IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

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# Deliverable 5.5

## Launch of T.T.#3 activities on Smart e-mobility (UTR)

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|---|---|
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| **Task:** | T5.5 Demonstrating Transition Track #3: Smart e-mobility |
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## Authors


| Surname | First Name | Beneficiary |
|---|---|---|
| Van der Ree | Bart | LomboXnet |
| Berg | Robin | LomboXnet |
| Scheifes | Ragnhild | LomboXnet |

In case you want any additional information or you want to consult with the authors of this document, please send your inquiries to: irissmartcities@gmail.com.


## Reviewers

| Surname | First Name | Beneficiary |
|---|---|---|
| Kok | Matthijs | Utrecht |
| Lund | Emma | Trivector |
| Tsarchopoulos | Panagiotis | CERTH |

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## Disclaimer

# Executive Summary

This deliverable describes the progress in WP5.5: Transition Track #3 in the Smart e-mobility per end 2019 within the IRIS Utrecht demonstration project.

Transition Track #3 focuses on two measures:

- Measure 1: V2G E-cars
- Measure 2: V2G e-buses

The work in Transition Track #2 has led to first actions being taken and in 2020, most of the other actions are expected to be taken, such as demand-driven growth of the number of V2G e-cars, growth of the e-bus fleet and integration into the smart energy management system of T5.4.

The realisation of V2G e-cars is progressing with one shared e-car realised and two e-vans procured, but the demand-following approach is posing a risk to reaching the planned number.

The implementation of e-buses is progressing quickly, which ensures a good basis for quantitative research on the value of flexibility provided by e-buses and e-cars on city level.

Already, the impact of this work is becoming rapidly visible, as it 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. Thus, a bi-directional ecosystem of V2G chargers and vehicles is created, which will work together with stationary storage, solar panels and other measures as a virtual power and flexibility plant. 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 open standard for V2G charging was launched by ElaadNL and the Open Charge Alliance. In November 2019, LomboXnet has installed 50 V2G charging points in the city of Utrecht and by April 2020, that number will have grown to 150. The number of smart charging shared e-cars presently in operation in Utrecht is now 50 plus an additional 10 in the region. Two actual V2G pilot Renault ZOE e-cars are being tested, while Renault is planning series production of these V2G ZOE's at the end of 2020. Similarly, the bus company QBuzz is currently exploiting 13 e-buses in the city with two charging / fast charging locations; by summer 2020, 55 additional e-buses will be in operation, plus two new large depots with in total 68 bus charging stations. The e-buses provide their services to the whole city; the charging stations at the bus depots will have their own medium-voltage connections and thus also act on city level rather than district level.

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 2025.

*Table 1: overview of the demonstrators included in this deliverable.*

| | |
|---|---|
| Measure 1: V2G E-cars | Brief summary: The MaaS "We Drive Solar" car sharing system will be demonstrated in the LH demo district by means of 14 solar powered V2G e-cars delivered by Renault. Also, Bo-Ex will procure 4 e-vans to replace its existing vans for maintenance and service use. |
| | Expected impact: The IRIS Utrecht demonstration is 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. 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 open standard for V2G charging was launched by ElaadNL and the Open Charge Alliance.<br>The shared e-cars will provide a green alternative mode of transport for the IRIS district residence, reducing NOx, fine particular matter, carbon monoxide and carbon dioxide emissions. At the same time their batteries contribute to smart energy management, combining sustainable transport with maximising self-consumption and reducing grid stress, and unlocking the financial value of grid flexibility. |
| Measure 2: V2G e-buses | Brief summary: 10 smart solar V2G e-buses by QBuzz |
| | Expected impact: The e-buses and charging stations will provide not only a green mode of public transport for the IRIS district residents and reduce emissions, but also generate large amounts of monitoring and research data for the ambition to integrate smart energy management, as well as an interesting case of how the large charging powers can best be connected to the grid. |

# Table of Contents

# List of Figures



# List of Tables

# List of Abbreviations and Acronyms

| Abbreviation | Definition |
|---|---|
| CIP | City Innovation Platform |
| DoA | Description of Action |
| DSO | Distribution System Operator |
| EMS | Energy Management System |
| EU | European Union |
| EV | Electric Vehicle |
| FC | Follower City |
| IS | Integrated Solution |
| KPI | Key Performance Indicator |
| LH | Lighthouse |
| LHCSM | Lighthouse City Site Manager |
| MaaS | Mobility as a Service |
| PoR | Programme of Requirements |
| PV | Photovoltaic |
| RES | Renewable Energy Sources |
| TSO | Transmission System Operator, trusted with transmission of energy on national / regional level. In the Netherlands this is TenneT. |
| TT | Transition Track(s) |
| V2G | Vehicle-to-Grid |
| WP | Work Package |

# 1 Introduction

This deliverable aims to describe the progress in T5.5: Smart e-mobility.

The demonstration area for all the five transition tracks in Utrecht is situated in the district of Kanaleneiland-Zuid and the neighbouring area Westraven. The district is a densely populated multi-cultural district, characterized by social housing, schools and shops and a majority of households with a low income.

## 1.1 Scope, objectives and expected impact

The objective of this deliverable is to provide an overview of the work done, the plans for further implementation, updates to the planning and lessons learned so far, for the Transition Track #3: Smart e-mobility within the Utrecht Lighthouse of IRIS.

Utrecht is a frontrunner in e-mobility. Building upon this experience, a district wide V2G e-car sharing system has begun realisation, offering zero emission mobility, decreasing household mobility costs, mostly powered by the sun. The rate of implementation is demand dependent, which enables learning experience about actual demand and business models to be used. The car sharing system is integrated with smart solar charging, using V2G charging systems that can load and unload the solar power stored in V2G batteries. As a result, the e-cars are mostly solar powered, grid stress is reduced thanks to the V2G storage, local air quality is improved, and children get more room to play since less parking space is needed. We Drive Solar, partner of LomboXnet, is the provider of the Smart Solar Charging system, developed with Stedin in the preceding research pilot in the Lombok district in Utrecht (2012-2015).

The main demonstration activities in this task will focus on the V2G e-car sharing system 'We Drive Solar', consisting of 14 shared V2G e-cars (specially prepared Renault ZOEs) plus 4 smart charged maintenance e-vans, along with 143 e-buses for public transport in the city/region. Furthermore, an analysis will be conducted on how citizens actually use the smart solar powered e-car sharing system 'We Drive Solar' and testing and co-creation of IT interfaces and apps motivating citizens to change their mobility patterns, adopting the mobility provided by the district wide V2G e-cars sharing system.

The IRIS demonstrator has contributed considerably to the large step that was made in the introduction of V2G-technology on the market (see 5.3.1). 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.

## 1.2 Contributions of partners

For the deployment of the V2G-cars, LomboXnet is working with IRIS project partners and subcontracted companies to deliver the services, like the subscription system, software system etc. Key partners are:

| | |
|---|---|
| LomboXnet | Coordinator |
| We Drive Solar | E-car, reservation app, subscriptions options |
| Qbuzz | Electric buses: batteries and charging |

## 1.3 Relation to other activities

The Smart e-mobility works closely together with the Smart Energy Management system and storage of TT#2 and cooperation is foreseen with the data services developed in TT#4 so that coincident charging peaks may be spread and managed. The aim is to learn about managing and aligning the demand and supply sources towards a more robust, stable solution that poses less challenges to electricity distribution and grid balancing.

The five Transition Tracks are embedded in the project as depicted in Figure 1 below.

