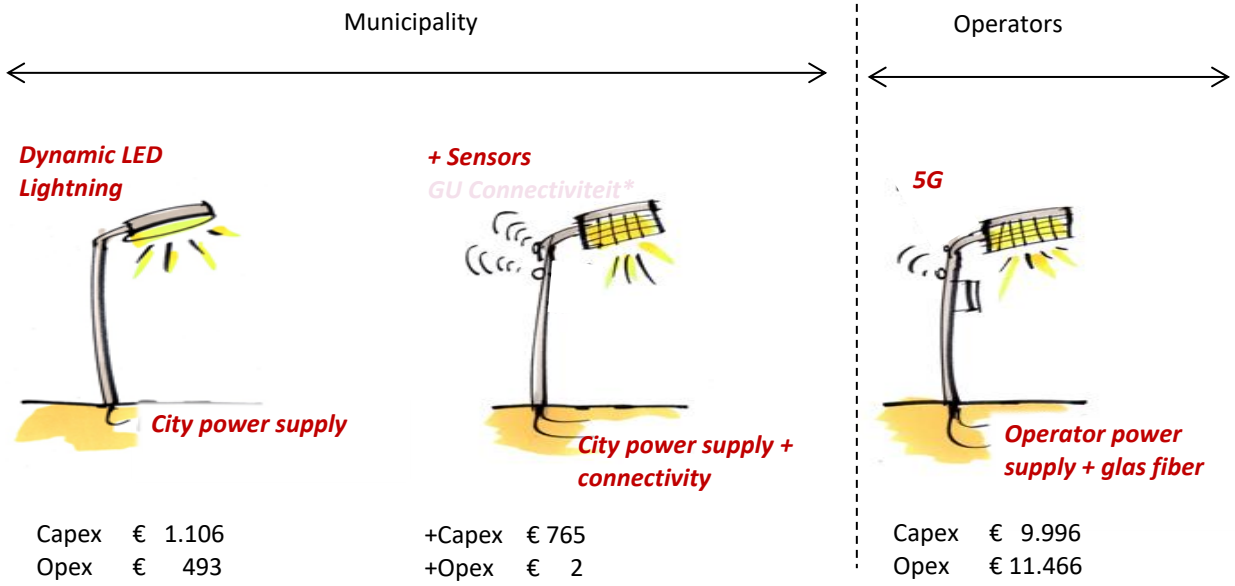


Figure 28: Estimated investments for 60.000 light posts in Utrecht (source: Municipality of Utrecht)

The Dutch knowledge network *OVLNL Smart Lighting* estimates revenues from commercial connectivity services such as 5G or WIFI at € 600 to € 1.200 per lamp post. In the long-term positive business case for the exploitation of connectivity services can be expected.

5.3.4 Conclusions, lessons learned and next steps

To make conclusions on the pilot we have to wait for the evaluation that is planned for the coming period. The lessons we have learned so far have to do with the procurement and realization process of the smart street lighting. So far, the outcomes have been used as input for a tender for the framework agreement for the procurement of new public lighting.

Most valued lessons are:

- The co-creation and design process lead to a solution that is more valuable to citizens and contributes to their problems and needs in a more direct manner.
- Currently the city has procurement contracts with very technical detailed specified requirements for the demanded products and services. Question is if complex and innovative smart city application can be specified in such technical detail up-front, or if a more functional approach could fit better. A functional specification of requirement leaves more room for innovative solutions from supply partners.
- Technical integration is complex. Important to select a partner who can carry responsibility for system integration. This should be an important selection criterion on future suppliers of public lighting services.
- The city is working on de role-out of 60.000 LED fixtures. Based on the experience in the IRIS project the city has proposed to install fixtures with a Zhaga connector, so the city is prepared for future IoT solutions and permanent power supply becomes an option.
- One of the solutions for permanent power supply is to install low power chargers in lamppost that are powered by the public lighting grid. This grid could supply power to approximately 5.000 charge points city wide at 16 amperes at the installation cost of about € 600 per charge point with very limited exploitation costs. A normal charger with a standalone grid connection cost € 2.200 per charger for installation. This could potentially give a big boost to the charging network at relative low cost.

5.4 Data service 3: 3D Utrecht City Innovation Model

5.4.1 Overview

Various smart city solutions are being applied in the demonstration area. The solutions are aimed at making the district's energy system more sustainable, in which battery storage, solar panels, heat pumps and charging stations work together smartly to use electricity efficiently and sustainably. In addition, smart street lighting is applied and tested with sensors using several sensors in public space. For example, air quality, noise and traffic speed are measured. The aim is to gain experience with the operation of these types of systems so that they can also be applied elsewhere in the city or in Europe.

The IRIS project aims to increase the involvement of the residents of the neighbourhood in the transition of their neighbourhood. However, the visibility of the developed solutions is limited. Solar panels are invisible on the roofs, battery storage is a bare box and sensors on lampposts mean nothing either. However, behind all these solutions is data; the air quality, the amount of electricity generated, the status of the battery, etc. The aim of this 3D Utrecht City Innovation Model is to make this data visible to residents in an AR application within the demonstration area. and wants to develop an 3D AR experience.

Figure 29: 3D city model (digital twin) of Utrecht in Unity

5.4.2 Implementations

All data generated by these solutions in the district is collected in the City Innovation Platform (CIP). The aim is to unlock these data sets in an attractive application that can be used on a smartphone or tablet. The municipality is issuing a challenge to develop this application on the game platform Unity. The tendering party makes a detailed application within Unity that shows the added value of 3D

visualizations. The municipality has a ready to use 3D model of the city available in the 3D gaming platform Unity (Figure 29). This makes the application a perfect use case for the further development of Utrecht's 3D ambitions on the one hand, and the added value in the IRIS project by informing residents of Utrecht and raising awareness about the complex challenges and benefits of a modern energy chain on the other. and smart city applications.

Description of the challenge

A Unity AR application that informs the target group via their smartphone about the complex challenges and benefits of a modern energy system and smart city applications in their residential area. The user target group is residents and passers-by with an Android and iOS smartphone and without additional resources (think of 3D glasses or something similar). The municipality does not provide exact result descriptions and wants to leave the call as open as possible and to be inspired. A possible way of thinking is a game or a route/question through the neighbourhood, but other solutions that contribute to the stated objective are also possible. The objective is central, and the municipality wants to challenge the tendering parties to innovation and a certain WOW factor.

Cooperative work process and maximum learning

The winner of the challenge works out the assignment together with the municipality in at least 4 sprints. Involvement of residents and user groups is also desirable. Because the municipality also aims to learn about gaming principles and the Unity platform, we ask you to develop the application within the Azure cloud of the municipality. In addition, the municipality makes a GitHub available to secure sub-products, scripts and process documentation. In this way, assurance and cooperation are central to the work process. We will take this principle into account during the assessment of the Action Plan.

Requirements

Delivered application consists of a minimum of 5 from the 9 datasets below, from the CIP, through OGC services:

- Code of the 3D platform (explanation is in Readme)
  - https://github.com/GemeenteUtrecht/3d.utrecht.nl
- Package with asset bundles of land and buildings
  - Delivery by the municipality of Utrecht
- Battery storage status (state of charge profile)
- Location of batteries
- Location of light poles
- Location of energy pipes underground Location data cables and pipes | city
- Occupancy of charging stations (OCPI)
- Energy labels of houses (colour code)
- Location and status of PV plant
- Sensor data from sensor hotel (air quality, noise)

Delivered application will be available as a Unity web application one year after delivery, and will be managed by supplier during this time;

Service provided is offered for no more than €25,000 in total;

5.4.3 Preliminary results

The planning is to put the challenge into the market early October, so the preliminary results are limited.

At the beginning of 2020, a market survey was conducted in which it was investigated under which conditions Unity developers could participate in the challenge. The main conclusions from this market survey are:

- Combining and visualizing the datasets supplied should, if properly disclosed, indeed be possible for much less than 20,000 euros. A significant part of the work will go into developing the UI/UX for the AR Game. It is difficult for us to say how much work is involved in this.
- When web-based AR is mentioned, a good solution is AWS Sumerian, which provides a scalable platform in the cloud for such developments. Because the assignment does not just ask for an AR game, but a Location Based AR game, this adds a lot of complexity. The complexity lies mainly in the correct representation of the virtual world over the 3D world. Think of Pokemon Go, with the caveat that the requested app must not only know where the phone is in 2D, but also in 3D. VRBANISM is not familiar with the possibilities of a 3D Location Based AR game via the web browser, because we have no market experience with this.
- The question is, of course, whether marketing should be considered within the assignment, or whether this should be left to the municipality of Utrecht itself or a third party. When this assignment is completed, metrics can be collected such as number of unique visitors to a website or number of app downloads. These metrics allow for keeping track of how many people actually use the AR Game. It is not the expertise of such app developers to attract a lot of visitors to the respective apps, so it is difficult to make recommendations about this.
- The data access must be adequately described. Provide insight into the open API so that the developers can determine the impact and possibilities, study and use it. clarify costs.
- Unlocking 10 data points for 20,000 is a lot. Count on 4,000 each. It would be wiser to include 2 or 3 as a requirement and the rest as nice to have. Also, can limit the number of features (gamification and AR experience).
- Gamification is more complex. Inherent in gamification is directing human behaviour, often towards a positive outcome. When such an objective is added to the competition, it becomes a lot clearer.
- Developing a web-based application is feasible but has limitations (including in terms of performance and integration options). With Unity it is not possible to open the game in the mobile browser, this is only possible via an iOS and/or Android app. Web-based is also less ideal for some objectives (for example, for user retention). It is recommended not to set any requirements for the development platform (e.g., Unity), so that advice from the market can be tailored to the preconditions (such as maximum mobile accessibility) of the solution.
- It is advised to keep the marketing of the application outside the development assignment.
- Given that this is a 'competition' in which the municipality is looking for the 'best idea', it is recommended to avoid naming concrete functionalities as much as possible (such as Augmented Reality). For example, by only specifying the objectives, the developers

themselves can fill in which functionalities and techniques they would implement to achieve the objectives (linked to the preconditions).

The market survey has led to several adjustments to the request:

- The budget has been increased;
- The number of required functions is limited;
- The number of datasets that have to be used is limited;
- The marketing of the application has been left out of scope;
- More insight has been provided into the API of the data sets to be accessed.

5.4.4 Business models and exploitation

The municipality sees great potential in the 3D applications for both integrated urban planning and informing citizens about plans in their living environment. That is why the municipality has developed a digital twin of the city in Unity and is seeking opportunities to use this digital twin. The solution developed in this task is a first application in which the digital environment is filled with real life data and serves more as a proof of concept than as a solution with a business model. The potential for digital twin applications is great, but it is still very much in development.

