



D5.5 Ameland system integration report

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H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-2020-EC-ES-SCC

EUROPEAN COMMISSION

Innovation and Networks Executive Agency

Grant agreement no. 957810

PROJECT CONTRACTUAL DETAILS

Project title	IntegrAted SolutioNs for the DecarbOnization and Smartification of Islands
Project acronym	IANOS
Grant agreement no.	957810
Project start date	01-10-2020
Project end date	30-09-2024
Duration	48 months
Project Coordinator	João Gonalo Maciel (EDP) - JoaoGoncalo.Maciel@edp.com

DOCUMENT DETAILS

Deliverable no.	D5.5
Dissemination level	public
Work package	WP5 - Deployment, Use Cases Realization and Monitoring at LH#1 (Ameland)
Task	T5.3 – System Integration, Implementation & Commissioning
Due date	30-07-2022 (V1)
Actual submission date	19-04-2023
Lead beneficiary	Neroa

Version	Date	Beneficiary	Changes
0.1	First Draft	Neroa	Started the document and TOC
0.2	15/April/2022	TNO & Repowered	ToC feedback collected
0.3	31/May/2022	Partners in Ameland	Sent to partners to collect inputs if necessary
0.4	20/December/2022	TNO, Municipality of Ameland	Overall feedback
0.6	3/February/2023	Neroa	Overall feedback processed
1.0	20/March/2023	Neroa	Feedback TNO processed

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1. Introduction

1.1 Purpose and Scope of the Deliverable

The first version of this integration report aims to provide a comprehensive guide to be used by the involved parties, such as local installers and manufacturers of equipment for the correct installation, integration and commissioning of the technologies to be deployed at the Ameland pilot.

The report will highlight the implementation of the energy system, and next to this, it will give more insights into the way device drivers will be installed at the RES on Ameland. The installation of those device drivers will be done by the owners of the RES. This installation will be supervised by Neroa and supported by TNO since this can be a complex process. Every asset has a specific way in which drivers should be installed, which makes supervision of a technology partner necessary.

The commissioning procedures will be formulated in D5.7, which is highly intertwined with this deliverable.

Due to several energy assets that are not yet available, it is not possible to describe the installation, integration and commissioning for those assets. The project team decided that this report gives a description of the available energy assets and their installation. Integration and commissioning.

1.2 Structure of the Deliverable

This deliverable is structured as follows:

- Chapter 2: A list of all assets on the island and a categorisation of all those assets applicable to be deployed on the Ameland case. An explanation of the integration platform which will give insight into the relationship between the system and all assets and how the asset will be connected to the integration platform.

- Chapter 3: the annexes are providing more detailed information about several assets and explain how we have set up the DefPi environment.

1.3 Relation to Other Deliverables

Work Package 5 (WP5) relates solely to the lighthouse island of Ameland and aims to prepare the demonstration of the several Use Cases (UCs) and technologies defined for this island and detailed in T2.1 – Islands Requirements engineering and use case definitions.

The present deliverable is included in task T5.3, under WP5 - Deployment, Use Cases Realization and Monitoring at LH#1 (Ameland).

Within T5.1, a specification is formulated for all systems and equipment to be commissioned in T5.3. T5.1 is also responsible for the identification of the pilot site requirements and constraints, by assessing existing infrastructures and the feasibility of installing the different systems and equipment.

This deliverable will also feed other Work Package tasks with relevant information. The pilot site identification (pilot ID) and equipment to be installed are to be used on the interpretation of the data arriving at the Enterprise Service Bus (ESB – T4.1), on the Common Data Model being developed and on the Centralized Dispatcher developments (T4.3) under the scope of WP4.

Figure 1 highlights the relationships described, also pointing to the flux of outputs/inputs expected.



Figure 1: Relation of other tasks to task 5.3.

Technologies to be deployed.

This Chapter presents the preliminary list of the pilot sites that together compose the Ameland pilot and the technologies to be deployed in each one of them.

Due to delays in the pilot site audits and surveys, it has not been possible to provide further details and characteristics of each one of the asset groups. This information is important for the installation procedures and will be considered after all the onsite audits and surveys are conducted.

In the next three subsections, the different technologies to be deployed for each pilot site are provided and categorized into 'large', 'residential' and 'municipal' assets. The pilot sites are identified with a "Pilot ID" and divided by their building category. The "Pilot ID" is an identification for each pilot site that will be followed during IANOS implementation. This identification ID is an internal correspondence to the individual physical pilot installation, that is only known for a restricted number of IANOS partners.