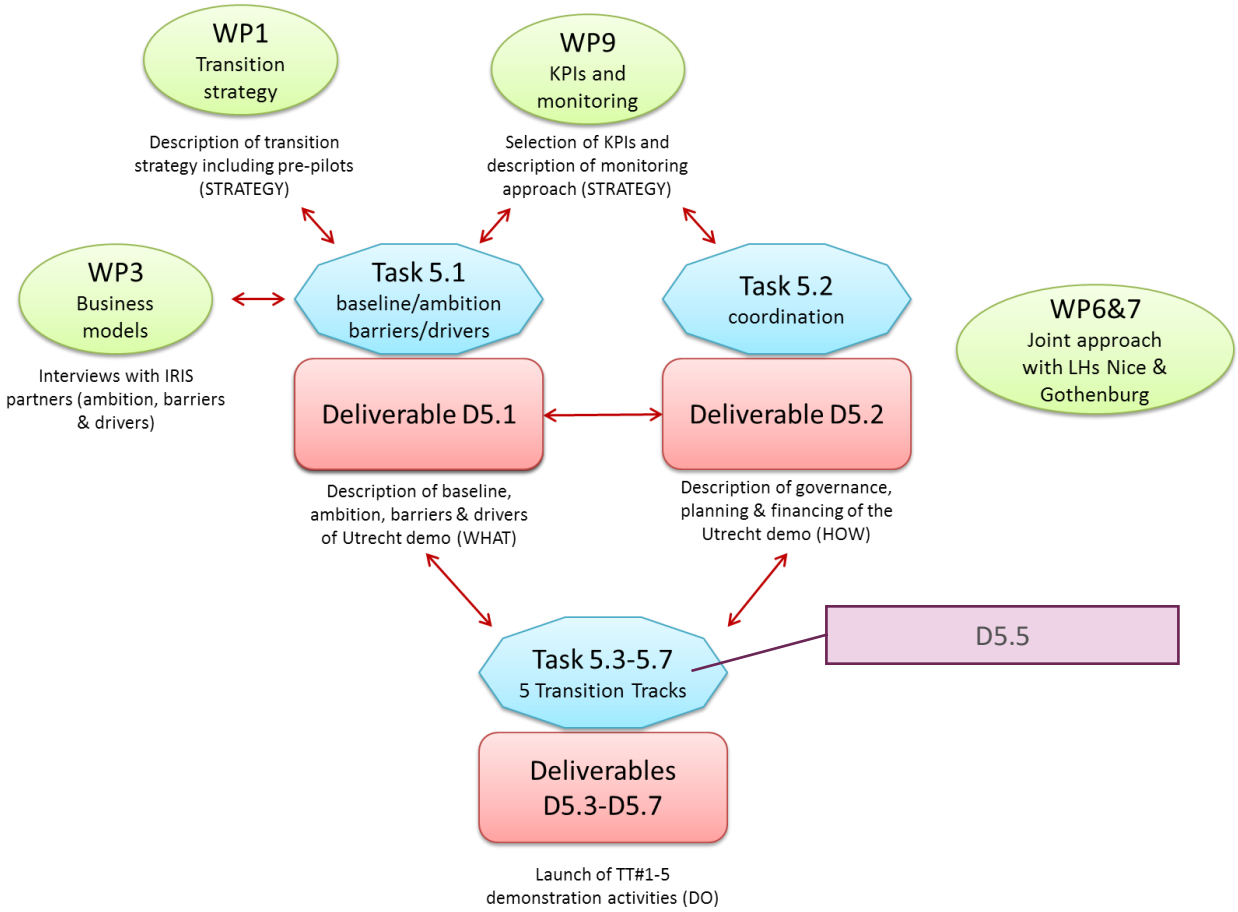



*Figure 1.Relation of this Deliverable to other activities*

## 1.4 Structure of the deliverable

In Chapter 2, the demonstration activities in TT#3 are introduced. In Chapter 3, baselines, drivers and barriers are discussed. Chapter 4 describes the organization of the work. In Chapter 5 and 6, each of the two Measures in Transition Track #3 is elaborated in more detail.

In Chapter 7, societal, user and business impacts are described. Chapter 8 deals with KPI's and their monitoring and Chapter 9 with ethics requirements such and GDPR compliance. In Chapter 10, links to other work packages are described and Chapter 11 presents conclusions and next steps to be taken.

# 2 Demonstration in a nutshell

## 2.1 Ambitions for TT#3

The DoA [1] states that Utrecht's ambition is to integrate solar powered V2G e-cars, operated in the car sharing system We Drive Solar, e-vans operated by Bo-Ex, as well as solar powered V2G e-buses in the urban mobility system for (a) local zero-emission Mobility as a Service, (b) lower household mobility costs and (c) smart energy storage in V2G batteries. Solutions developed in small-scale pre-proposal pilots in the Lombok and Central Station area will be integrated and jointly demonstrated in the demo district Kanaleneiland Zuid, and include the measures in Table 2.

*Table 2: Ambitions of TT#3 (Adapted from: D5.1)*

| Measures | | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| Measure 1: V2G e-cars | Original plan | 0 | 14 V2G e-cars We Drive Solar 4 V2G e-vans | 0 | 0 | 0 |
| | Updated plan | | 14 V2G e-cars We Drive Solar 4 smart charged e-vans | | | |
| Measure 2: V2G e-buses | Original plan | 10 V2G e-buses | 0 | 143 e-buses | 0 | 0 |
| | Updated plan | | 143 e-buses | | | |

## 2.2 Demonstration area

The demonstration area for all five transition tracks is situated in the district of Kanaleneiland-Zuid in the city of Utrecht and the neighbouring area Westraven. 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).

## 2.3 Integrated Solutions in TT#3

In TT #3 the following two Integrated Solutions are demonstrated (see DoA P122 and D5.1 p17):

- IS-3.1: Smart Solar V2G EVs charging
- IS-3.2: Innovative Mobility Services for the Citizens

Both these Integrated Solutions are implemented by means of the two Demonstrators in this TT:

- Measure 1: V2G e-cars / e-vans
- Measure 2: V2G e- buses

## 2.4 Integration of Demonstrators

The interaction between the Smart Solar Charging of EVs and the Innovative Mobility Services is that Smart Solar Charging and V2G, while providing an important part of the electric network flexibility that is managed by the Smart Energy System (TT#2), work best when the e-cars are coupled to Smart Solar Charging points (also in TT#2) whenever they are not in use. With private e-cars, that may not be possible if the charging points are public (in that case, car owners should decouple their car after charging so that other car owners can use the charging point for their cars). But with shared e-cars, MaaS and similar Innovative Mobility Services, the shared e-cars are coupled whenever not in use so that the potential for Smart Solar Charging and V2G is much higher. In TT#4, a pilot data service will be elaborated to evaluate the effects of the shared e-cars and their charging points, together with the effects of other flexibility measures, on flexibility and peak load reduction – an important KPI for TT#2.

## 2.5 Deviations according to the Grant Agreement

With respect to the Grant Agreement, the following deviations are expected:

*Measure 1: V2G e-cars / e-vans*

The number of shared V2G cars is following a demand-driven path and the interest in shared cars is below average in the social housing district concerned. Therefore, the number of e-cars stationed in the area is developing more slowly than planned and may not reach the planned 18 by 2022. As described in 7.1, the citizen engagement activities are being scaled up to generate as much interest as possible. V2G e-cars will be realised once they are available on the market (which depends on the actual production and launch of V2G Renault ZOE and/or Sono Zion cars).

The e-vans will be smart charged, but not V2G, as V2G e-vans are not expected to come on the market in the project duration.

*Measure 2: V2G e- buses*

QBuzz is expanding its e-bus fleet quickly. At this moment, already 13 e-buses are in operation in Utrecht and this number is expected to increase to 68 before September 2020. The e-buses will be operated from two premises: one in new the Westraven location just south of the IRIS district, the other in a new location which is almost directly on the other side of the Amsterdam-Rijn channel from Westraven. These locations will also harbour the main charging facilities of the buses. At the time of writing of the proposal it was thought that vehicle-to-grid e-buses would be available, but they do not yet exist. Therefore, at this time it is not foreseen to have V2G e-buses in the project. The smart bus chargers are being integrated into the smart energy system for the district and the city, and the University of Utrecht will work together with QBuzz to elaborate the business case and market opportunities for the technology.

Steep further growth of the number of e-buses is foreseen and the number of 143 e-buses in the region seems well attainable.

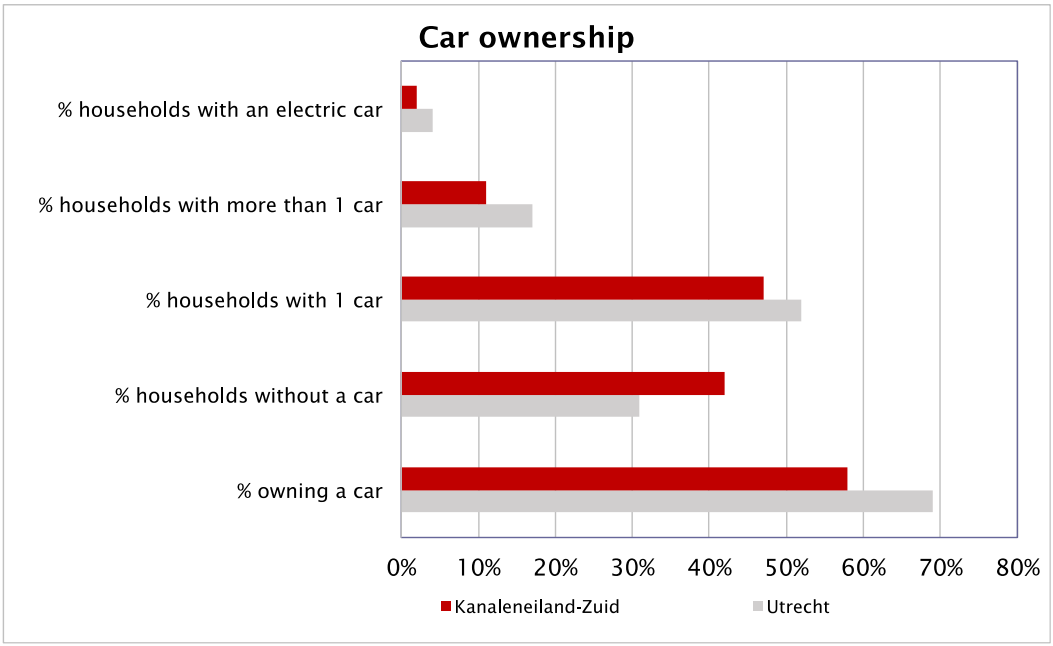
# 3 Baseline / Drivers and Barriers

## 3.1 Baseline

The district of Kanaleneiland-Zuid has a non-average profile when it comes to car ownership and choice of transport mode compared to the average for Utrecht. This is illustrated in Figure 2: car ownership is lower compared to the average for Utrecht (top) and use of tram and bus to visit the city centre is higher compared to the average for Utrecht (bottom).