5.4.5 Conclusions, lessons learned and next steps

In the current phase of the project, we are working on setting up the challenge and its elaboration in collaboration with the market. We have learned that it is possible to set up a 3D model that can inform local residents about the smart city applications in their living environment. It is important to provide good insight into how the data is made available and made accessible for participants in the challenge. The parties also request limitation of the required functionalities in relation to the available budget and the necessary freedom to give their own creative interpretation to the solution.

The coming period will be used to put the challenge on the market, where we hope to gain more insight into the potential of this application.

5.5 Data service 5: Fighting Energy Poverty

5.5.1 Overview

Housing Corporation Bo-Ex has the ambition to contribute to improving the financial position of its tenants. A large proportion of its tenants have a relatively low income and, after deducting all fixed costs such as rent and energy, less than 100 euros per month to spend freely. The objective is to develop a data service for tenants of housing corporation Bo-Ex, which gives them control over and/or better understanding of their energy bills, resulting in reduced energy bills and increased disposable income of tenants.

Research: scoping of the problem

We started with research into the topic of energy use and poverty, which revealed that[4]:

- The energy consumption of households in comparable homes can vary enormously;
- The tenants have little / no insight into their energy bill because, for example, they do not understand the bill, insufficiently understanding of the Dutch language and / or have no knowledge of energy use in the home and what the influence is of their own behaviour;
- Chronic money stress leads to short-term thinking;
- Tenants consider energy use issues as a task for the housing corporation over which they cannot influence themselves;
- Tenants value personal contact and are best approached from existing structures and are sensitive to positive incentives and framing.

The data service has been developed in two steps that will be described in this report.

1. An Energy Poverty Challenge was put into the market.
2. A combined effort was done to improve an existing energy advise service for tenants with energy data based advise.

5.5.2 Implementations

Implementation of the Energy Poverty Challenge

In 2019 an Energy Poverty Challenge was organized by the municipality of Utrecht. The objective of was to 'challenge' both new and incumbent market parties to come up with innovative solutions that allow tenants of social housing with a low income to get a better grip on their energy bill. An additional requirement for the market parties was to make use of data-sets available through the City Innovation Platform in their proposed solution.

A total of 20,000 euros was available for the winning entry to further develop the idea into a scalable product or service. The winner was given the opportunity to use these resources to further develop the

[4] Complete overview of used sources and finding is available in report Harmelink M, L Zanders (2019 "Evaluatie Challenge "Grip op uw Energierekening" (in Dutch available on request)

idea supported by the incubation program of Utrecht Inc. Bo-Ex would act as a launching customer for their product.

In May/June 2019, the challenge was widely communicated and deployed in the Utrecht network. This resulted in 5 entries. 2 entries were ineligible, 3 of which were invited to pitch their idea before a jury in July.

The challenge aimed for a suitable solution for tenants of social rental properties, with which they can get a better grip on their energy bill, lower their housing costs and increase their disposable income. The service must thereby meet the following conditions:

- Scalable, i.e., solution must be replicable towards other areas / cities;
- Use (open) data that is made available through the City Innovation Platform (which is based on the open FIWARE architecture);

We also asked market parties who want to propose a solution that they:

- Have demonstrable experience with open APIs, mobile applications, and knowledge of data (flows)
- Must be willing to share their knowledge and have the ambition to realize national solutions.
- Have demonstrable experience with co-creation of solutions together with end users

A total of 20,000 euros was available for the winning entry to further develop the idea into a scalable product or service. The winner was given the opportunity to use these resources to further develop the idea supported by the incubation program of Utrecht Inc. Bo-Ex would act as a launching customer for their product.

Implementation of the Data Based Energy Advise

TOON is a dashboard giving tenants real time insight into energy usage and costs. This already provides a big step into control of energy consumption and thus reducing energy poverty. Eneco has an extra data service developed that gives insight into energy spillage/leakage in the household. It tells TOON owners were energy inefficiencies and loss are happening. Based on energy usage profiles it shows stand-by losses, inefficient household equipment etc.

Figure 30: HEMS TOON and Eneco Wast Manager

In anticipation of the refurbishment of apartment blocks in the demonstration area the HEMS TOON has been installed in 20 dwellings. The HEMS TOON is offered to the tenants of two other apartment blocks with a total of 96 dwellings. In these dwellings the TOONS are currently being installed. Also, in the apartment block with 48 dwellings that is currently undergoing refurbishment installation is of the TOON in all dwellings is planned. So, at the end of this year approximately 100 to 150 TOONS will be installed.

Together with different partners on March 25th, 2020, a workshop was planned to work out a concept to help tenants save energy using the TOON data. These partners took part in de workshop:

- Yvette Feld — Feldkracht
- Willem-Jan Renger — HKU
- Hanneke Peters — Eneco/Quby (TOON developer
- Jan Sanders — Eneco/Quby
- Jurgen Tielbeke — JMA/EnergieBox (Energy Advise BOEX)
- Kees Stap — Energiepaleis (Energy Advise private house owners)
- Patrick van der Hofstad — Stichting Technotrend
- Matthijs Kok — Gemeente Utrecht

In the workshop a concept was developed of giving data-based energy advise tot tenants and house owners. Attach development to Energy Coaches and Energy Box. Both Energiepaleis and JMA have an assignment form the municipality to give energy advise. Currently energy advisers give advise based on a conversation and what they can see in the house. It would be helpful to collect data from a Home Energy Management System (HEMS) like the TOON before the energy advisor starts so the energy profile can be analysed and a beter, more specific energy advise can be offered.

The concept is worked out for the first apartment block where the TOONs were installed. Tenants would get the option to get a TOON and after to month they would get the offer to get an *Energiebox* (see figure below) and a free energy advise. A participant would need to sign that the HEMS TOON data will be used to optimise the energy advise, this also provides al legal GDPR basis for the processing of the data. Two energy advisors from JMA were educated to interpret the energy profiles that were provided to them via the CIP data connection. In this way the advisors could add measures and enlarge possible energy savings.

Figure 31: Energiebox that is offered to tenants together with the energy advise

The measure was implemented in the second half of 2020 during the corona pandemic. A lot of effort was put into convincing people to install a TOON into their home and to be open for energy advise. Due to the COVID-19 situation tenants were hesitant to do a TOON installation and even more to receive an

energy advisor into their homes. So far about 70 TOONs have been installed, but only 2 energy advisors have visited these houses. Since the COVID-19 situation has become less of a problem we expect to have some more advises over the next months, especially in the refurbished apartments.

Results of the Energy Poverty Challenge

The jury was unanimous in its decisions that none of the entries was of sufficient quality and therefore none of the parties was rewarded the budget of 20,000 euros for the further development of their idea. The main shortcomings were:

- Ideas were insufficiently in line with our problem "Grip on the energy bill" for people on low incomes. Ideas on how to reach this target group were insufficiently elaborated.
- In all cases, there was a lack of solid ideas about a good business case for scaling up the service to be developed.
- Unbalanced composition of the presented project teams, which reduces the chance of successfully completing the incubation process.
- Parties who registered did not give the impression that they really had insight into the possibilities on how to use the offered datasets and develop an innovative analysis/approach based on these data.

Results of the Data Based Energy Advise

- About 70 TOONs have been installed prior to the refurbishment of the apartment blocks, giving direct insight into energy usage before renovation of the dwellings.
- A data connection between the CIP and the HEMS TOON has been established giving input for KPI monitoring and improved energy advise.
- Two energy advisors have been educated to interpret the energy data and improve their energy advise for tenants.
- Over the next month data collection is with the installed TOONs and the improved COVID-19 situations gives way for the role out of more energy advises. The upside is that we now collect seasonal data that helps to provide better advise.

5.5.3 Business models and exploitation

Since there was no follow up on the Energy Poverty Challenge there is not much to say about potential business models or exploitation.

For the Data Based Energy Advise partners see potential business opportunities. Currently about 300.000 TOONs are installed, and multiple other HEMS are available and installed in maybe millions of households. If a system developed that allows owners of a TOON of another HEMS get offered an energy advise based on their energy data, this provides a potential market for energy advisors. In the project partners hope to get more insight into the customer journey, market potential, exploitation model and possible business models.

5.5.4 Conclusions, lessons learned and next steps

Lessons Learned of the Energy Poverty Challenge

We evaluated the challenge with a couple of people involved in the process. Lessons learned include:

- Question: We did ask the market the right question and we were also clear about what we wanted. The requested product was a data service, but we could possibly have investigated even better whether the intended end users need a data service for this specific challenge. We might have been able to define the problem even more clearly, which might have led to parties being able to generate a better idea.
- Network: putting the challenge out into the right network of market parties and teams is challenging. We used many channels, all linking to the stakeholders involved in the IRIS project, and we also saw a peak in visits to the IRIS website. However, we do not know whether we have reached the right parties. During a previous, similar type of program (the 'Start up in Residence program' of the municipality of Utrecht) a budget was allocated to networking parties (such as start-up managers) for promoting the Start up in Residence challenges to the attention of parties. We do not have that marketing budget within IRIS.
- Requested result / product: we asked for a 'complete' product, a data service. However, experience with this kind of process shows that the price offered is too low to attract the right parties. The practical rule is 1:10: the development of an idea (a prototype) is 10% of the costs, the realization of a complete product costs a factor 10 of this.

Conclusions of the Energy Poverty Challenge

- It seems in general useful to align the data-challenge/-development more with on-going initiatives within the IRIS partnership. This to enable the integration of the challenge results in on-going processes in a more productive way.
- We therefore decided that further development of a data-service would be linked to the implementation process of TOON. In this implementation process we are going to try to find a user group that wants to be engaged in the development of a data service (with data via TOON and complementary data via CIP).

We furthermore concluded that instead of a challenge through a tender, it would be more effective to approach several parties with a good team of designers and experts (energy, behaviour, energy data) to sharpen the problem with a user group and realize a first idea (Minimum Viable Product, MVP). Followed by a second step in which a product is developed based on this MVP with a real entrepreneur, who can actually bring the product into operation. However, the question is how we can realize this second step within the IRIS project given the 1:10 rule.

Lessons learned and conclusions of the Data Based Energy Advise

Preliminary conclusions on the data-based energy advise are that it is very well possible to use HEMS data for optimalisation of energy advise to tenants en potentially also house owners. Data connections are in place, energy advisors are committed and educated, de costumer journey working and GDPR issues are solved.

It is still too early to draw conclusions on the practical use of the date in real live energy advise. Due to the COVID-19 situation little only two advises based on energy data has been provided. The coming period will give us more insight into this.