In Table 1, 2 and 3 the preliminary list of technologies to be deployed is mentioned. In the next paragraphs, the installation, commissioning and integration procedures of all technologies are described.

1.4 Large Consumers and Producers

Pilot	Asset	Number	Connection	Asset available
A-L-1	3 MW solar park and battery	1	Backoffice	N
A-L-2	SUWoTec Battery	1	Direct	N
A-L-3	Electrolyser	1	Backoffice	N
A-L-4	6MW Solar Park	1	Backoffice	Y
A-L-5	Tidal Kite	1	Direct	N
A-L-6	CHPs 75KWe/110KWth	3	Backoffice	N
A-L-7	500KWe Fuell Cell	1	Backoffice	N
A-L-8	NAM platform	1	Backoffice	Y
A-L-9	Mainland connection	1	Backoffice	Y
A-L-10	Digester	1	Direct	N
A-L-11	Wind Turbines	2	Backoffice	N

Table 1: Technologies to be installed for large consumers and producers.

1.5 Residential producers & consumers

Pilot ID	Residential Asset	Number	Connection	Asset Available
A-R-1	Battery EMS, PV, micro-CHP	1	Direct	Y
A-R-2	Methane fuel cells	35	Direct	Y
A-R-3	Hybrid heat pumps	136	Direct	Y
A-R-4	1MW residential PV	TBD	other	Y

Table 2: Assets in residents' houses.

1.6 Municipal assets

Pilot ID	Municipal Assets	Number		Asset available
A-M-1	Public Charging Stations	10	Backoffice	Y
A-M-2	Charging Stations Buses	1	Backoffice	Y
A-M-3	Heating Grid Nes	1	Backoffice	N
A-M-4	Heating Grid Buren	1	Backoffice	N
A-M-5	H2 Water Taxi	1	TDB	N
A-M-6	H2 infrastructure	1	TDB	N

Table 3: Municipal assets

The preliminary list of back-office connections includes 11 connections in total. Of the 11 connections, there are 4 asset types currently available and 7 asset types that are not yet available.

Additionally, the preliminary list of direct connections comprises 6 connections in total. Among these connections, 3 asset types are currently available, while 3 asset types are not yet available.

Please notice that one 'asset type' can consist of many assets of the same type.

2 Installation, integration and commissioning procedures

2.1 Integration

In the next subsections each one of the technology providers that will deploy their equipment in the Ameland Island project sites, describes the main procedures for the installation, integration and commissioning of it.

This is not meant to be an exhaustive description of the procedures, but to summarize the main aspects to be considered during the deployment of each technology. Some of the equipment is more complex than others and will require the adequate training of local installers, the provision of technical manuals, remote or on-site assistance and the use of software tools.

In the next paragraph, the architecture is explained. This gives an overview of the way the integration has been done. Next, the installation and commissioning procedures will be provided.

2.2 Integration architecture

In the project, an architecture is developed to integrate assets on the island of Ameland, see Figure .

Depending on the interface of the above-mentioned energy assets, a connection is made [1] either through dedicated hardware for IANOS (right side of Figure 1), or [2] is connected through a software connection of the back office of the device (left side of Figure 1). Paragraph 3.3 will mention which type of connection is made for every energy asset.