Figure 3 provides an overview of the number of cars available through various carsharing platforms active in the city of Utrecht, at the start of the project. The left picture provides the location of cars available for sharing in Kanaleneiland Zuid and the picture on the right the number of cars available for sharing in various districts in Utrecht. The figure shows that carsharing is less developed in Kanaleneiland-Zuid compared to other districts in the city of Utrecht.

At the start of the project, no shared e-cars were present in the project district; this is the baseline.



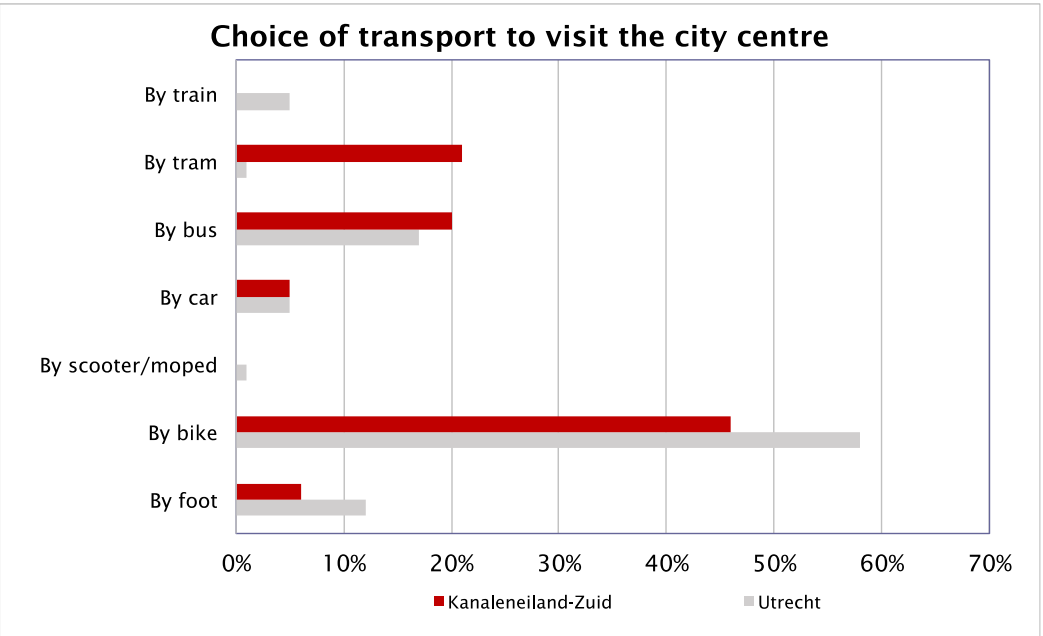




*Figure 2. Car ownership (top) and choice of public transport to the city centre (bottom) for the residents of Kanaleneiland Zuid compared to Utrecht. Source: WistUData*, D5.1

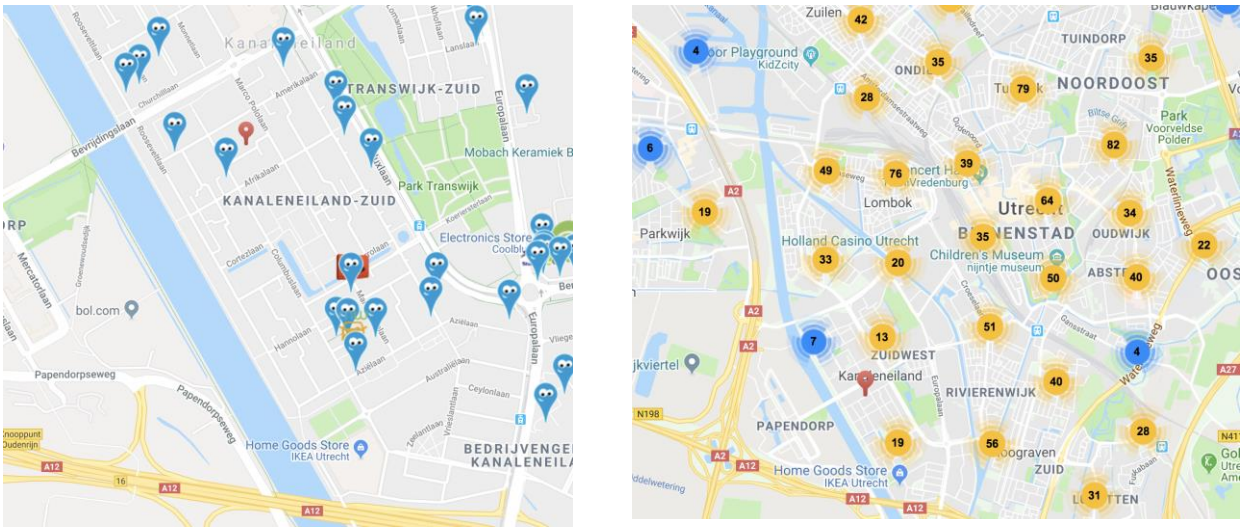



*Figure 3. Available cars through various car sharing platform in Kanaleneiland Zuid (left) and in the city of Utrecht (right). Source: [5]*

## 3.2 Drivers and Barriers

The drivers and barriers for TT#3 identified in D5.1 (see D5.1, pp. 47-49) are given in boxes below and reviewed below the boxes:

Environmental

In case an electric car replaces a fossil fuel driven car, this leads to reduction of the CO2 emissions, improvement of local air quality and reduction of noise levels.

Political

Besides contributing to the ambitions of the municipality of Utrecht to become climate neutral in 2020 (see TT#2), car sharing reduces the number of cars parked in public space. The city of Utrecht has the ambitions to grow to 430.000 inhabitants in 2040 (an increase with 80.000). Large part of this growth needs to be accommodated within the current city boundaries. This will be realised through more compact building (increase in the number of homes per km2) and at the same time creating an attractive green and healthy environment. Therefore, the city council has the objective to create low-traffic areas amongst others by stimulating car sharing.

Economic

By using the EV Batteries in the energy system an extra business model may be added to the cars, in the form of price bonuses compared to classic EV charging tariffs. At this moment, this business model is in its pilot phase; several aspects are under investigation.

These drivers have further intensified. Stedin and the municipality are setting up a city-wide experiment with variable electricity network tariffs for smart EV charging, in order to explore the business model mentioned.

Sociological

The main challenge is to stimulate citizens in the demonstration and change their habits of using private cars and subscribe to the We Drive Solar car sharing system instead. The population in the pre-pilot area is highly educated, environmentally aware and has above average income. While in the demonstration the population has a relatively low education, income levels are below average and people are less environmentally aware.

This social barrier is becoming increasingly clear, also from the citizen research presented below. The multicultural, low income population has less intrinsic motivation to use e-car sharing systems than some other groups. Also, because the citizens often maintain their cars themselves at low costs, the financial incentive for car sharing is absent.

Technological

Technical barriers are not anticipated because the technology applied in the demonstration area is already applied in another district in Utrecht.

Legal

The city of Utrecht incentivizes the use of car sharing systems. The municipality e.g. provides incentives to apply for a double-parking license in districts with paid parking for one car for households sharing the car in adjacent districts (so that the shared car may be parked in both parking districts of the shared owners). New construction districts in Utrecht have a high density. In these districts the municipality applies lower parking norm (parking-space that needs to be reserved per dwelling) and actively stimulated the development of MaaS concepts.

The legal driver mentioned above will have less effect in the IRIS demonstration area than in some other districts because there are little new building construction activities, there is no paid parking in the district, and there are only few households have second cars (replacing a second car by a shared car is a common way for households to enter car sharing systems – and often enough, over time the first car may also be replaced by the car sharing system).

# 4 Organisation of work

For the deployment of the V2G-cars, LomboXnet will work with IRIS project partners and will subcontract companies that can deliver the services needed, like the subscription system, software system etc. Key partners in TT#3 are:

| | |
|---|---|
| LomboXnet | Coordinator |
| We Drive Solar | E-car, reservation app, subscriptions options |
| Jedlix | Charging point aggregator. |
| Last mile solutions | Back-office Smart charging |
| Qbuzz | Electric busses: batteries and charging |
| Bo-Ex | Operation of e-vans |

The work is organised as part of WP5, in collaboration with the other Transition Tracks.