6. Preliminary Results of Transition Track 5 - Citizen engagement and Co-creation

The ambitions of this transition track #5 'Citizen engagement and Co-creation' consist of: design and demonstrate feedback mechanisms and inclusive services for citizens to achieve that citizens are motivated to (1) save energy, (2) shift their energy consumption to periods with abundant renewables and (3) use shared e-mobility instead of private cars.

KEY MESSAGE
The continued presence and communication in the district Kanaleneiland-Zuid leads to better connections with the citizens and also more participants for the different measures.
The personal approach with installing the Eneco TOON and personal connections with the social networks in the district have led to a good cooperation with the district. This also benefits the refurbishment actions in TT#1.
COVID-19 has hampered the progress because we have not been able to organise live meetings in the district and at schools for over a year. Currently, the corona situation in the Netherlands is developing positive because of a high vaccination grade amongst the Dutch inhabitants. This has led to national policy to slowly release COVID-measures and the possibility to organise events with citizens. Next steps include extending the local network and execution citizen engagement activities at schools and in the district.

6.1 Overview

In this paragraph the designed Measures and activities are explained including the timeline over the past four years and a forecast for the last 1,5 year.

Measures:

This Transition Track consists of 6 Measures (initially 5 Measures, but increased to 6 due to the approved change of scope):

- Measure 1: Community building by Change agents
- Measure 2: Campaign District School Involvement
- Measure 3: Co-creation in Local Innovation Hub
- Measure 4: Campaign Smart Street Lighting
- Measure 5: VR New Home and District Experience
- Measure 6: Citizen engagement and Self-Maintenance within project Complex 507

The activities related to these Measures are executed in two districts in the city of Utrecht, the district of Kanaleneiland-Zuid and the district of Lombok:

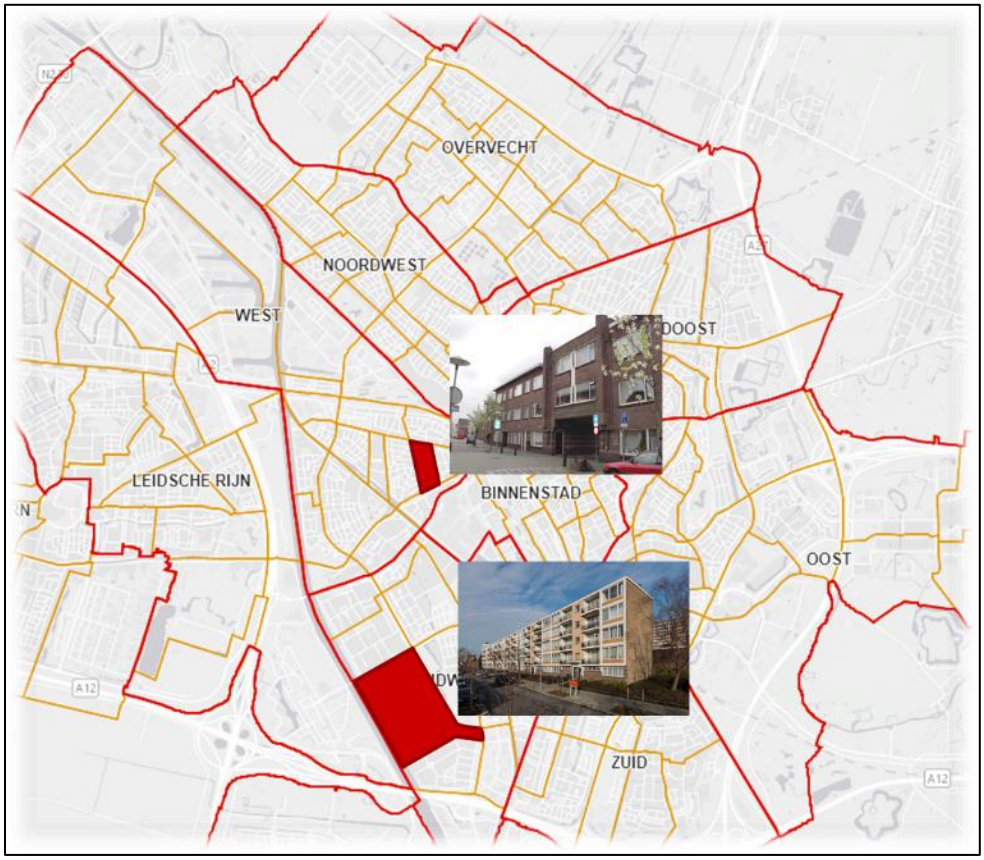
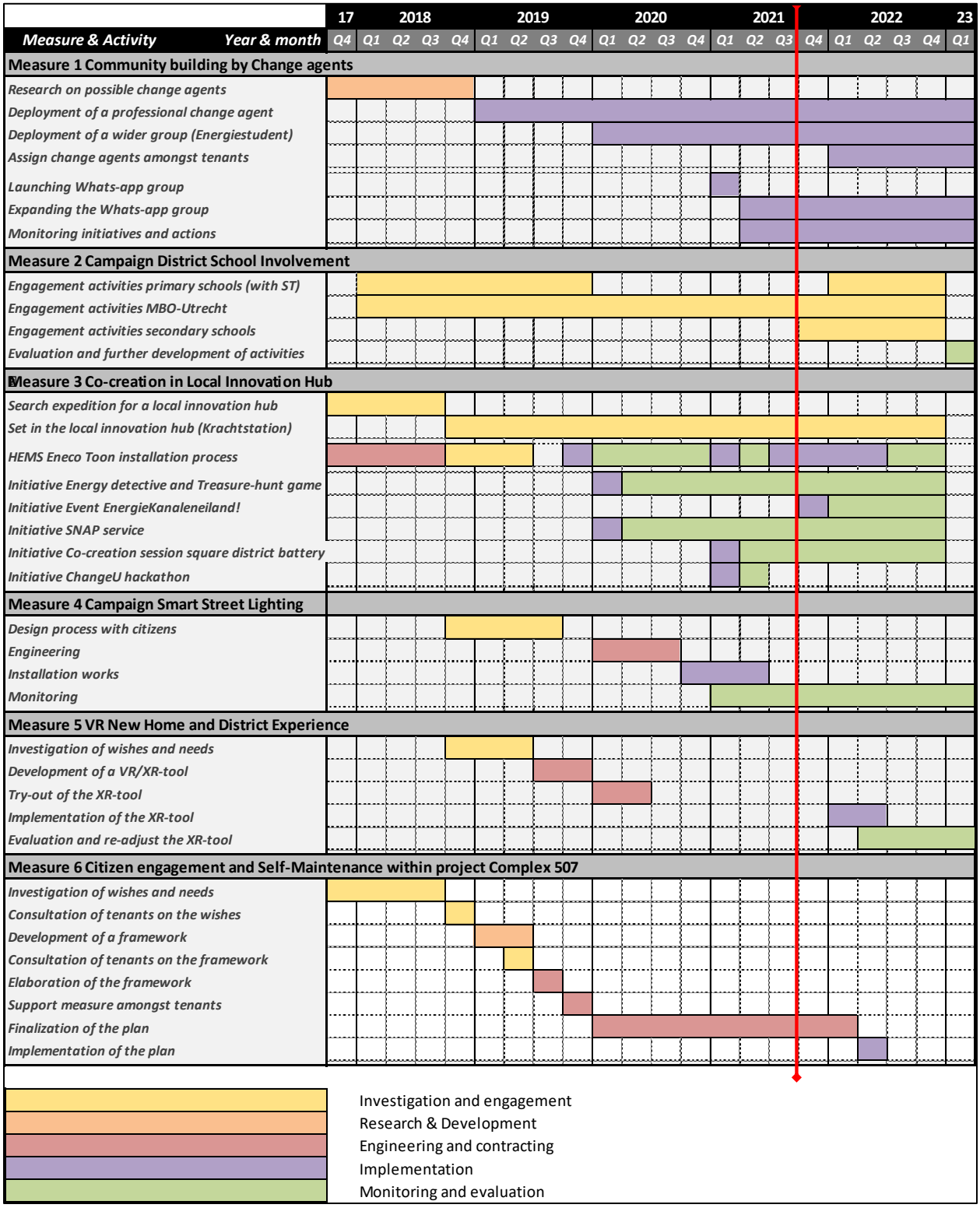


Figure 32 Overview of the demonstration areas in the city of Utrecht

On a high abstraction level, the following schedule is followed till the end of the IRIS-project in March 2023:


17
2018
2019
2020
2021
2022
23
Measure & Activity
Year & month
Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1
Measure 1 Community building by Change agents
Research on possible change agents
Deployment of a professional change agent
Deployment of a wider group (Energiestudent)
Assign change agents amongst tenants
Launching Whats-app group
Expanding the Whats-app group
Monitoring initiatives and actions
Measure 2 Campaign District School Involvement
Engagement activities primary schools (with ST)
Engagement activities MBO-Utrecht
Engagement activities secondary schools
Evaluation and further development of activities
Measure 3 Co-creation in Local Innovation Hub
Search expedition for a local innovation hub
Set in the local innovation hub (Krachtstation)
HEMS Eneco Toon installation process
Initiative Energy detective and Treasure-hunt game
Initiative Event EnergieKanaleneiland!
Initiative SNAP service
Initiative Co-creation session square district battery
Initiative ChangeU hackathon
Measure 4 Campaign Smart Street Lighting
Design process with citizens
Engineering
Installation works
Monitoring
Measure 5 VR New Home and District Experience
Investigation of wishes and needs
Development of a VR/XR-tool
Try-out of the XR-tool
Implementation of the XR-tool
Evaluation and re-adjust the XR-tool
Measure 6 Citizen engagement and Self-Maintenance within project Complex 507
Investigation of wishes and needs
Consultation of tenants on the wishes
Development of a framework
Consultation of tenants on the framework
Elaboration of the framework
Support measure amongst tenants
Finalization of the plan
Implementation of the plan
Investigation and engagement
Research & Development
Engineering and contracting
Implementation
Monitoring and evaluation

6.2 Implementations

In this paragraph the implementation results of each Measure are described.

In Deliverable 5.7, the 'Changed tactics' for the activities/measures in this Transition Track have been explained. The performed activities, experiences and lessons learned have been evaluated and led to clues to set up a different approach. This reconsideration of strategy and approach has been conducted by the involved IRIS Utrecht partners Bo-Ex, Municipality of Utrecht, HKU, LomboXnet, Energie-U and Utrecht Sustainability Institute. The change of tactics consists of a 'push' strategy towards the citizens. The first activity in which this has been tested is in the implementations of HEMS Eneco Toon.

By getting in contact with these people and gaining a better insight in the target group, we hope to create a better relationship and more engagement. This is key in the Utrecht demonstration activities, especially to get support of the tenants for the refurbishment plans, an important anchor of transition track #1 and dependencies with a couple of measures within this transition track.