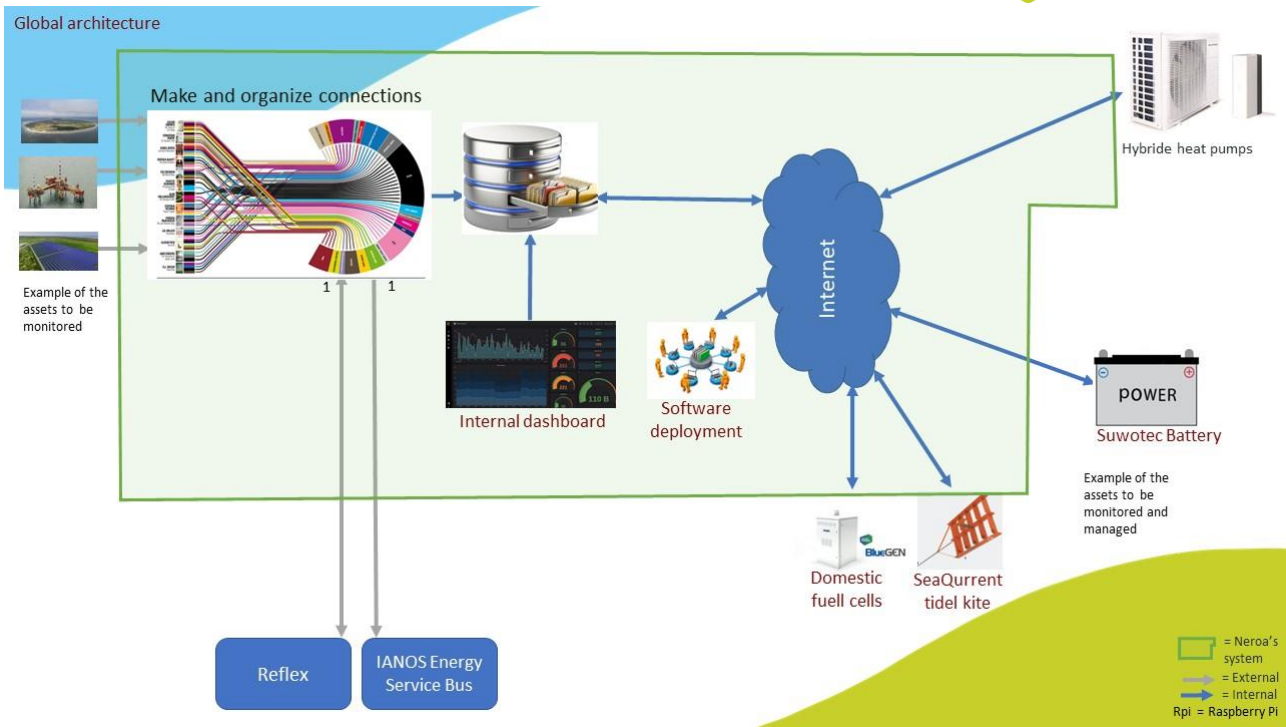


Figure 2: IANOS integration architecture

The Architecture in figure 2 pictures the overall and global overview of how we integrate all different assets. In figure 3 the same architecture is shown in more detail.