# 5 Measure 1: V2G e-cars

## 5.1 Specifications

### 5.1.1 Hardware

The MaaS "We Drive Solar" car sharing system will be demonstrated in the LH demo district by means of 14 solar powered e-cars delivered by Renault. The subscription models currently offered in amongst others the Lombok area will be applied for the rollout of the system in Kanaleneiland-Zuid. This roll-out is demand driven, implying that introduction will follow a phased approach with more cars being added once demand is established for the first ones. The first car will be placed at the local innovation hub Krachtstation. Together with local partners citizen engagement activities will be organised to investigate demand for car sharing services.

| Main component | Technical specification |
|---|---|
| **V2G e-cars** | • Renault Zoe by We Drive Solar MaaS<br>• Range up to 395 km<br>• 22 kW fast AC charging, later in project V2G bidirectional charging once available |

Also, Bo-Ex will procure 4 e-vans to replace its existing vans for maintenance and service use. V2G e-vans are not expected on the market in the project.

| Main component | Technical specification |
|---|---|
| **e-vans** | • Renault Kangoo Z.E. Maxi<br>• Range up to 200 km<br>• 44 kW motor |

### 5.1.2 Software

The V2G cars will have ISO15118 compatible car battery management software. Customers can book the cars and manage their bookings in the We Drive Solar / Goodmoovs app.

| Main component | Technical specification |
|---|---|
| **Operating software and booking app** | • ISO 15118 compatible V2G car battery management software developed within the Smart Solar Charging partnership<br>• We Drive Solar / Goodmoovs booking app which provides user friendly facilities for choosing one of the available cars, booking and managing bookings. |

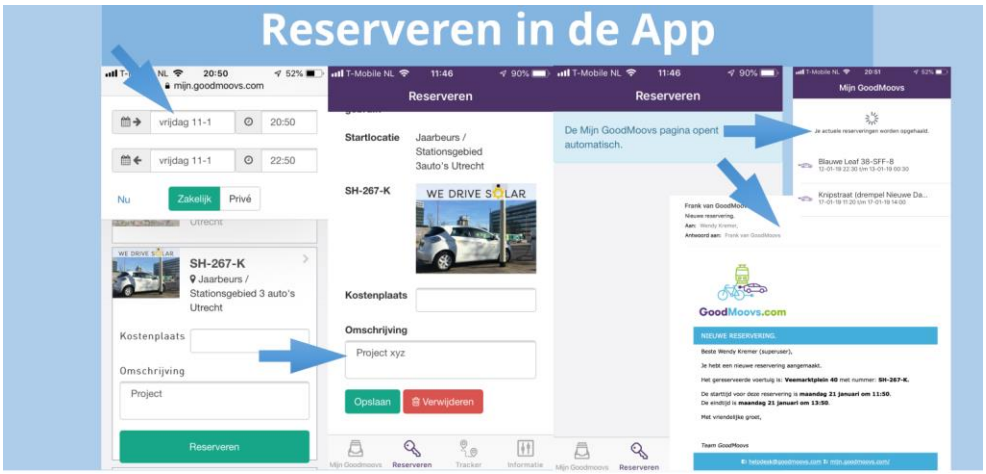



*Figure 4: Screenshots of the We Drive Solar / Goodmoovs e-car reservation and management app: reserving a shared car*

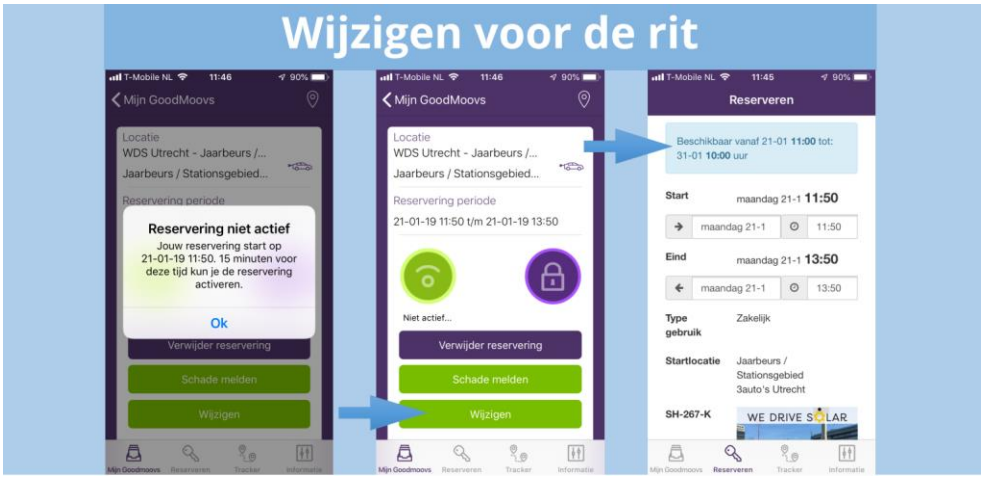



*Figure 5: Screenshots of the We Drive Solar / Goodmoovs e-car reservation and management app: editing a reservation*


*Figure 6: Screenshots of the We Drive Solar / Goodmoovs e-car reservation and management app: picking up the car, checking for new damage, using the digital key*

### 5.1.3 Procurement of equipment and/or services

The e-cars are procured and operated by We Drive Solar, a partner company of LomboXnet.

The e-vans will be procured and operated by Bo-Ex.

## 5.2 Societal, user and business aspects

These are discussed on Transition Track level in Chapter 7.

## 5.3 Impact Assessment

### 5.3.1 Expected impact

*City-wide innovation, smart energy management and smart mobility*

The IRIS Utrecht demonstration 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. The V2G e-car charging points and smart shared electric vehicles in the IRIS demonstration area are an important step but, in the meanwhile, LomboXnet is rolling out the technology in the whole city and even in the region around Utrecht city. 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 open standard for V2G charging was launched by ElaadNL and the Open Charge Alliance. In November 2019, LomboXnet has installed 50 V2G charging points in the city of Utrecht. By April 2020, that number will have grown to 150 V2G charging points throughout the city. Similarly, over 50 smart charging shared e-cars are presently in operation in 10 of the 12 districts of the City of Utrecht and an additional 10 in the region, a number that is also expected to grow to 150 in 2020.

The IRIS demonstrator has contributed considerably to the large step that was made in the introduction of V2G-technology on the market. IRIS funding and the demonstrator have caused Renault to speed up the development of AC V2G technology based on the new open standard ISO 15118 and in 2022, V2G Renault ZOE e-cars according to the standard are expected on the market. Also, the Sono Motors company has committed to the standard and will introduce ISO 15118 compatible V2G-cars, three other car manufacturers (OEMs) are considering following the open standard, and Enedis, the network manager in France, will embrace the AC-V2G technology.

Bundling 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. With smart grids, MaaS (Mobility as a Service) and smart energy management, the laws of large numbers favour cooperation on a larger scale than one district. A recent change in regulations now makes it possible for a network aggregator to operate a group of V2G e-cars as one ‘virtual battery’ to deliver flexibility to the TSO (Transmission System Operator, in the Netherlands this is TenneT). A larger network will have more options to virtually group V2G-cars that are connected to charging points at a certain moment in time into such a ‘virtual battery’, and to deliver different kinds of flexibility. This is elaborated in more detail in TT#4.

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. Utrecht has participated in the EVS32 event in Lyon where main sponsor Renault will launch the large-scale introduction of V2G.

The shared e-cars will provide a green alternative mode of transport for the IRIS district residence, reducing NOx, fine particulate matter, carbon monoxide and carbon dioxide emissions. At the same time their batteries contribute to smart energy management, combining sustainable transport with maximising self-consumption and reducing grid stress, and unlocking the financial value of grid flexibility. This is necessary infrastructure to demonstrate in the selected demonstration areas the opportunities for flexibility creation through district scale storage, combining the batteries from V2G e-cars and e-buses with stationary batteries, supported by open ICT for interconnection, performance monitoring and new information services for aggregators, grid operators, municipality and citizens.