In the following description of results, other and new activities are described which initially were not part of the DoA. For example, the Whatsapp-group EnergieKanaleneiland was not an activity within Measure 1 (community building by change agents) but is a result of an iterative process as mentioned before.

Measure 1: Community building by Change agents

- What has been implemented?:
  1. Informing tenants personally about IRIS projects: the company EnergieStudent and a tenant consultant of Feldkracht visited the tenants of five apartment buildings (Columbuslaan II, Alexander de Grotelaan I and IV and Rooseveltlaan I and II). The tenants were informed personally about the free HEMS Eneco TOON, individual energy saving options through the 'Energiebox' (an Energy savings box) and the upcoming renovation process. Furthermore, for each apartment building, a call amongst tenants was held to take part in the tenants committee that will be working on the upcoming renovation plan. With these visits, a social map of the buildings was created, which makes it easier to address social problems. Also, contact has been made and a first seed has been sown for more awareness and involvement in the renovation process.

Figure 33 Energiebox (soucre: www.energiebox.org)

  2. The residents Whatsapp-group EnergieKanaleneiland: in the demonstration district of Kanaleneiland-Zuid, a dedicated Whatsapp-group has been set up called 'EnergieKanaleneiland'. IRIS, together with two residents of Kanaleneiland-Zuid, is the

initiator of this app group. In May 2021, this group counted 74 residents as a member of this app-group. In this app-group, all kind of news regarding sustainability and energy efficiency is shared. From this initiative, actions concerning litter pick-up, creating tiny forests and vegetable gardens have been realized. Also, IRIS related activities are shared, such as the Treasure Hunt, the sustainable weekend with the tour and jurors for the ChangeU hackathon.

- How has it been implemented?
  It is important that IRIS is visible in the neighbourhood, that the several initiatives and projects are linked to IRIS. Residents can read about IRIS in the neighbourhood newsletter of the city of Utrecht. Furthermore, more and more tenants have an individual conversation at their front door about IRIS activities such as the district battery, the upcoming renovation, energy savings or the HEMS Eneco Toon.
  Also, events such as a guided tour and the 'EnergieKanaleneiland sustainability market' are organized to involve residents.
  And the mentioned app-group is an approachable means to learn, discuss and participate in initiatives that are organised in the district.
- What activities/implementations are still in planning?
  Energiestudent, the tenant consultant of Feldkracht, the EnergieKanaleneiland app-group and other initiatives will remain active in the coming period and new opportunities will be explored.

Measure 2: Campaign District School Involvement

- What has been implemented?:
  1. Primary schools:
     The first series of technical education lessons for pupils of primary school De Kaleidoscoop (in the district of Kanaleneiland-Zuid) were held by Stichting Technotrend (Technotrend Foundation) in 2018/2019. These lessons were quite a success and resulted in a programme of technical education lessons for pupils on three primary schools in the district of Kanaleneiland-Zuid for the school years 2019/2020, 2020/2021 and 2021/2022. The lesson series, called Energy Detective and the Treasure Hunt, planned for last year were cancelled due to the Corona pandemic unfortunately.
     Stichting Technotrend therefore launched the online lesson series Energy Detective and the Treasure Hunt. These lesson series can be used in class at school but can also be used at home: pupils can follow the lessons/workshops at home and fill in the worksheets and submit them at school or digitally. Three schools in Kanaleneiland were enthusiastic about the series of lessons, but unfortunately none of them used it. Because of the Corona pandemic the schools focussed on keeping track of their children and pay attention to children who were underperforming due to the pandemic. The Treasure Hunt can also be carried out by parents with children, next to the school curriculum.

  2. Secondary schools: IRIS seeks contact with secondary schools in the area to collaborate. A number of students from the UNIC secondary school designed a postcard for the District Battery project, the winning concept was used in the project. The secondary school X11, also established

in the city of Utrecht, will organise and execute the evaluation of the smart street lighting in cooperation with the IRIS project leaders.

3. MBO schools (post-secondary vocational education): Stichting Technotrend works together with the MBO Utrecht and other schools to achieve:
    a. More primary and secondary school pupils to follow technical education (construction, installation technology, etc.) by getting the pupils acquainted with the subjects, the relevance and professional work.
    b. More internships/jobs for MBO students in the technical area, for example at IRIS projects. The MBO Utrecht has already had several interns at Bo-Ex.

    On this subject, Bo-Ex acts as client for 2nd and 3rd years students Architecture and Engineering for dedicated assignments regarding the refurbishment plans for the apartment buildings in the district of Kanaleneiland-Zuid.

- How has it been implemented?
  Stichting Technotrend has regular contact and seeks coordination with the three primary schools in the district of Kanaleneiland-Zuid. Unfortunately, this was reduced to a minimum during the Corona pandemic last years. But as soon as it is possible again, it will be resumed.
  Stichting Technotrend and project leaders of the IRIS project regularly consult with schools in Utrecht in, among other things, the 'Bouw = Wouw project'. The Bouw = Wouw project aims to make more pupils enthusiastic for technical education and jobs, especially in the poorer districts of Utrecht such as Kanaleneiland-Zuid.
  There is a network of (high) schools that meets regularly to share experiences and to look for new projects in which pupils can work together and receive assignments from the business community. This network meets once or twice a year. IRIS and Stichting Technotrend participate in these meetings.
- What activities/implementations are still in planning?
  As soon as the Corona pandemic is (almost) over, the primary schools, IRIS and Stichting Technotrend will resume their cooperation and launch activities. The activities for MBO-Utrecht will resume till the end of the IRIS project. Also other initiatives with other schools will be developed and further implemented in the coming months. During the sustainable weekend in July 2021, the Treasure hunt tour will be held in Kanaleneiland-Zuid.

Measure 3: Co-creation in local innovation hub

- What has been implemented?:
  1. HEMS Eneco toon installation process: the engagement and installation process of the HEMS Eneco Toon has been implemented in five apartment buildings. In chapter 2 of this deliverable numbers of installed Toons are presented.
  2. Treasure hunt Kanaleneiland-Zuid for children: a treasure hunt for children aged 10-13 along IRIS projects and other sustainable hotspots in Kanaleneiland-Zuid.
  3. Event EnergieKanaleneiland! This took place at the 8th of October 2021 (originally planned for October 2020): At this green sustainable market for residents of the district of Utrecht Kanaleneiland, residents are introduced in IRIS and other green initiatives and companies. The idea is to inspire residents, help them to become more sustainable and greener and to make them aware of what is going on in sustainable and green Utrecht.

4. SNAP service: How to reach residents in their language? Residents often find communication via letters difficult and complicated. In the summer of 2020 we worked together with SNAP Service to find out how we can better communicate with residents in writing. Bo-Ex made a number of letters available to the SNAP Service. Ten residents and the SNAP Service have jointly read the letters and assessed their readability. The SNAP Service has made a list of what we can do to make clear, better readable and better understandable letters.

Figure 35 SNAP service meeting

5. Co-creation process with residents for the square of the district battery: On the square between Columbuslaan and Magelhaenlaan a District battery has been placed. The square is old and rarely used. Bo-Ex wants to renovate the square together with the involved residents who live near or next to this square. In April 2021, we have sent out an information letter to the area residents about the battery and asked them also what they think of the square and what they want to do with the square. In 2021 the designs are presented to the neighbourhood and in 2022 the winning design will be realized.
6. Jury of ChangeU hackathon: In March 2021 the ChangeU Hackathon took place. More than 70 students thought and worked on solving various problems in Kanaleneiland. Topics for the hackathon included: improving community health, public space, work for all, local energy transition. Fourteen teams of students came up with solutions for loneliness, better use of public space, an energy saving app et cetera. The hackaton was won by Room for Living. The prize was awarded by a group of professionals and a residents' jury, organised by IRIS. And Room for Living thinks along with the refurbishment of the square of the District Battery.

- How has it been implemented?

  During the incremental process of the HEMS Eneco Toon installation, the installation of the HEMS device is not the only desired result. The other objective is to get in touch with the tenants. When having a positive contact with a tenant, space is created to move on with other things. Such as becoming more aware of energy usages and also the Bo-Ex‘ call for becoming part of a feedback group (or tenants committee) for the upcoming refurbishment plan. In the first apartment building Columbuslaan II, a group of 6 out of 46 tenants has reacted positively of becoming part of a feedback group. Meanwhile several meetings with this feedback group have been held and the refurbishment plan for this apartment building becomes more concrete. The Corona pandemic has influenced the schedule for the implementation process and delayed the installation process, but we’re on track to get a lot of HEMS Eneco Toon devices installed within the lead time of the IRIS project. After the installation process of the HEMS Eneco Toon, tenants

are requested by mail and phone to fill in a short inquiry. The outcomes of the inquiry helps Bo-Ex and their partners to further optimize the process of installation.
The Treasure hunt is included in the regular offer for the schools of Kanaleneiland, but also towards the weekend school, the sustainable weekend and after-school care.
The Event EnergieKanaleneiland! on 8 October has been organised with a group of residents (and the app group) and some local businesses. A number of Moroccan mothers made soup and savours. Companies from the Krachtstation (the neighbourhood cooperation) organised sports clinics and the communication for this event.
The SNAP Service gave us a number of tips that we consistently apply in our communication with residents (many residents get stressed when they receive a letter from the housing company, always put a phone number in a letter, keep it short, don't cover too many subjects at once et cetera.

For the renewed square with the District battery, a large group of area residents could drop ideas to tell what they wanted to do with the square or fill a dedicated postcard with ideas. In the last months of 2021, based on the ideas collected, three concepts will be made for a renewed square. After this we will present the concepts to the residents and choose which concept will be used to adapt the renewed square.

Figure 36 co-creation session with citizens about the district battery

- <u>What activities/implementations are still in planning?</u>

The EnergieKanaleneiland market will be held annually on the day of sustainability in October, also in 2022.
Energy education together with the neighbourhood council: Technotrend wants to work on energy saving together with the neighbourhood council and local students. A large group of MBO students from Kanaleneiland cannot find a work placement. Technotrend wants to train these students to become energy advisors, energy handymen or Energy Detective instructors.
The elaboration of the refurbishment plan of the battery square will result in three designs in the End of 2021. Hereafter, the designs are presented, chosen and realized in 2022.

Measure 4: Campaign Smart Street Lighting

- What has been implemented?:
  In 2018, a group of professionals together with area residents, used co-creation principles to think about the following question: How can smart street lighting contributes to a better/healthier/safer/more funnier neighbourhood for and from the residents and entrepreneurs in Kanaleneiland-Zuid? 11 concepts were created and in the end one concept won: the self-illuminating zebra crossing. A zebra crossing that lights up in the dark and is accompanied by two poles that detect air quality, traffic speed and movement. In a final meeting with residents in June 2020, a group of residents jointly decided where the zebra crossing would be placed. In May 2021 the self-illuminating zebra crossing was installed at the street Columbuslaan in the demonstration district of Kanaleneiland-Zuid.