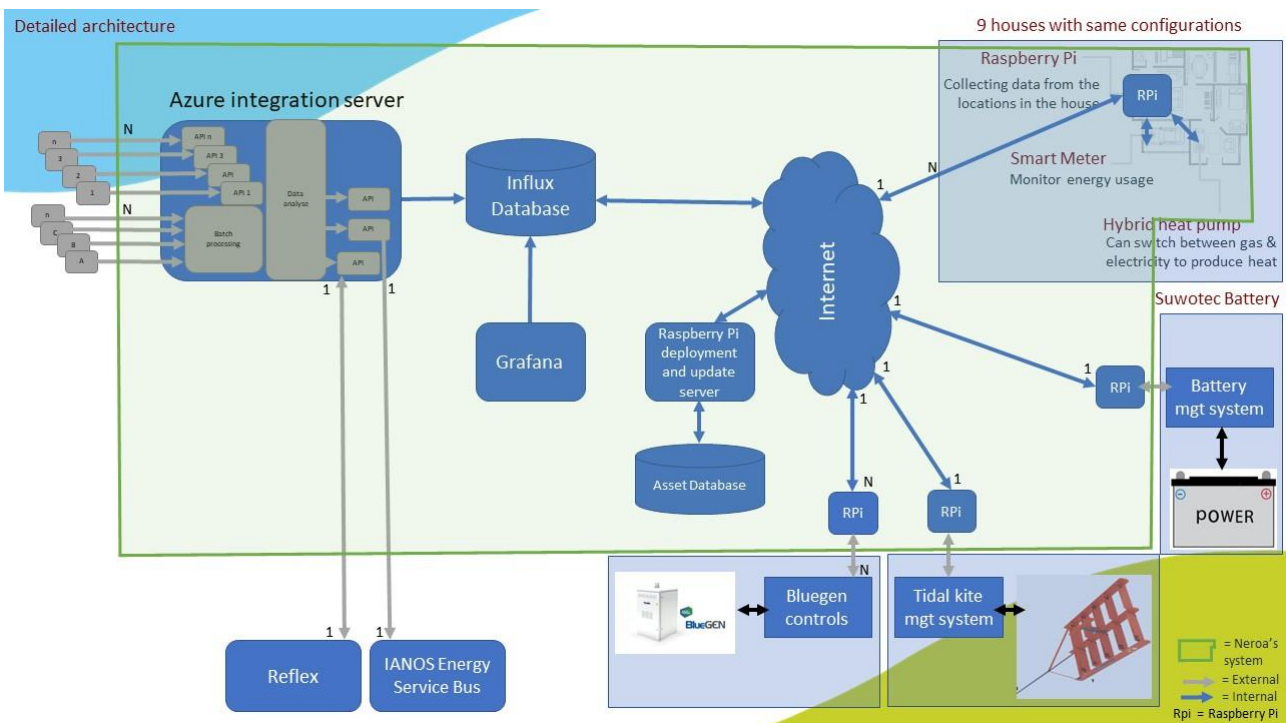


Figure 3: IANOS integration architecture

This architecture offers us 2 ways of reading energy data: one by integrating with back offices of third parties which monitor certain or several energy assets (left side of the figure above 'Azure integration server'), and the second by connecting a Raspberry Pi (open-source computing device used locally) directly to the Energy Asset. The Pi sends data to a server dedicated to IANOS (right side of the figure above 'all assets connected to the internet cloud').

On the left side the different back offices, which monitors certain assets in the field, are integrated by the Azure integration Platform. An example of a back-office connection is the data of the PV solar field. Also, the integration platform reads for instance batch files of other energy assets. Examples of this process are the data from the NAM platform and the mainland connection of Alliander.

On the right side of the figure, we have local devices (Raspberry Pi's) installed which we use to read energy data from local energy assets. Also, the Pi's can be used to steer/manage the assets. The database (Influxdb) and the user interface (Grafana) are used internally to monitor the dataflows and for debugging.

2.3 Integration of all assets

This paragraph will highlight all assets implemented within the IANOS project on their technical specifications, possible communication protocols and a first impression of the possible energy-flexibility that the specific asset can offer. This last aspect is made in cooperation with asset owners. The reason for this is that (regulatory, operational or other) constraints in flexibility are incorporated this way.

Per asset, the (expected) connection type is mentioned. This connection type refers to the 'left' or 'right' side of the architecture. The left side are connections made via an API (*back-office connection*) and the right side refers to connections via a local Raspberry Pi (*direct*).

2.3.1 A-L-1 3MW Solar Park and Battery (Municipality of Ameland)

Expected connection type: back-office integration.

The first asset is a 3Mw solar park and a 3MWh BESS (Battery Energy Storage System) with a DC connection at Ballumerbocht Ameland.

The design of the park is scheduled for Q1 2023. In the design and build phase the connection with the iVPP will be developed.

2.3.1.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the solar park and battery which are available from the manufacturer of the solar panels and the battery.

To integrate this asset into the iVPP, communication protocols should be analysed first. When the assets are developed, this becomes available. It is expected to have an integration through a back-office connection. In this case, the following steps should be taken:

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the data points which needs to be monitored.
2. Determine the frequency. This is depending for instance on the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.1.2 Integration and commissioning procedures

The installer of the energy asset must take care that the PV panels and battery are connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform. This in turn will deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa team.

2.3.1.3 Checklist

The local installers will be provided with the following checklist table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.2 A-L-2 Biobased Saline Battery 120kWh (SuWoTec)

Expected connection type: Direct

The design of the Biobased Saline battery is scheduled for Q2 2023.

2.3.2.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the battery which are available from the manufacturer of the battery.

1. Make sure the BMS of Suwotec is up and running.
2. First install the network cable to the Pi. The network cable must be connected to the internet and DHCP must be enabled on this network.
3. Connect the Pi with Modbus (via a red and white cable) to the BMS of Suwotec.
4. Connect the power to the Pi
5. Wait 20 seconds so that the Pi can fully start up. The Pi will try to reach the Neroa management server and if connected it will set up a data connection with our database.
6. Contact Neroa to check if the connection is ready and working

2.3.2.2 Integration and commissioning procedures

The Pi will be pre-configured by Neroa and if the installation steps are completed the Pi will connect automatically to our Pi management system.

Afterwards, the Pi will set up a data connection with the BMS and the back office of Neroa (see figure 1, right side).

2.3.2.3 Checklist

The local installers will be provided with the following checklist table, for fast acknowledgement

1. Check if a wired (RJ45) network internet connection is available with DHCP enabled.
2. Check if the wires are connected between the BMS of Suwotec and the Pi.
3. Check if the memory card (on the side of the Pi) is inserted correctly
4. Connect the Pi to the electrical grid to power up the Pi.



2.3.3 A-L-3 Electrolyser

Expected connection type: back office connection

A small electrolyser will be installed in the Ballumerbocht in Q2 2023. In the design and build phase the connection with the iVPP will be developed.

2.3.3.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the electrolyser which are available from the manufacturer of the electrolyser.