*Figure 7: Opening of the 'City-wide bi-directional Ecosystem' in Utrecht by Willem-Alexander, King of the Netherlands, a member of Groupe Renault's Executive Committee and EVP Design Groupe Renault.*

### 5.3.2 KPIs

This measure contributes to the following KPI's of TT#3:

*Table 3. Summary-list of KPIs and related parameters for Measure 1*

| KPI | Parameter(s) | Baseline | Target (as described in DoW or declared) |
|---|---|---|---|
| 1. NOx emission | Car km counter or LomboXnet monitoring system | same amount of km/year driven by comparable fossil fuel cars | 1 ton in 5 years |
| 2. Fine particulate matter emission | Car km counter or LomboXnet monitoring system | same amount of km/year driven by comparable fossil fuel cars | 0,02 ton in 5 years |
| 3. Carbon monoxide emission reduction | Car km counter or LomboXnet monitoring system | same amount of km/year driven by comparable fossil fuel cars | 3 ton in 5 years |
| 4. Carbon dioxide Emission Reduction | Car km counter or LomboXnet monitoring system | same amount of km/year driven by comparable fossil fuel cars | 308 ton in 5 years |
| 5. Access to vehicle sharing solutions for city travel | Number of vehicles available for sharing per 100.000 inhabitants | nr of shared cars at start of project | 18 cars |
| 6. Yearly km driven in e-car sharing system | Number of kilometres done by the car-sharing fleet | same amount of km by shared cars at present | 270,000 km per year |

### 5.3.3 Monitoring plan

LomboXnet is monitoring the driven km by all e-cars as part of their monitoring system, as well as the number of shared e-cars in the district. For calculation of the emission reductions, the same conversion factors will be used as those used in the DoA. Project partner Civity has a data connection to the car sharing system that will enable it to transfer driven km data for KPI evaluation. This will be implemented in the year 2020.

## 5.4 Commissioning Plan

The e-cars are procured from Renault by LomboXnet and its partner We Drive Solar. LomboXnet actively participates in the development of IEC15118-compliant V2G Renault cars and the IRIS project is one of the living labs to obtain practical experience with these cars. LomboXnet / We Drive Solar are already exploiting some 60 of these Renault ZOE cars.

| Phase | Activity | Parties involved | Responsibility | Relevant standard |
|---|---|---|---|---|
| **1 Design** | Design of V2G Renault ZOE | LomboXnet, Groupe Renault | Groupe Renault | ISO 15118 |
| **2 Engineering** | Engineering V2G Renault ZOE | LomboXnet, Groupe Renault | Groupe Renault | ISO 15118 |
| **3 Contracting** | Contracting | LomboXnet | LomboXnet | ISO 15118 |
| **4 Realization** | Realisation | LomboXnet | LomboXnet | ISO 15118 |
| **5 Testing** | Testing | LomboXnet, Groupe Renault | Groupe Renault | ISO 15118 |
| **6 Completion** | Completion | LomboXnet, Groupe Renault | LomboXnet, Groupe Renault | ISO 15118 |

The e-vans will be commissioned by Bo-Ex:

| Phase | Activity | Parties involved | Responsibility | Relevant standard |
|---|---|---|---|---|
| **1 Design** | Design of e-van Renault KANGOO | Groupe Renault | Groupe Renault | |
| **2 Engineering** | Engineering e-van Renault KANGOO | Groupe Renault | Groupe Renault | |
| **3 Contracting** | Contracting | Bo-Ex, Groupe Renault | Bo-Ex | |
| **4 Realization** | Realisation | Bo-Ex, Groupe Renault | Bo-Ex | |
| **5 Testing** | Testing | Bo-Ex, Groupe Renault | Bo-Ex | |
| **6 Completion** | Completion | Bo-Ex, Groupe Renault | Bo-Ex | |

## 5.5 Implementation plan

### *5.5.1 Planning of activities*

In 2019, one shared e-car was placed as a pilot for investigating demand. Further cars will be installed following actual demand. The demand for the shared e-cars is being actively stimulated with various actions (see 7.1). in 2020 Bo-Ex will purchase the first two e-vans.

At present these cars are not yet V2G, but ISO 15118 compatible V2G e-cars will be added to the project / replace the existing e-cars after they become available on the market (expected 2022). LomboXnet actively participates in the development of IEC15118-compliant V2G Renault cars and the IRIS project is

one of the living labs to obtain practical experience with these cars. When V2G-cars come on the market, these will also be applied in the IRIS area.

### 5.5.2 Planning of costs and (equipment) investments

Regarding costs and investments, the following conditions are applicable:

- The main order for the contractor is assigned after sufficient demand has been observed.
- The purchase order from the contractor to the supplier is assigned shortly after the main order to the contractor.

### 5.5.3 Risk management

In the Project Team and WP5 Coordination Team meetings, risks and their management are regularly discussed. D5.2 lists the following risks related to this measure:

| | | |
|---|---|---|
| TT#3 | 1. No interest in demonstration area Kanaleneiland-Zuid for the MaaS We Drive Solar | 1. Communication and engagement of citizens in TT#5 activities.<br>Start introduction of MaaS at location where people are interested. And use the first MaaS-users as ambassadors. |
| | 2. People find it difficult to operate the technology used for MaaS (booking app and V2G-charger), due to language barriers, low education level | 2. Perform a test with the target audience aimed at gaining insight in the usability of the current technology.<br>Change the technology where possible or provide instruction (courses). |

The first risk is being addressed by several communication and citizen engagement measures. From first market research, interest for the MaaS indeed seems limited. Further actions are being taken to research the barriers and increase citizen engagement, see section 7.1.

### 5.5.4 Progress achieved up to M24

In 2019, one shared e-car has started operations. The business model is in its testing / demonstration phase, as will be elaborated in chapter 7.2. The above risks are showing, as demand in the district up to now has not been such that the expected growth is taking place. An initiative is being planned to involve local entrepreneurs to use the shared e-cars and thus serve as an example to the citizens. and two e-vans procured.

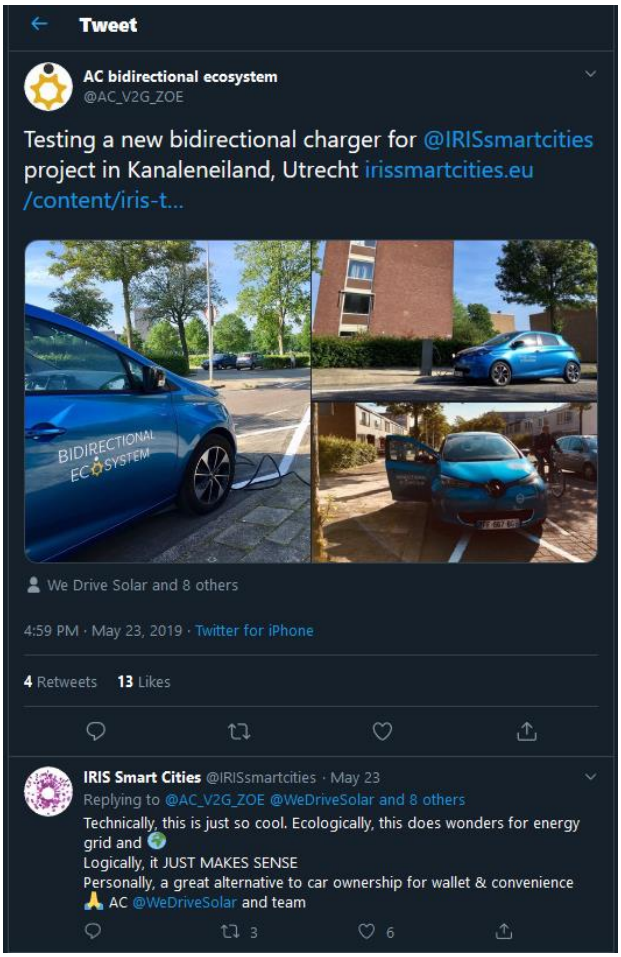



*Figure 8: LomboXnet actively contributes from IRIS to the development and testing of the V2G Renault ZOE, and communicates these contributions on Twitter.*

## 5.6 Conclusion

The realisation of V2G e-cars is progressing with one shared e-car realised and two e-vans being procured, but the demand-following approach is posing a risk to reaching the planned number. Demand stimulation measures are being taken to minimise that risk.

# 6 Measure 2: V2G e-buses

## 6.1 Specifications

### 6.1.1 Hardware

IRIS partner QBuzz is relocating its bus depot from the Europalaan in Utrecht to Westraven, a district just south of the IRIS district in Kanaleneiland-Zuid, and at the Remiseweg, across the Amsterdam-Rijn channel from Westraven. Smart charging of the buses will be tested, but V2G e-buses and chargers are not available. QBuzz will investigate the options for V2G charging at its new bus-depot with the objective to demonstrate and optimize smart charging. At this moment, 13 e-buses are in operation by QBuzz and by summer 2020, this number is expected to have grown to 68. Actual implementation of 68 e-buses on city level is now planned for 2020 and on regional level, as the province of Utrecht is working on emission free transport by 2028, the upscaling to 143 e-buses is well underway [7].