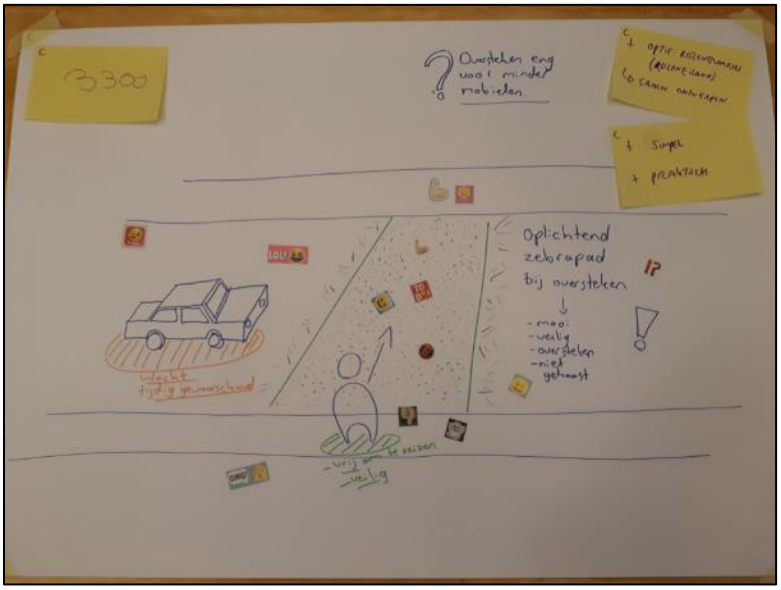


Figure 37 Outcome of a co-creation session about smart street lighting

  New low-energy light bulbs: 50 low-energy light bulbs have been placed at the Columbuslaan. The fittings are dimmed and as soon as a car or cyclist approaches the light intensity increases. Once the traffic has left, the luminaires dim again. The light intensities can be varied. In this way, we save a lot of energy.
- How has it been implemented?
  The design of the smart street lighting took place together with residents. The primary school The Kaleidoskoop was also involved in working out the options and the location of the self-illuminating zebra crossing. Luminext and their partners developed and installed the zebra crossing and the poles with the measuring equipment.
- What activities/implementations are still in planning?
  In the autumn of 2021, energy-efficient light fittings and the self-illuminating zebra crossing will be evaluated. We will do this together with X11, a secondary school, and the professionals from the municipality of Utrecht who helped developing the smart street lighting.

Measure 5: VR New Home and District Experience

- What has been implemented?:

XR-experience in physical and digital form: the HKU has designed and developed an XR experience. The aim of the XR experience is to enable tenants and pupils/students to become acquainted with energy saving (measures) in an enthusiastic and interesting way. The XR-experience is a kind of game and consists of two forms: the actual experience, a kind of television that represents a flat in which a lady called IRIS lives. By pressing buttons you can react to what is happening in the flat. You can turn the lights on and off, charge your phone, install solar panels, take a shower etc. At the end of the game you can see how energy-efficient you have been. The other form is the digital XR experience. On the website you can play the game, press the buttons and measure how energy efficient you are. You can find the XR experience here: http://huntedwumpus.nl/Box/

Figure 38 screenshot of the digital XR-experience

- How has it been implemented?
  We are going to use the XR experience at school (the digital version) and at markets, guided tours and fairs. Because of the Corona pandemic, we have not yet deployed and used the XR experience.
- What activities/implementations are still in planning?
  We are investigating with the primary schools, Technotrend and the secondary school X11 whether we can use the digital form of the XR experience at schools.

Measure 6: Citizen engagement and Self-Maintenance within project Complex 507

- What has been implemented?:
  With self-maintenance the tenants of 353 dwellings in Complex 507, owned by Bo-Ex, aim: an office dedicated for the tenants of this complex which will result in fast action, better service, better maintenance, less bureaucracy and more customization. And even more important: more influence from the tenants on how things should go. The tenants of Complex 507 will have more influence on the administrative, social and technical activities within this neighbourhood.
  At this moment, the last open standing items are discussed between Bo-Ex and the tenants committee TC507. These items concern financial and governance arrangement.
- How has it been implemented?
  Many meetings and (for some tenants voluntary) hours have been spent by a lot of people to set this plan. This plan has been designed from scratch and it took a long period before the framework was suitable, feasible and attractive for both Bo-Ex and the tenants. From 2017 till end 2019, this plan has been elaborated, also with the support of external advisors and an external chairman who led the meetings. In 2019, the principal framework was ready to officially submit to the tenants. During the period 2017 till begin 2019 several presentations have taken

place to inform and involve the tenants of Complex 507. Based on this feedback information, the framework for self-maintenance has been elaborated. In the first half of 2019 independent tenants consultants have visited most of the tenants individually to explain and clarify the plan of the retrofitting works and self-maintenance. Based on the feedback of this house-visits both the plans for retrofitting as well as self-maintenance have been adjusted and finalized.

In November 2019 the formal support measurement took place, parallel to the support measurement of the retrofitting works for this complex. The outcome of this measurement was that 74% of the tenants of Complex 507 supports this plan of self-maintenance, enough to further finalize and implement this initiative!

Figure 39 Brochure self-maintenance for the support measurement end of 2019

- What activities/implementations are still in planning?

  Early 2022 Bo-Ex expect that the first activities will take place by the new established self-maintenance organization. These activities consist of the assignment of a board with a supervision board for the new organization. Also the assignment of a local self-maintenance is scheduled for early 2022. By the end of the refurbishment project, scheduled for Autumn 2022, the self-maintenance organization shall operate fully and independently.

6.3 Preliminary results

With the executed activities within the described measures, several results have been gathered. Except for Measure 5, where the testing and implementation activities are being held up by the Corona pandemic which makes it very difficult to reach the target group. For most of the measures the monitoring data is still not sufficient and representative. In the coming period Bo-Ex together with their partners will focus on gathering validated monitoring data.

Experiences and feedback

The following table contains a summary of the experiences, feedback per Measure:

Table 7. Summary of experiences and feedback per measure in TT#5

Measure	Experiences and feedback
Measure 1: Community building by Change agents	The HEMS Eneco Toon installation process achieves positive results: more and more tenants chose for the Eneco Toon and people are informed about the refurbishment plan process in the future and respond on the call for becoming a member of the peer-group. The amount of members of the Whatsapp-group EnergieKanaleneiland grows and more and more sustainable initiatives by residents are planned.
Measure 2: Campaign District School Involvement	The activities together with MBO-Utrecht are continued, the students and teachers appreciate the involvement of Bo-Ex and the possibility to work on a concrete project. The activities on the primary schools are being held up by the Corona pandemic unfortunately. The first round of activities held by Stichting Technotrend in 2018-2019 were successful. The lesson series on three school in Kanaleneiland-Zuid for three school years are still suspended due to the Corona pandemic.
Measure 3: Co-creation in Local Innovation Hub	The experiences and feedback differs per activity: - HEMS Eneco toon installation process: the response of tenants on the call is rather high in comparison with other sustainable initiatives and services tenants can make use of. - Treasure hunt Kanaleneiland-Zuid for children is done by only a few children. Next year this Treasure hunt is promoted. - Event EnergieKanaleneiland! has been held in October 2021. The attendance of residents was rather low, for the next event in 2022 we try to increase the amount of visitors substantially. - SNAP service: the participants of the workshop were pleased to participate and happy to give feedback on the communication style of Bo-Ex towards their tenants. - Co-creation process square district battery: people who live in the area are happy with this initiative (and no wrong feelings amongst other people). In the coming months the co-creation process will continue and feedback is requested. - Jury for the ChangeU hackathon: the participants of the Hackathon were happy with the input and feedback from the IRIS jury member.
Measure 4: Campaign Smart Street Lighting	Inquiries amongst participants of the co-creation will be send out early 2022 (one year after the installation of the lighting).
Measure 5: VR New Home and District Experience	T.b.d. (no testing and implementation activities can take place at this moment).

Measure 6: Citizen engagement and Self-Maintenance within project Complex 507	More than 70% of the tenants of complex 507 (353 dwellings in total) supported the plan for self-maintenance End of 2019. Inquiries amongst the tenants of complex 507 will be held after the implementation of this initiative (planned for End of 2022).

Progress of the KPI's:

For all the KPI's within TT#5 it is clear what information is requested and who is responsible for the information supply. But, this transition track consists of mainly social activities of which the effect is not easy to capture in a score on a likert scale. Eventually we would like to measure and describe the impact of the activities on people in the demonstration area. Therefore several sources are used and also the effect of activities is measured, not only quantitatively but also qualitatively. For example, the effect of a Whatsapp-group EnergieKanaleneiland is to be considered in relation to the total population of the demonstration area. We can measure the amount of participants, but this does not give information on the effect of this activity, the drivers behind this activity and the key participants in this group.

As mentioned, at this moment already some data is gathered from several measures. In the coming months more and more valuable data is gathered.

The following table contains an overview of the current state of each KPI within TT#5:

Table 8. Progress of KPIs in TT#5

KPI	Current state
Measure 1: Community building by Change agents: - increased environmental awareness - people reached - local community involvement	The sources for these KPI are the following: Increased environmental awareness: - district survey by Gemeente Utrecht with specific questions about sustainability: information is provided in 2022. The municipally yearly sends out inquiries amongst all the citizens in every district of Utrecht, of which Kanaleneiland-Zuid. In the last years, the response rate of citizens from Kanaleneiland-Zuid was very poor (the lowest of whole Utrecht). Hopefully we'll receive more filled forms from citizens this year; - tenants survey HEMS Eneco Toon: first surveys have been received, in the coming months approx. 100 filled surveys are expected; - tenants survey Refurbishment Alexander de Grotelaan II and III: first surveys have been received, in the coming months approx. 60 filled surveys are expected; - activities from the Whatsapp-group EnergieKanaleneiland is measured. People reached - amount of people who visit the IRIS website is measured (at this moment approx. 1600 visitors); - reactions on IRIS on social media is measured; - amount of people who uses a shared V2G-car (as described in TT#2);

	- amount of members Whatsapp-group EnergieKanaleneiland is measured (at this moment approx. 70 members). Local community involvement - tenants survey DC pilot: for the first pilot the survey has been sent out, in 2022 the other seven will follow (after the installation of the pilots); - tenants survey Refurbishment Alexander de Grotelaan II and III (see above); - tenants survey HEMS Eneco Toon (see above); - SNAP service workshop has been held. This workshop brought on several do's and don'ts for communication activities for the target group; - participants survey for the renewed district battery square, after the realization of the square; - participants survey smart street lighting will be send out and gathered in Winter 2021/2022.
Measure 2: Campaign District School Involvement: - people reached	People reached: - in school year 2018/2019: 150 out of 500 children have been reached (= 30%); - in school year 2019/2020: 100 out of 500 children have been reached (= 30%). - In school year 2020/2021: very little children have been reached to the restrictions of the corona-pandemic, which caused that lessons on school have been cancelled.
Measure 3: Co-creation in Local Innovation Hub - local community involvement	*Refer to Local community involvement at Measure 1.*
Measure 4: Campaign Smart Street Lighting - ease of use for end-users - advantages for end-users - local community involvement	For all the KPI's: - participants survey smart street lighting will be send out and gathered in Winter 2021/2022.
Measure 5: VR New Home and District Experience - ease of use for end-users	No data is gathered yet, this depends on the moment we're able to test the XR-experience amongst people at schools and public spaces. It's expected that in Autumn 2021, the XR-experience can be tested and evaluated.
Measure 6: Citizen engagement and Self-Maintenance within project Complex 507 - local community involvement in development process	The support measurement on this initiative resulted in 74% (74% of all the tenants are favour of this plan). Tenants survey about self-maintenance will be held end of 2022.