First, we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation, the following steps must be taken:

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the data points which needs to be monitored.
2. Determine the frequency. This is depending for instance on the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.3.2 Integration and commissioning procedures

The installer must take care that the electrolyser is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by Neroa's team.

2.3.3.3 Checklist

The local installers will be provided with the following checklist table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa including connection credentials.
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.4 A-L-4 Solar Park 6MW (Municipality of Ameland)

Connection type: back office connection

A 6 MW solar farm at the airport of Ameland. The solar farm has three owners: the municipality of Ameland (AME), Amelander Energie Coöperatie (AEC) and Eneco.

The solar park is monitored, and the data is stored at a third party. This third party is monitoring the park since the beginning. To get the data needed we need to build an API interface with this third party. See below for an example of the monitoring of the month May of 2022.



Figure 3: energy production of the 6 MW solar park in May 2022

2.3.4.1 Installation procedures

Based on the technical specification of the operator of the solar park, we can receive the generated electricity from all solar panels.

- Operator shares specification of the API interface to read the solar electricity production of the 6MW solar park
- Operator gives access to the API interface
- Neroa will use the developed software to connect to the operator's interface

2.3.4.2 Integration and commissioning procedures

The installer must take care that the solar park is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service

Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.4.3 Checklist

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa, including credentials to make the connection.
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.5 A-L-5 Tidal Kite (SeaCurrent)

Expected Connection type: Direct

This asset is a 500kWe Tidal Kite to be installed between Ameland and Terschelling. During the development, it became clear that there are not many suppliers able to provide the right parts for the kite, which made the design and production of those parts necessary for SeaCurrent. This created delay in the asset deployment. The kite is being tested in inland water. Integration is planned in Q2 2023. After this phase, a connection with the iVPP will be made.

2.3.5.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the kite which is available at the manufacturer of the kite.

1. Make sure the control system of SeaCurrent is up and running.
2. First install the network cable to the Pi. The network cable must be connected to the internet and DHCP must be enabled on this network.
3. Connect the Pi with Modbus to the control system.
4. Connect the power to the Pi
5. Wait 20 seconds so that the Pi can fully start up. The Pi will try to reach the Neroa management server and if connected it will set up a data connection with our database.
6. Contact Neroa to check if the connection is ready and working.

The order in which these steps are taken is crucial for a successful deployment of a Raspberry Pi that monitors the energy asset.

2.3.5.2 Integration and commissioning procedures

The Pi will be pre-configured by Neroa and if the installation steps are completed the Pi will connect automatically to our Pi management system.

Afterwards, the Pi will set up a data connection with the control system and the back office of Neroa (see figure 1, right side).



2.3.5.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Check if a wired (RJ45) network internet connection is available with DHCP enabled.
2. Check if the wires are connected between the control system of SeaCurrent and the Pi.
3. Check if the memory card (on the side of the Pi) is inserted correctly
4. Connect the Pi to the electrical grid to power up the Pi.

2.3.6 A-L-6 CHP's (Municipality of Ameland)

Expected connection type: back office

3 CHP's will be installed at Ameland. In the design and build phase the connection with the iVPP will be developed.

2.3.6.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the CHP which is available at the manufacturer of the CHP's.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation, the following steps must be taken:

4. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
5. Determine the frequency. This is depending for instance on the KPI's and the technical possibilities of the assets.
6. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.6.2 Integration and commissioning procedures

The installer must take care that the CHP is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.6.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.7 A-L-7 Fuel Cell 500 kWe (Municipality of Ameland)

Expected connection type: back office

A fuel cell was planned to be installed at a holiday resort to replace a CHP. Because of COVID plans have changed. This year, discussions with the owners have resumed to draw up a new plan for the energy system of the holiday park. In the design and build phase the connection with the iVPP will be developed.

2.3.7.1 Installation procedures

When the installation is ready to start the local installers must follow the installation and pre-configuration procedures of the fuel cell which is available at the manufacturer of the fuel cell.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

7. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
8. Determine the frequency. This is depending for instance on the KPI's and the technical possibilities of the assets.
9. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.7.2 Integration and commissioning procedures

The installer must take care that the Fuel Cell is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.



2.3.7.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.8 A-L-8 NAM platform

Connection type: API, processing of Batch files

The energy consumption of the NAM platform (located in the sea nearby Ameland Island) will be monitored.

2.3.8.1 Installation procedures

The NAM platform is installed and ready to be monitored. Neroa will receive CSV files and integrate them into the platform. Afterwards, the information is processed and sent to the Enterprise Service Bus.