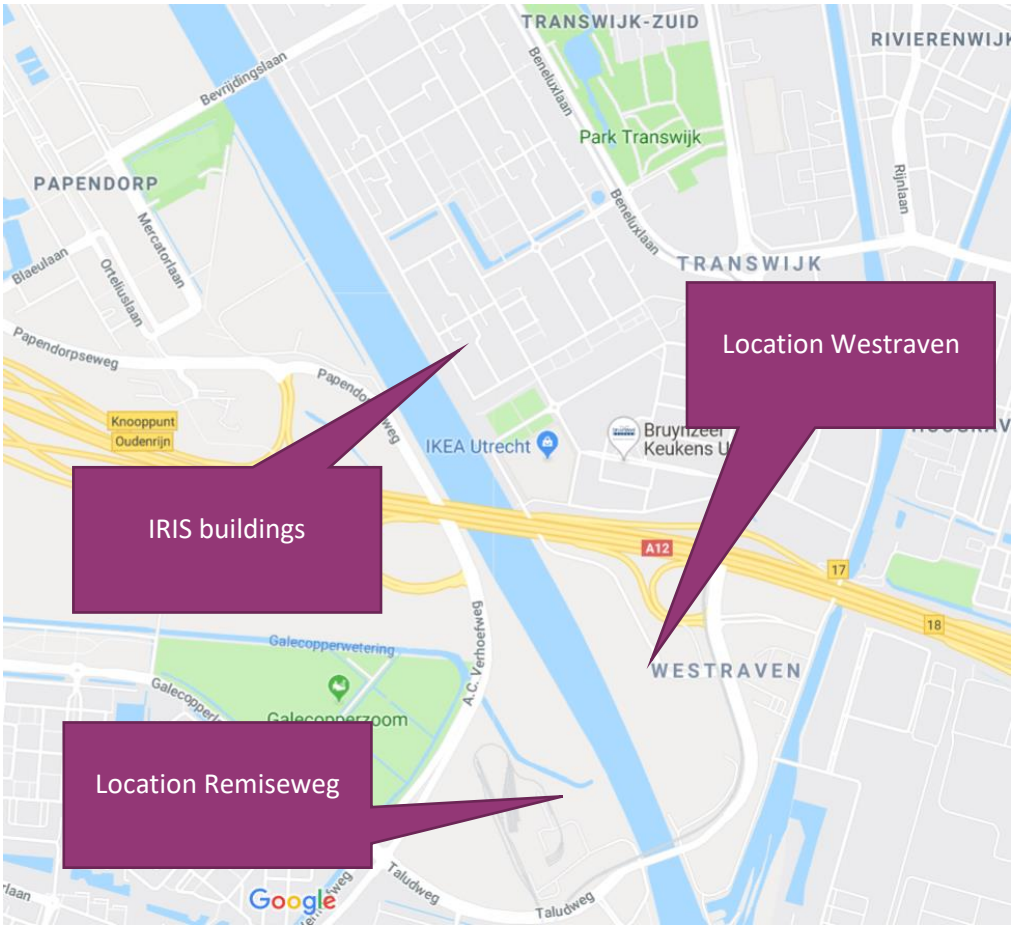



*Figure 9: New e-bus charging locations of QBuzz*

| Main component | Technical specification |
|---|---|
| **Qbuzz: electric busses: batteries and charging** | • Bus length: 12 meters or 18 meters<br>• Bus width: 2.55 meters<br>• Battery capacity: 250kW, 362 kWh depending on type<br>• Fast charging power: 450 kW<br>• Continuous recharging 10 to 100 kW, OCPP 1.6 protocol |

### 6.1.2 Software

The buses feature detailed monitoring and data storage equipment based on the Vericiti platform [6], which monitors in the buses and in the chargers many parameters including voltage, currents, state of charge, energy charged, accelerator usage and other parameters. QBuzz has appointed a Data Scientist to analyse the data being generated and started a research cooperation project with Universiteit Utrecht, LomboXnet and USI to research the business case of V2G-buses and chargers. This will be described under 6.5.1.

### 6.1.3 Procurement of equipment and/or services

QBuzz has procured the buses itself and is realising the charging locations under own direction. The IRIS contribution is the coupling to district transition and the monitoring and research actions.

## 6.2 Societal, user and business aspects

These are discussed on Transition Track level in Chapter 7.

## 6.3 Impact Assessment

### 6.3.1 Expected impact

The bus company QBuzz is currently exploiting 13 e-buses in the city with two charging / fast charging locations; by summer 2020, 55 additional e-buses will be in operation, plus two new large depots with in total 68 bus charging stations. The buses provide their services to the whole city; the charging stations at the bus depots will have their own medium-voltage connections and thus also act on city level rather than district level.

The e-buses and charging stations will provide large amounts of monitoring and research data for the ambition to integrate smart energy management, as well as an interesting case of how the high charging powers can best be connected to the grid.

A cooperation is being set up between QBuzz, Utrecht University, USI and LomboXnet to start to analyse the available data towards answering a number of research questions related to flexibility. These will be described below under 6.5.1.

### 6.3.2 KPIs

In the GA, the following KPI's are given:

| KPI | Parameter(s) | Baseline | Target (as described in DoW or declared) |
|---|---|---|---|
| 1. NOx emission | E-bus km counter or Vericiti monitoring system | same amount of km/year driven by comparable fossil fuel E-buses | 22 ton in 5 years |
| 2. Fine particulate matter emission | E-bus km counter or Vericiti monitoring system | same amount of km/year driven by comparable fossil fuel E-buses | 0,26 ton in 5 years |
| 3. Carbon monoxide emission reduction | E-bus km counter or Vericiti monitoring system | same amount of km/year driven by comparable fossil fuel E-buses | 1,6 ton in 5 years |
| 4. Carbon dioxide Emission Reduction | E-bus km counter or Vericiti monitoring system | same amount of km/year driven by comparable fossil fuel E-buses | 4785 ton in 5 years |

### 6.3.3 Monitoring plan

The buses feature detailed monitoring and data storage equipment based on the Vericiti platform, which continually monitors many parameters including voltage, currents, state of charge, accelerator usage and others. QBuzz has appointed a Data Scientist to analyse the data being generated.

QBuzz will cooperate with Utrecht University, USI and LomboXnet to research the data thus obtained and investigate the options and business case for V2G e-buses, see 6.5.1.

## 6.4 Commissioning Plan

QBuzz is procuring the e-buses and charging points at own costs (not in project budget).

## 6.5 Implementation plan

### 6.5.1 Planning of activities

At this time, the two e-bus charging locations are being designed and realized under direction of QBuzz. At this moment, 13 e-buses are in operation by QBuzz and by summer 2020, this number is expected to have grown to 68; QBuzz is procuring these e-buses.

A research program has started in which QBuzz, Utrecht University (Copernicus Institute), USI and LomboXnet are cooperating in order to answer the following research questions:

1. What is the value of smart charging and V2G of e-buses in relation to electricity and network tariffs, is there a business case?
2. How does this value compare to a risk of an e-bus not able to complete its schedule, or the risk of no local sustainable electricity being available?
3. Can the availability of e-buses for smart charging be predicted, for instance as function of air temperature or battery degradation?
4. Can battery degradation be predicted, possibly as a function of seasonal influences, driving behaviour and other factors?
5. What is the impact of e-buses on the electricity grid (medium voltage level, congestion)?
6. What is the impact of e-buses on the IRIS district (houses, heat pumps, PV, shared cars) energy system?

These questions will be addressed in the next two years as an additional action in the IRIS project (first activities have started in autumn 2019) by UU students under coaching of scientists and using the district electricity system simulation model available at UU.

### 6.5.2 Planning of costs and (equipment) investments

Regarding costs and investments, the following condition is applicable:

- The main order for the contractor is assigned after sufficient demand has been observed.

### 6.5.3 Risk management

In the Project Team and WP5 Coordination Team meetings, risks and their management are regularly discussed.

D5.2 does not list any risks specific for this measure. While the buses will not actually be smart-charged, the data that QBuzz is gathering them will provide an excellent basis for the above-mentioned research on opportunities for smart charging and flexibility on a higher level (medium voltage network, city level), together with the 150 Smart Solar Charging stations that are being placed throughout the city of Utrecht by LomboXnet.

### 6.5.4 Progress achieved up to M24

At this moment, 13 e-buses are in operation by QBuzz in Utrecht and by summer 2020, this number is expected to have grown to 68.

## 6.6 Conclusion

The implementation of this measure ensures a good basis for quantitative research on the value of flexibility provided by e-buses and e-cars on city level.

# 7 Societal, user and business aspects

As these aspects are best discussed on Transition Track level, they have been placed in this separate chapter.

## 7.1 Citizen engagement

The citizen engagement activities in TT#2 and TT#3 are interconnected and are presented in combination here.

In March 2019, LomboXnet / We Drive Solar, civil energy co-operation Energie-U and the municipality of Utrecht have conducted an information session for citizens and local entrepreneurs on attitude towards and demand for electric shared cars. Promotion was done using flyers, posters and social media. Research and consulting company Labyrinth has in 2019 conducted a research action to gain more insight amongst the inhabitants of the Kanaleneiland district in the demand for shared mobility. The work was based on the above meeting and street interviews. 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, the wish to choose the brand and fear that sharing cars with unknown others might cause conflicts.

Based on this research, a communication calendar for further citizen engagement was drawn up.