6.4 Business models and exploitation

The Measures in Transition Track 1 don't contain a Bankable Business model (financial nor societal) in the way these are executed by involved parties. Though there are Measures which might be considered as a Key Exploitable Result:

- Measure 1 Community building by change agents: no business model opportunities acknowledged.
- Measure 2 Campaign District School Involvement: no business model opportunities acknowledged.
- Measure 3 Co-creation in Local Innovation Hub: no business model opportunities acknowledged.
- Measure 4 Campaign Smart Street Lighting: this measure contains a Key Exploitable Result in terms of a co-creation amongst citizens which can be applied on many subjects and in many circumstances to find the best solution for all involved parties.
- Measure 5 VR New Home and District Experience: no business model opportunities acknowledged.
- Measure 6 Citizen engagement and Self-Maintenance within project Complex 50: this measure contains a Key Exploitable Result in terms of decentralization of maintenance tasks can result in lower exploitation cost due to a higher commitment amongst tenants regarding the maintenance of "their" assets.

6.5 Conclusions, lessons learned and next steps

In the last period (from M36) a lot of activities in this Transition Track have been done and implemented. Looking back on this period unfortunately the Corona pandemic (Covid-19) suspended some planned activities such as the lesson series at primary schools. Also, the testing and implementation activities for the XR-experience, is suspended. Hopefully these activities can resume in the end of 2021. However, despite the Corona pandemic a lot of activities did take place and some new additional activities have been initiated. More than in the other Transition Tracks, the activities within this Transition Track are rather depended on the response of tenants/residents. Some activities have shown to be a success, others not. This resulted in adjustments of activities (such as the HEMS Eneco Toon approach) and some new activities which contribute to the objectives of this track and of the IRIS project (such as the co-creation sessions with area residents of the district battery).

In report D5.7 the reported major lessons learned for this Transition Track included the following two:

1. It is not easy to get in contact with our target group, because of language barriers, people have bigger problems to worry about and a natural distrust within a large part of the target group towards institutions such as the municipality and housing corporation.
2. The distrust in housing corporation Bo-Ex amongst tenants is high and it's hard to find reasonable solutions. The distrust is strengthened by the plans of the other housing corporation who act in the same area and offer their tenants more value for money according to the tenants of Bo-Ex.

Still these lessons learned are actual and the most important for TT5, but we have achieved improvements on these topics. With the approach we follow to install the HEMS Eneco Toon, we come

into personal contact with more and more tenants in an earlier stage. This resulted in a wider group of tenants who want to participate in the plan formation for the refurbishment. Also, the engagement process held for the two apartment buildings at the Alexander de Grotelaan II and III resulted in enough support – though the ambition is to increase the consent rate towards 80-85%.

In the next (and last) period of the IRIS project, the main focus points are:

- Expanding the networks within the district of Kanaleneiland-Zuid;
- Execute engagement and school activities (if possible);
- Gathering information (feedback) from involved people for the different activities;
- Continuing with monitoring and analysing the results of measures and improving the approach.

7. Preliminary Results at the Lighthouse City Level

7.1 Introduction

Utrecht wants to be a sustainable and healthy city, in line with the ambition of healthy urban living. A climate-neutral and circular Utrecht is a dot on the horizon. Utrecht has formulated two objectives in this area:

- Utrecht is saving energy and generating renewable energy
- Utrecht is a city with a healthy, quiet and safe living environment (as little noise pollution as possible, a safe living environment, clean soil and clean air).

Utrecht aims to be gas-free by 2050 and has been working with a Sustainable Energy Action Plan since 2015. In 2019, the Dutch national government presented the Climate Agreement; a package of measures to achieve a 49% reduction in CO_2 emissions by 2030. The Climate Agreement implements the 2015 Paris Climate Agreement. Municipalities are therefore taking on the task of drawing up a Transition Vision Heat.

Currently, the city council is writing a Transition Vision Heat, consisting of two parts. Part I of the Transition Vision Heat describes the strategy and vision. It sets out how the existing homes and buildings in Utrecht can gradually, and neighbour-by-neighbour, be converted to new forms of heating and cooking. In a way that is affordable and feasible for everyone. Part I was adopted by the municipal council on 3 June 2021.

Part II of the Transition Vision Heat indicates when and in which neighbourhoods we will start the preparations to become gas-free. In total, until 2030, about 40,000 homes will be involved, spread over 24 neighbourhoods. That is about 1/3 of the total number of homes. The rest will follow afterwards.

Besides energy, the city of Utrecht is facing, as fast-growing city, challenges to create for everyone a healthy and nice place to live in. A Mobility Plan 2040 is created in 2021 that contains an approach to create this healthy and reachable city. The approach consists of 5 steps:

- smart zoning,
- travelling differently,
- networks in order,
- smart parking
- smart management.

And very important: we organise mobility in such a way that everyone can participate.

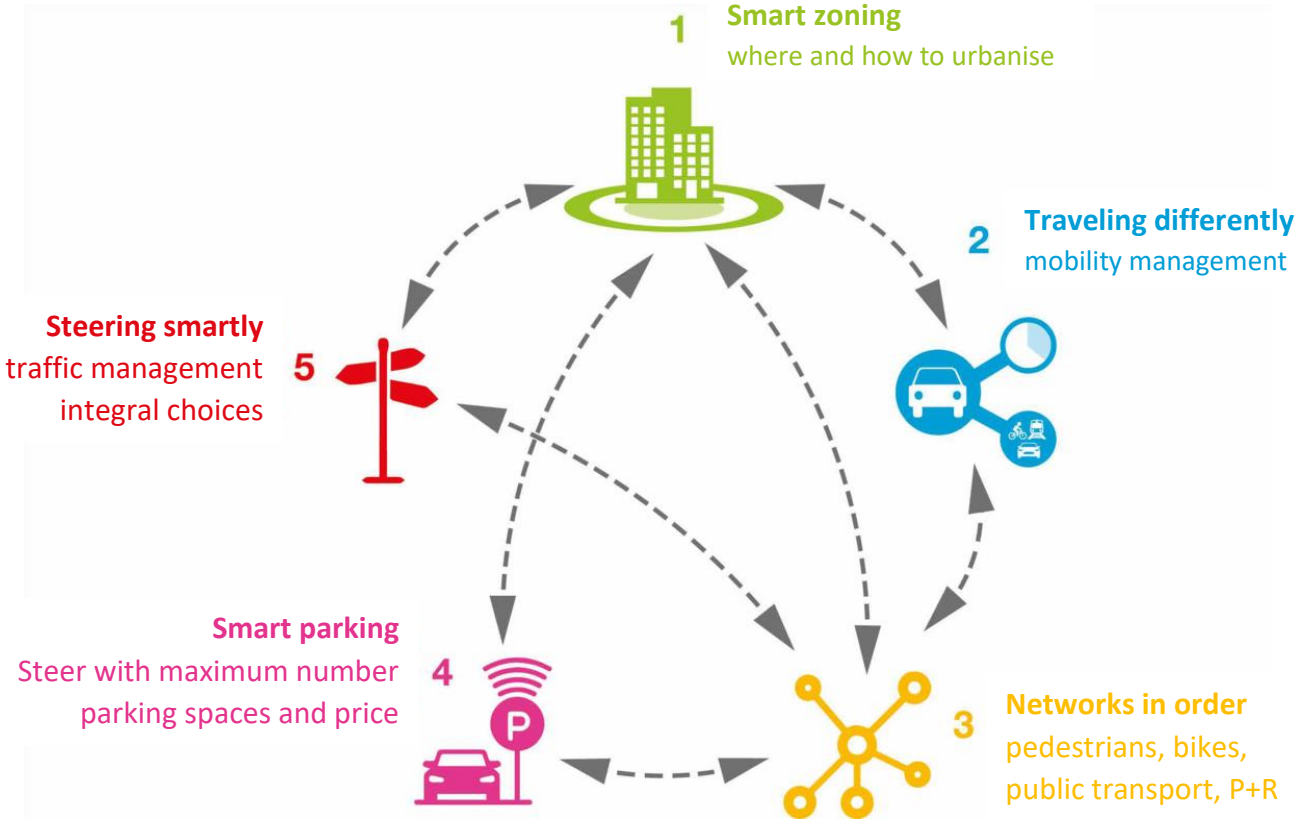


Figure 40. Five steps of Mobility Plan 2040, Utrecht

7.2 Impact on the Lighthouse City Level

Every year, the city of Utrecht writes a sustainability report to find out where we stand as a city and organisation in terms of sustainability. This report provides an overview of the state of sustainability within the Utrecht municipal boundaries. Attention is paid to:

- The policy objective on the various themes
- The results of implemented policies
- Utrecht's performance compared to Amsterdam, Rotterdam, The Hague and the Netherlands

At present, Utrecht is only at the beginning of a major revolution when it comes to energy supply in the city. Recent years have focused mainly on the emissions that the municipality itself can influence, such as the purchase of sustainable energy from its own buildings and installations. A plan has also been drawn up to make the municipal buildings more sustainable by 2040. Looking at the total CO_2 emissions in the city, this action is a small part of the total CO_2 emissions in the city. Only when the large numbers of homes and businesses are made sustainable, and the energy sources are sustainable, will significant CO_2 reductions be reflected in the figures.

CO_2 emissions in the municipality of Utrecht will be around 1.2 million tonnes in 2019. In the period 2015-2019 CO_2 emissions decreased by 16% in total. Despite an increase of number of houses with 5% and an increase in number of inhabitants with 6%, the overall energy usage only rose with 0,2% in the

period 2015-2019. Installed solar energy capacity increased between 2018 and 2019 with 50% to 70 kWp (figure 40).