Another goal of the work of Labyrinth was to find central key persons who could help to approach other citizens. This turned out to be hard to realise, owing to the observations that many residents are in a constant struggle with regard to health, food security and safety. For instance, an important issue found was litter on the streets because that could evoke rat plagues.

Therefore, another action was taken to also involve the entrepreneurs in the district: an application was submitted to the local Entrepreneurs Fund to support a free trial period for entrepreneurs to use the electric shared cars. This application is still under consideration and could stimulate local entrepreneurs to start using the shared electric cars.

## 7.2 Business model

At this point, the business model of the shared e-cars is in a demonstration phase. 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. Public incentives are in most cases necessary for the extra costs compared to shared fossil cars to be covered – but the public demand is growing in cities with mobility-

related issues. Also there is a market demand, which means that in the Utrecht region the number of shared e-cars is growing. In the IRIS area, as described above, demand is lower because of the demographics in this district. The municipality of Utrecht plays an important role with its current project to place 150 smart charging stations throughout the city, based on local demand and the expected steep growth of the number of electric vehicles in the city.

In the meanwhile, LomboXnet is exploring business models based on the multiple values that can be created by car sharing systems and smart charging infrastructure in large new housing development projects that take place under stringent mobility and environmental boundary conditions. First experiences from the citizen engagement activities and research described above indicated a limited interest amongst the inhabitants of social housing districts such as the IRIS district, which however might be turned around if addressed properly.

The business case for smart charging of electric vehicles is still under development.

The business case of e-buses is strongly driven by municipal concessions and policies. As described above, QBuzz is very rapidly expanding its e-bus fleet in Utrecht. QBuzz is intent on winning the next concession which will be tendered in 2022/2023 and further expand the e-bus fleet and services. The business case for smart charging of e-buses is still very unclear at this time; no products are available on the market. As described in 6.5.1, an additional research action on the business case for charge charging of the e-buses has started.

## 7.3 Governance

While LomboXnet started as an exploiter of smart e-car charging stations and shared electric cars, its Smart Solar Charging approach couples this to domestic energy use and local sustainable energy production, which turns it into a new form of sustainable energy service provider. LomboXnet's network partnership includes network operator Stedin, car manufacturer Renault, mobility service provider Jedlix, e-car leasing companies and research bodies and thus provides a broad expertise base for developing this new combined market.

The municipality of Utrecht as a very active, stimulating partner ensures public support while the commitment of housing association Bo-Ex ensures the practical execution in such a way that the tenant interests are safeguarded.

# 8 Summary on monitoring of KPIs

## 8.1 Expected impact

The IRIS Utrecht demonstration 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. Over 50 smart charging shared e-cars are presently in operation in the City of Utrecht and an additional 10 in the region. The IRIS demonstrator has contributed considerably to the large step that was made in the introduction of V2G-technology on the market. Renault has sped up the development of AC V2G technology based on the new open standard IEC 15118 and other car manufacturers are developing compatible products. A larger network will have more options to virtually group V2G-cars that are connected to charging points at a certain moment in time into such a 'virtual battery', and to deliver different kinds of flexibility.

Similarly, the bus company QBuzz is currently exploiting 13 e-buses in the city with two charging / fast charging locations; by summer 2020, 55 additional e-buses will be in operation, plus two new large depots with in total 68 bus charging stations.

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. As the batteries in about 8,500 e-cars have enough capacity to power all houses in the city of Utrecht, the Smart Solar Charging 'city-wide bidirectional eco-system' can quickly become a significant factor in the energy network management of Utrecht.

## 8.2 Aggregation of KPIs for each LH city

Each LH city has its own set of KPIs that can be related to the IRIS KPI house; the top level of the house containing the IRIS level KPIs (IL) is however the same for all cities. On solution level (STT1-5), the KPIs may vary between the cities since different solutions are implemented in each city and the cities have different objectives, but in many cases the same KPIs can be found in all cities, thus allowing comparison between the Transition Tracks of the cities. For some Transition Tracks the evaluation of integrated solutions cannot be separated and the KPIs are hence calculated at Transition Track level (TT1-5). The KPIs for each transition track and possibilities to aggregate them are presented in Table 4.

The KPIs for TT#3 are defined on TT level:

1. NOx emission
2. Fine particulate matter emission
3. Carbon monoxide emission reduction
4. Carbon dioxide Emission Reduction
5. Access to vehicle sharing solutions for city travel
6. Yearly km driven in e-car sharing system

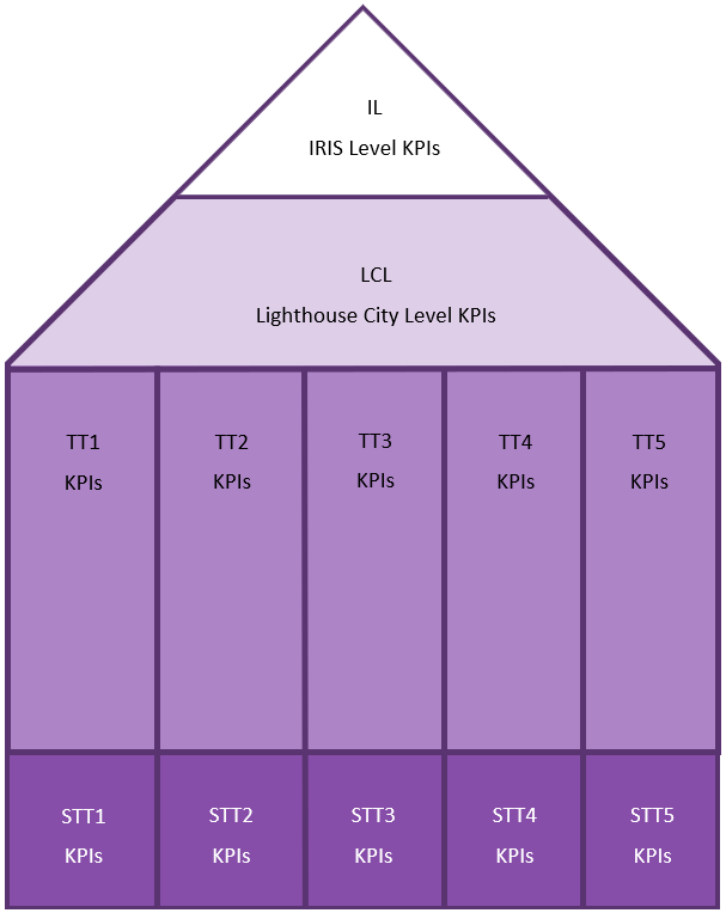



*Figure 10 IRIS KPI-house. The KPIs presented in Tables 4-6 are, if possible, aggregated to transition track level (TT1-5) or higher.*

### 8.2.1 Utrecht / Nice / Gothenburg

In the below table, for each KPI a position in the KPI-house is proposed.

*Table 4. Relation and possible aggregation of KPIs to solutions and the IRIS KPI-house in Figure 10.*

| KPIs | Solution | Proposed position in IRIS KPI-house |
|---|---|---|
| **1. NOx emission** | Car/bus km counter or LomboXnet / Vericit monitoring system | **TT#3** |
| **2. Fine particulate matter emission** | Car/bus km counter or LomboXnet / Vericit monitoring system | **TT#3** |
| **3. Carbon monoxide emission reduction** | Car/bus km counter or LomboXnet / Vericit monitoring system | **TT#3** |
| **4. Carbon dioxide Emission Reduction** | Car/bus km counter or LomboXnet / Vericit monitoring system | **TT#3** |

| | | |
|---|---|---|
| **5. Access to vehicle sharing solutions for city travel** | Number of vehicles | **TT#3** |
| **6. Yearly km driven in e-car sharing system** | Number of kilometres done by the e-cars | **TT#3** |

# 9 Ethics requirements

## 9.1 GDPR compliance

The overall Data Protection officer (DPO) of LomboXnet is mr. Robin Berg. Robin Berg is involved in the IRIS project in the role of Project Legal Signatory.

### *9.1.1 GDPR compliance per IRIS demonstration measure*

The following table shows the GDPR elements per measure of TT#3.

| Demonstrator | In a nutshell | |
|---|---|---|
| Measure 1: V2G E-cars | Data controller: | The V2G e-cars are operated by We Drive Solar, which is not an IRIS project partner. |
| | Personal Data: | We Drive Solar handles personal data of its customers and is GDPR compliant. This data is not used in any way in the IRIS-project of energy-management.<br>Other than this, no special actions are taken in IRIS connected to this data. |
| | High risk involved: | No |
| | DPIA: | Not applicable |
| | Informed Consent Procedure | We Drive Solar has informed consent from its customers. |
| Measure 2: V2G e-buses | Data controller: | Q-buzz operates the e-buses. |
| | Personal Data: | Q-buzz collects public transport card info and transfers it to the card service providers for handling of transport fees, without knowing the identity of the travleller or obtaining personal data.<br>Other than this, no special actions are taken in IRIS connected to this data. |
| | High risk involved: | No |
| | DPIA: | Not applicable |

| | | |
|---|---|---|
| | Informed Consent Procedure | Not applicable |

If other research methods will be used in the future of the project in which personal data is recorded or shared, DPIA and informed consent procedures will be followed.