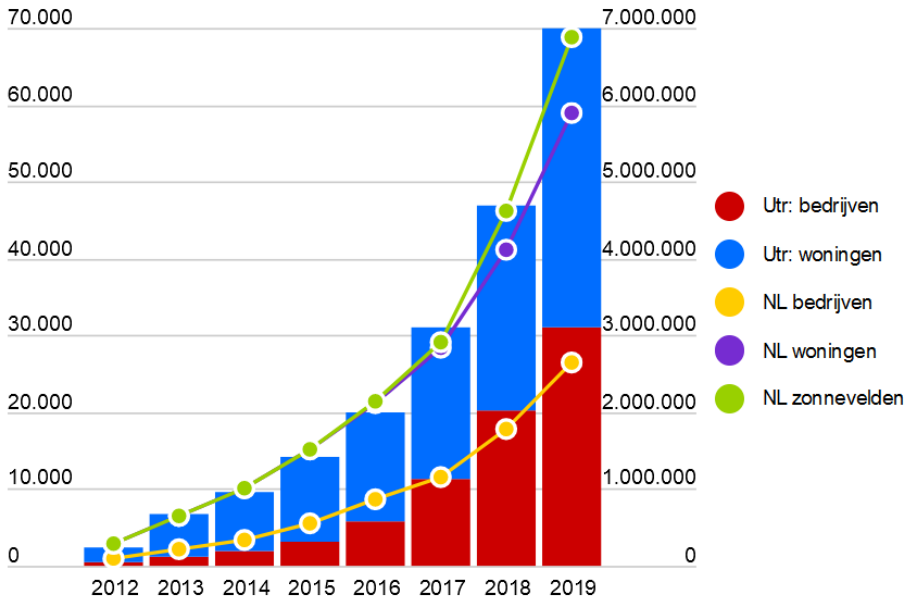


Figure 41. Installed solar capacity in Utrecht compared to the Netherlands (source: Klimaatmonitor RWS)

It is difficult to quantify the impact of the IRIS project to these results of the sustainability report. However, the IRIS project is a well-known project in the city of Utrecht and attention is paid to the progress and results by the city council, grid operators and local stakeholders in the district.

Especially, the V2G bidirectional ecosystem as detailed in chapter 3, has a huge impact at city level. It not only creates the results as described in chapter 3, but also leads to design criteria for new-built districts like Merwedekanaalzone, Carthesiusdriehoek and also for the redevelopment of areas like the transformation of the Jaarbeurs exhibition centre to become an integral part of the city centre of Utrecht. Also the interest of car manufacturers like Renault, Hyundai and Sono Motors to launch their V2G-enabled cars in Utrecht, is an indication that Utrecht is world-leading in bi-directional energy-mobility systems.

The IRIS project has also led to networks of stakeholders that want to continue the cooperation in new innovation projects. For the refurbishment of mid- and high-rise apartment buildings, a new Horizon2020 project has been granted, as part of the European Green Deal call (LC-GD-4-1-2020). In this project, called ARV - Climate Positive Circular Communities, the renovation concept *Inside Out,* piloted at the Positive Energy Building in Overvecht, is begin further developed and industrialised, aiming to speed up the renovation wave. And half September 2021 a proposal, called SCALE, has been submitted in Horizon Europe, to scale-up and replicate the V2G-ecosystem and V2G-standard ISO15118, with involvement of a.o. car manufacturer Polestar. The involvement of Polestar is a direct success of peer-to-peer knowledge exchange between Lighthouse Cities Utrecht and Gothenburg.

7.3 Next Steps

In the period October 2021-September 2022, we want to further explore and detail the impact of the IRIS project at city level. We want to do this by organising talks and sessions with key stakeholders, in whicht the results of the IRIS project will be dissimenated. We also like to use the research team of the city of Utrecht (responsible for the sustainability report) to detail the numbers of the sustainability report to concrete actions in the demonstration districts of IRIS.

Annex 1: KER table – Bidirectional Ecosystem

KER No. 3 Lomboxnet Smart Energy Management

Characterization of the result

KER name	
Description	A smart pedestrian crossing including smart public lighting and luminous white LED strips in the crossing itself. The light is controlled by sensors that detect the proximity of traffic and pedestrians. Furthermore feedback is provided to approaching vehicles based on colours depending on their speed
Problem	In the area there was an unsafe traffic situation, including speeding traffic especially at night. It was decided to develop a smart solution for the traffic safety issue in combination with the replacement of the aging streetlight system in the area with energy efficient smart LED lighting. Hereby, the smart functionality of the street light system was utilized to add to the safety situation.
Alternative solution	Alternatives to increase the safety situation consisted of fixed traffic regulation obstacles, such as speed bumps
ProblemUnique Selling Point USP - Unique Value Proposition UVP	▪ Need to correspond to the increasing demand of large amounts of storage capacity. ▪ Capability for a quick response to accommodate the large amount of intermittent renewable electricity generation expected ▪ Increasing demand for grid balance due to electrification of cars and building heating/cooling. *Problems are still generic, with no quantification nor identification of problems owners (potential customers (TSOs, DSOs Energy Companies?)) Discuss and validate problems together with your "early adopters". Leverage on the* The remotely managed smart pedestrian crossing enables adapting the behaviour of the system after installation. Once installed, there is no need for any ground work in case a change in the functionality of the installation is required This saves costs and energy. Fixed systems would require a team to visit the site to make any changes in the system, including ground work. In fact the introduction of the smart pedestrian crossing means the replacement of a fixed infrastructure system with a smart electronics and software solution.

	regions and Follower Cities to collect the information you need. Use the workshops planned in each Lighthouse City to discuss problems. The Lighthouse Cities can be very useful in the remaining months to collect data and facts. We will continue our contacts with current and future problem owners and early adopters to clarify the problems and their ownership, including DSO Stedin (already an active partner in the project), ELaadNL which is a national platform of DSO's focusing on e-transport, municipalities, real estate developers. We will also use Lighthouse City platforms to discuss and broaden the replicability. **UPDATE september 2021:** The problem has become much clearer as a result of various actions and activities. We give here the problem from a viewpoint of two main players: DSO and municipality. From DSO viewpoint: the Dutch DSO's have in the past year published several press items on the need for grid reinforcement in order to deal with the requirements of the energy transition: intermittent renewable energy generation, increased EV charging and increased heat pump utilization. DSO Stedin estimates that up to 7 billion Euro is needed until 2030. Stedin has also identified V2G charging as a major factor in reducing these costs: potentially, V2G EV charging could almost totally eliminate the need for reinforcement of the Utrecht city grid by 2035. From municipality viewpoint, City of Utrecht has repeatedly expressed that electricity grid reinforcement has large inpact on the city. Not only would possibly one third of all road have to be opened to reinfoce cables, but also a number of power stations would have to be placed into the existing city, which is difficult and costly. For this reason, the city of Utrecht is active as it is with regard to the Bidirectional Ecosystem.
Alternative solution"Market" – ***Target market***	▪ TSO: Stationary batteries, H2, curtailment of wind and solar. ▪ DSO: Upgrading the grid by putting extra transformers on the street and cables in the ground; purchasing services from exploiters of stationary storage; curtailment of wind, solar or local electricity consumers. ▪ Energy Company: PM. Weakness of alternative solutions: massive storage capacity needed, high costs. Strengths: PM *Alternative solutions are important to benchmark the proposed solution and to get a better insight on competition. Please analyse how are guaranteed large storage capacities, how alternative solutions are used by larger audience of customers? The collected info on alternative solution will help to add credibility at the final plan. It*

	is suggested that you integrate the information with weakness and strengths of the alternative solutions listed into a SWOT. It will help you to better define the added value of your solution. Plan proper actions with Light House regions and Follower Cities to identify the alternative solutions and perform a SWOT. As the problem and alternative solutions are largely not yet on the market but anticipated for the future, the competitiveness and availability of alternative solutions are not easy to analyse in detail. We will continue to observe developments, so as to be able to describe expected competitiveness of alternatives in relation to the KER towards the end of the project. **UPDATE september 2021:** For TSO and DSO, the real alternative is classic grid reinforcement (see above) with all costs and other negative impacts.The system can be applied in all traffic situations with a need to increase traffic safety and pedestrian crossings in particular. The target market therefore consists of lower governments (municipalities) that have responsibility for street maintenance and traffic safety.

"Market" - CompetitorsUnique Value Proposition (UVP)	▪ Use of existing assets to obtain the larger storage capacity in a cheaper way.
	  ▪ Multiplying by a factor of 3 storage capacity by using AC-bidirectional charging of cars.
	  ▪ AC-bidirectional charging offers a cheaper solution than DC bidirectional charging.
	▪ Universal solution for car manufacturers and other users with the adoption of ISO 15118 standard for AC-bidirectional charging (compatibility with the AC charging, now the standard for conventional EV charging).
	
	It is important that the UVP is validated and backed with facts and data (action needed). Align the UVP with customers' problems and alternative solutions. Use the workshops planned in each Lighthouse City to discuss the UVP.
	
	Smart Solar Charging will provide DSO's with a new means to improve the local electricity grid congestion management that they will need to balance the fast-increasing network loads as a result of the energy transition. Because Smart Solar Charging utilizes batteries in e-cars that 'have already been paid for' the flexibility generated will be considerably less costly than that of its competitors. Validation actions of the value of the UVP are part of the IRIS plan and can be discussed to validate and backup the UVP.
	
	UPDATE september 2021:
	
	Another unique part of the proposition is that because the V2G chargers are downward compatible, they can be used for both public charging and V2G charging of shared EV's. This greatly flattens the introduction path, as the present roll-out in Utrecht shows (500 charging stations in 2021).

The smart / V2G charging approach has the potential to almost eliminate the expected local grid congestion, as results by DSO Stedin and the Utrecht University indicate, and as illustrated in Figure 1. Scaled up to the level of city regions, this technology promises major positive impact on local congestion problems.

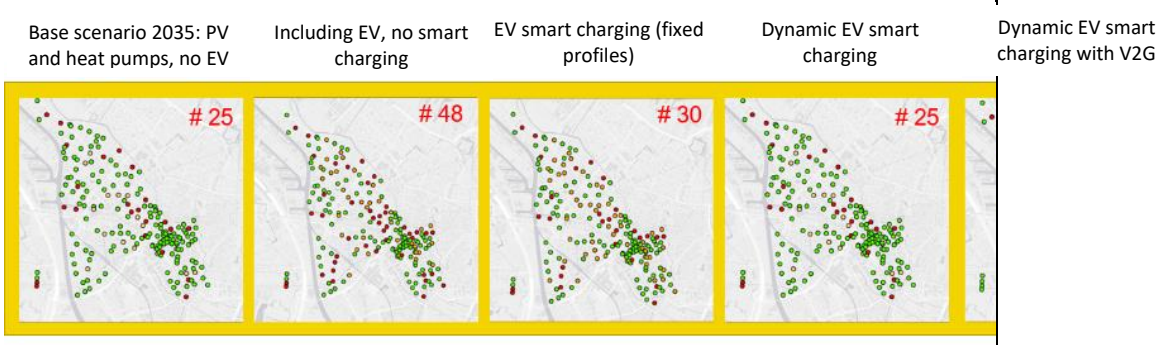


Figure 1: "Opportunity map" made by DSO Stedin for part of the Utrecht city, visualising scenarios for 2035. : transformer station with load below 80% : transformer station load 80-100% : transformer station with load above 100% # 48: number of transformer stations in overload (total: about 200 transformer stations).

The alternatives available to road owners are classical street furniture including speed bumps and other fixed obstacles.
These can not be actively regulated and adapted to the actual environment (light/dark etc) or to the present situation (high/low traffic, speeding vehicles)

DescriptionGo to Market – Use model

Fully bidirectional ecosystem management system, combining smart charging electric cars, renewable energy plants, and storage in vehicles and stationary batteries with supporting structures as ICT backbone and user apps.

The bidirectional ecosystem management system uses existing assets (cars, batteries, renewable plants) to sell flex/energy services to different energy markets.

Integrate, describing in a simple and plain way how the different components are connected together and how the system delivers the UVP to customers.

The AC bidirectional charging stations are cheap and compatible to normal e-car charging, and are therefore already being rolled out in Utrecht. Bidirectional shared e-cars connected to these stations will be managed by the shared car operator as a network of electric flexibility generators and will supply flexibility services to the DSO, thus enabling the DSO to reduce grid reinforcement costs.

Based on the upcoming project results and validation we will be able to discuss a simple formulation of the value of the UVP to DSO's and possibly other customers.

UPDATE september 2021:

Discussion to be started at the ESS	Another unique asset is that because the V2G chargers are downward compatible, they can be used for both public charging and V2G charging of shared EV's. This greatly flattens the introduction path, as the present roll-out in Utrecht shows (500 charging stations in 2021). The network of V2G chargers (both for public charging and shared EV) will, together with centrally and intelligently managed fleets of shared as well as private EV's, deliver enough flexibility to the grid to strongly reduce the need for grid reinforcement.The business model for this solution consists in duplicating the installation at other locations. Since the system concerns a 'plug and play' solution with a working demo installation it can be offered to other municipalities. The system installation work and hardware will be sold to the client, whereby a software license will be offered to manage and monitor the system in operation.
"Go to Market" – Target market – IPR	Main final market is As the European electricity market with as main consumersdeveloper of the innovation: • TSO's • DSO's • Energy companies *When fully developed the description should include both a qualitative and quantitative description in terms of size and features. Please discuss on the organisations listed, as it is needed a different approach for each of them.* For TSO's, networks of managed, shared, bidirectional e-cars will act as flexibility suppliers thatintegrated solution Luminext will be able to offer flexibility on the commercial party offering the product in the national markets. For DSO's, the bidirectional networks will reduce local grid congestion and thus decrease the need for costly electricity network reinforcements. As discussed above, the value of the UVP in relation to alternatives is still being determined within the IRIS project. Further on in the project, it will be possible to integrate the results. **UPDATE september 2021:** Urban municipalities have been identified as another target market, probably more so than energy companies. In cities, the spatial, financial and urban development impact of the required grid reinforcement is considerable, avoiding or reducing that impact is therefore interestingmarket.
Market" – Early Adopters	Dutch energy market TSO and DSO's will serve as Early adaptors. After that, North-West European countries will probably be the next phase. *Please provide a description on how you will interact with the Early Adopters, the ones who will take advantage of your result as first.*

	A first mover is DSO Stedin, which is an active partner to LomboXnet in developing the UVP and its benefits. Already contacts are ongoing with ElaadNL, a platform of DSO's in the Netherlands that represents the other DSOs in the country. Internationally, active contribution is made to the development of the ISO15118 open standard for AC bidirectional charging, which will enable first movers to quickly adopt the innovation. **UPDATE september 2021:** We can add the City of Utrecht as early adopter city from the municipality side.
Discussion to be started at the ESS	What local flex services are competitive, depends on the cost effectiveness of the flex solutions. For instance, car batteries are already paid for, while in stationary batteries a large investment needs to be completely returned by flex services. This puts additional pressure on the business case. For hydrogen storage, similar arguments are valid as for stationary batteries. Additional flex services (TSO balance management, portfolio management) and further aggregation of flex sources can improve the business case. *To be further analysed considering the result of the discussion on problems and alternative solutions and use model. Use the tools envisaged in WP3 to complete the characterisation of the competitors.* We will further discuss with WP3 to apply the tools when available. **UPDATE September 2021:** Smart charging is being developed and exploited by other parties, but not with the unique characteristics of the WDS approach: cheap, downward compatible V2G chargers that can also be used for conventional public charging; a growing fleet of shared EV's that allow intelligent management and smart / V2G charging; the shared EV's are always connected to charging stations when not in use, as opposed to publicly charged private EV's.
Go to Market – Use modelIPR	Sale of the aggregated flexibility through aggregators and/or other ecosystem parties, to DSO's and TSO. LomboXnet is coordinating this process and act as an integrator for different assets. *To be further discussed and finalised. Take advantage of WP3 to develop the use model into the business/exploitation plan. Use the next consortium meeting to agree on how to integrate different assets.* *We will further discuss with WP3.* **UPDATE September 2021:** Towards municipalities, the roll-out of the downward compatible V2G chargers is an interesting proposition, as most cities are expanding their charger networks.

Discussion to be started at the ESS	
Go to Market – IPR (Background)	*As for the Consortium Agreement.* *Please analyse how IPR on this KER has been arranged / agreed in the consortium agreement and decide if any additional agreements / arrangements will be needed for scaleup and exploitation after the project.* *Section 9 of the Consortium Agreement (CA) gives general protection of background and foreground knowledge. In Attachment 1 of the CA, it is stated that data and know-how of LomboXnet will be available to other parties for implementation of the Project or exploitation of that other Party's results, at the time of signature of the agreement.* *The smart charging technology is open-source and actively disseminated, for instance as part of the development of the ISO15118 standard. The USEF and Gopacs flexibility platforms are open source as well; information on these platforms is freely available. The actual shared e-car management software is proprietary of partners of LomboXnet. It is used in IRIS but not shared with IRIS partners.* After completion of the demo installation in Utrecht in Q2 2021 the system can be offered to other interested parties.
Go to Market – IPR (Foreground) Discussion to be started at the ESS	*As for the Consortium Agreement.* *Please discuss where an additional ownership protection is needed and agree on possible addendum to the Consortium Agreement. University of Brussels, VUB, is delivering a report, D3.5 IP Landscape Review, and is in lead of IP-related issues of IRIS. VUB has the role of guiding IRIS partners regarding questions on ownership. Make the most out of this opportunity.* *LomboXnet does not claim ownership of any information generated within IRIS.*
Go to Market **(Timing)Exploitation roadmap**	• The bidirectional chargers are ready to market; • The AC-bidirectional cars are expected to market early 2021; More in details the ecosystem is now being developed, validated and extended by: • Producing and exploiting bidirectional AC-V2G chargers based on ISO15118; • Developing marketing of flex services; • A new marketplace (GOPACS) is developed for this trade by DSOs supported by an open source 'Universal Smart Energy Framework' (USEF); • Promoting and implementing the use of the V2G standard by car manufacturers, charge point manufactures and aggregators (to bring the services to the customers: DSO and TSO). *Please develop the time planning and make a roadmap including financial plan for exploitation after the project. The innovation is at TRL5-6 now, at end of project will*

	be at 7-8. Use the next consortium meeting to work on the roadmap introduced in 4.4. Take advantage of activities inn WP3. *We will discuss this with WP3.* **UPDATE September 2021:** While the GOPACS market platform is still in development and early use, roll-out of the V2G charging stations and shared EV's is continuing with growth rates close to 50% per year.
Actions	
Roles	
Milestones	
Impact in 3-year time	
Costs	
Revenues	
Other sources of coverage	

Annex 2: KER table – Smart Pedestrian Crossing

KER No. 3 Smart Pedestrian Crossing

Characterization of the result

KER name: Smart Pedestrian Crossing	
Description	A smart pedestrian crossing including smart public lighting and luminous white LED strips in the crossing itself. The light is controlled by sensors that detect the proximity of traffic and pedestrians. Furthermore feedback is provided to approaching vehicles based on colours depending on their speed
Problem	In the area there was an unsafe traffic situation, including speeding traffic especially at night. It was decided to develop a smart solution for the traffic safety issue in combination with the replacement of the aging streetlight system in the area with energy efficient smart LED lighting. Hereby, the smart functionality of the street light system was utilized to add to the safety situation.
Alternative solution	Alternatives to increase the safety situation consisted of fixed traffic regulation obstacles, such as speed bumps
Unique Selling Point USP - Unique Value Proposition UVP	The remotely managed smart pedestrian crossing enables adapting the behaviour of the system after installation. Once installed, there is no need for any ground work in case a change in the functionality of the installation is required This saves costs and energy. Fixed systems would require a team to visit the site to make any changes in the system, including ground work. In fact the introduction of the smart pedestrian crossing means the replacement of a fixed infrastructure system with a smart electronics and software solution.

"Market" – *Target market*	The system can be applied in all traffic situations with a need to increase traffic safety and pedestrian crossings in particular. The target market therefore consists of lower governments (municipalities) that have responsibility for street maintenance and traffic safety.
"Market" - Competitors	The alternatives available to road owners are classical street furniture including speed bumps and other fixed obstacles. These can not be actively regulated and adapted to the actual environment (light/dark etc) or to the present situation (high/low traffic, speeding vehicles)
Go to Market – Use model Discussion to be started at the ESS	The business model for this solution consists in duplicating the installation at other locations. Since the system concerns a 'plug and play' solution with a working demo installation it can be offered to other municipalities. The system installation work and hardware will be sold to the client, whereby a software license will be offered to manage and monitor the system in operation.
Go to Market – IPR Discussion to be started at the ESS	As the developer of the integrated solution Luminext will be the commercial party offering the product in the market.
Go to Market – IPR Discussion to be started at the ESS	
Go to Market Discussion to be started at the ESS	After completion of the demo installation in Utrecht in Q2 2021 the system can be offered to other interested parties.
Exploitation roadmap	
Actions	
Roles	

Milestones	
Impact in 3-year time	
Costs	
Revenues	
Other sources of coverage	