## 9.2 Ethical aspects

No sensitive data are shared and the respective partners have stated to be GDPR compliant.

No people are excluded from the work based on ethnicity, gender, religion or similar reasons.

Persons or organisations are not exploited or exposed to unnecessary pressure – they will only be deployed in client – contractor relationships.

Care is taken that the work in this project does not lead to fear distrust or other negative outcomes.

# 10 Links to other work packages

Task 5.5 (TT#3) is mainly connected to TT#2: Smart energy management and storage for flexibility, see the figure below.

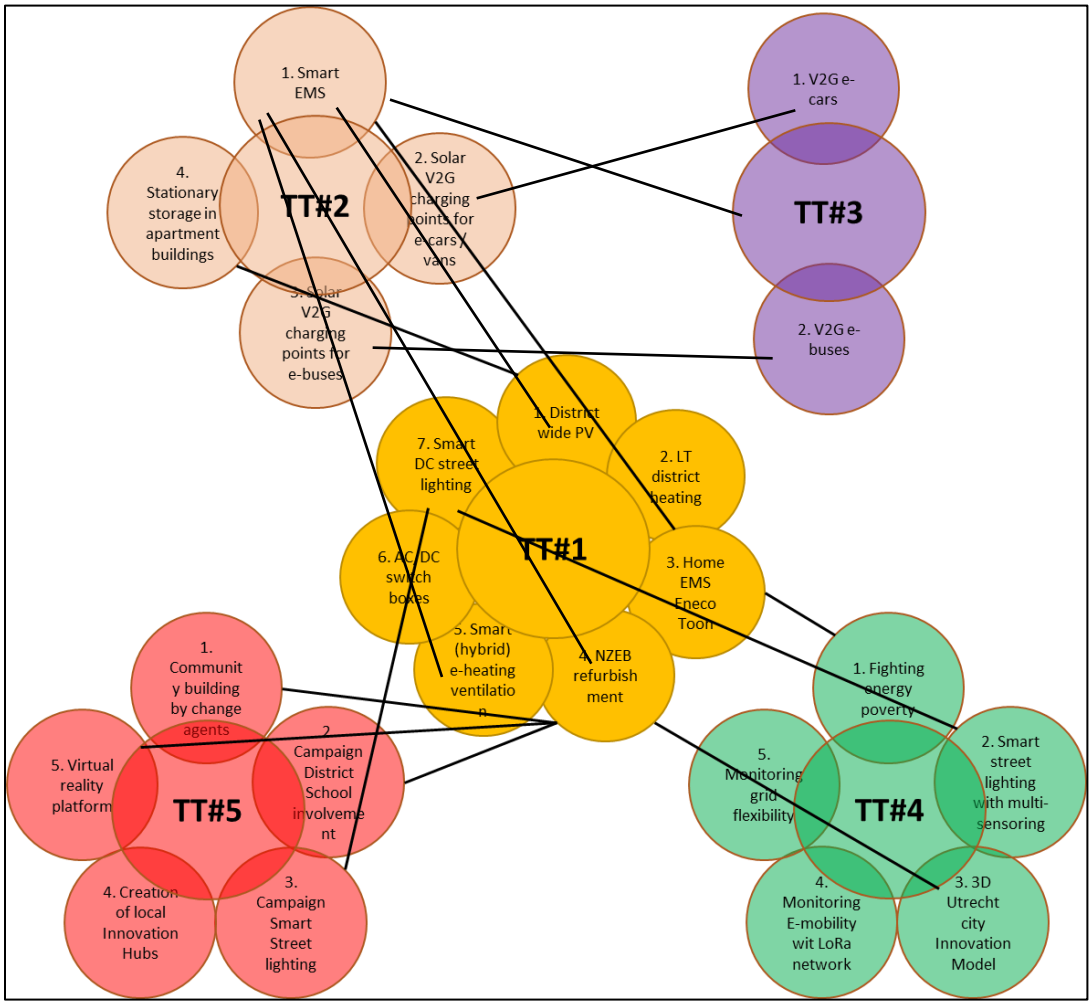



*Figure 11: relationships between the Transition Tracks in WP5.*

Especially with TT#2 the interaction is strong; this is managed by LomboXnet being the coordinator of both TT#2 and TT#3. The two TT's are being executed in close overlap with the charging hardware in TT#2 and the vehicles in TT#3.

There are number of barriers in current regulations, which are being investigated and addressed in the framework of the Innovation Deal. This important barrier for smart charging of e-cars, e-vans and e-buses has a strong connection to WP2, as European cooperation on these subjects can make an important contribution to alleviating these barriers.

The development of the business cases for the e-cars, e-vans and e-buses have a relation to WP3. Finally, there are relations to WP4 and WP9 on monitoring and KPI evaluation.

# 11 Conclusions and next steps

## 11.1 Conclusions and lessons learned

In general, activities are progressing according to plan, except that low demand for the V2G shared e-cars is starting to pose a risk that intended numbers will not be reached. There are some deviations: the demand for shared e-cars is lower than expected which may result in a lower number of shared e-cars in the district, and there are no V2G smart charging technologies for e-buses on the market yet. These are discussed in section 2.5; the overall ambitions of TT#3 of demonstrating smart e-mobility are not affected.

Important lessons learned include:

- The demand for shared vehicles in social housing segment is lower than in other segments of society and is until now not easy to activate.
- E-buses are developing strongly on city level.
- 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.

## 11.2 Next steps

The team is considering new and extra actions to be taken to increase the interest in shared e-cars in the district, together with local stakeholders and in collaboration with the citizen engagement activities. At the same time the underlying reasons will be further analysed. The new research on e-buses and the potential for smart charging and V2G operation will be started. Production of V2G shared cars will take off in 2020; shortly after that we expect the first cars to be tested in IRIS.

# 12 References

[1] Grant Agreement nr. 774199 — Integrated and Replicable Solutions for Co-Creation in Sustainable Cities (IRIS) Amendment, Reference No AMD-774199-24

[2] Deliverable 5.1 Baseline, ambition, activities, and barriers & drivers for Utrecht lighthouse interventions, 30 September 2018

[3] Deliverable 5.2 - Coordination of Utrecht integration and demonstration activities, 30 September 2018

[4] Deliverable 11.5 - Quality Assessment Plan, Risk Assessment and Contingency Plans, 16/04/2019

[5] https://ritjeweg.nl/

[6] https://viriciti.com/

[7] Ambition of Province of Utrecht to have emission free public transport by 2028 (in Dutch): https://www.provincie-utrecht.nl/publish/pages/195914/jaar-_en_trendrapportage_ov_2018-web.pdf

# Annex 1

For the KPI's for this Transition Track, the main data parameter is the total number of kilometers driven by the shared e-cars. Civity has a data connection to the LomboXnet car management system that will be used to report on the different KPI's as explained in 5.3.2.

*Table 5 Description of km driven measurements for Measure 1.*

| No | Parameter | Value |
|---|---|---|
| 1 | Data Variable Name<br>*i.e. Thermal energy consumption, locally produced electrical energy, etc.* | Km driven by shared e-cars in the district |
| 2 | Measure Number<br>*As it is stated in the measure tracker* | 1 |
| 3 | KPI Number<br>*KPI('s) that are related to the data* | 1, 2, 3, 4, 6 |
| 4 | Units of measurement<br>*i.e. kWh, Euro, etc.* | km total for all shared e-cars |
| 5 | Baseline (of data variable)<br>*e.g. relating to BaU or previous performance data* | Zero |
| 6 | Meter<br>*i.e. smart meter, survey, energy bill, etc.* | Km-counters in all shared e-cars |
| 7 | Location of measurement<br>*Where the measurements take place* | In the e-cars |
| 8 | Data accuracy<br>*How accurate is the measurement* | Standard car km-counter accuracy |
| 9 | Collection interval<br>*How often the data is recorded* | After each car sharing transaction |

| | | |
|---|---|---|
| 10 | Start of measurements *i.e. 1-1-2019, 0:00CET* | 2019 |
| 11 | End of measurements *i.e. 31-12-2020, 24:00CET* | Measurements will continue after end of project. |
| 12 | Expected availability *i.e. open data, public, confidential, no data available* | Confidential |
| 13 | Expected accessibility *i.e. 1) online without access constraints, 2) online, but requires authentication, and, 3) offline* | Online but requires authentication |
| 14 | Data format *i.e. csv file, json…* | OCPI-connection between Civity and We Drive Solar |
| 15 | Data owner *i.e. the name of the company that will give access to data* | We Drive Solar |
| 16 | Comments *Further info* | |