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
2. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.8.2 Integration and commissioning procedures

After receiving the Batch files with the energy usage of the platform delivered by the NAM, Neroa will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa team.

2.3.8.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the datatypes and syntax for the files in json or CSV.
2. Automate the process of sending the files to Neroa.
3. Send the technical specifications of the interface to Neroa
4. Neroa will import the files and integrate the data into the platform.

2.3.9 A-L-9 Mainland connection

Connection type: back office, processing of Batch files

The energy consumption of the mainland connection (monitoring the electricity cable between the mainland and Ameland) will be monitored by importing batch files.

2.3.9.1 Installation procedures

The mainland connection is already active and running. Neroa will receive CSV files from Alliander, and we will read the files in our integration platform. Afterwards, we will process the information and send it to the Enterprise Service Bus.

1. Determine the exact data points we need to monitor and the frequency. The KPI's are an important input to deduct the datapoints which needs to be monitored.
2. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.9.2 Integration and commissioning procedures

After receiving the Batch files with the energy usage of the platform delivered by the Alliander, Neroa will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.9.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the datatypes and syntax for the files in json or CSV.
2. Automate the process of sending the files to Neroa.
3. Send the technical specifications of the interface to Neroa

Neroa will import the files and integrate the data into the platform.

2.3.10 A-L-10 Digester

Expected connection type: back office

It is not yet clear if and when the digester will be operational. Therefore, it's difficult to determine the connection type of the digester. For the time being, we assume we will connect to this device via an API connection.

2.3.10.1 Installation procedures

When the installation is ready to start the local installers must follow the installation and pre-configuration procedures of the digester which is available at the manufacturer of the digester.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
2. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.10.2 Integration and commissioning procedures

The installer must take care that the digester is connected to the back office of the manufacturer or installer itself. After following this installation the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.10.3 Checklist

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.



2.3.11 A-L-11 Wind turbines

Expected connection type: Backoffice

There are three permit requests for wind turbines on Ameland. The goal is to connect these to the iVPP. It is not yet clear if and when the wind turbines will be operational. Therefore, it is difficult to determine the connection type of the digester. For the time being, we assume we will connect to this device via an API connection.

2.3.11.1 Installation procedures

When the installation is ready to start the local installers must follow the installation and pre-configuration procedures of the wind turbines which are available from the manufacturer of the turbines.

First, we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back-office installation the following steps must be taken:

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
2. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.11.2 Integration and commissioning procedures

The installer must take care that the digester is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as

defined on the Ameland Island simplified diagram. The integration and



commissioning procedures with the IANOS iVPP components will be done remotely by Neroa's team.

2.3.11.3 Checklist

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

1. Make sure the Murata system and the Micro-chp are up and running.
2. First install the network cable to the Pi's. The network cable must be connected to the internet and DHCP must be enabled on this network.
3. Connect the Pi with Modbus (via a red and white cable) to the control system.
4. Connect the power to the Pi
5. Wait 20 seconds so that the Pi can fully startup. The Pi will try to reach the Neroa management server and if connected it will set up a data connection with our database.
6. Contact Neroa to check if the connection is ready and working

2.3.12.1 Integration and commissioning procedures

The Pi will be pre-configured by Neroa and if the installation steps are completed the Pi will connect automatically to our Pi management system.

Afterwards the Pi will setup a data connection with the control system and the back office of Neroa (see figure 1, right side).

2.3.12.2 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Check if a wired (RJ45) network internet connection is available with DHCP enabled.
2. Check if the wires are connected between the control system of the Micro-chp and BMS and the Pi.
3. Check if the memory card (on the side of the Pi) is inserted correctly
4. Connect the Pi to the electrical grid to power up the Pi.

2.3.12.3 Technical specifications

The Murata system has its own language and interface which the manufacturer shared for the project. Also, the Siemens controls used by the Micro-chp are used to control the device directly. Communication between different Pi's and the back office is done via encrypted MQTT protocol. Neroa has developed dedicated software to connect to the BMS and the micro-chp.

2.3.12.4 Possible flexibility

Because the buffer in these three demonstration locations is very small, we will not include these in the ReFlex optimization algorithm. The buffers (2,4kw/h) are too small to have an impact. The goal of the buffers is to optimize the electricity usage for the household itself.



2.3.13 A-R-2 Methane fuel cells (municipality of Ameland)

Connection type: Direct

At Ameland, several domestic fuel cells are installed. The fuel cells use natural gas and produce electricity as well as heat, see picture below.

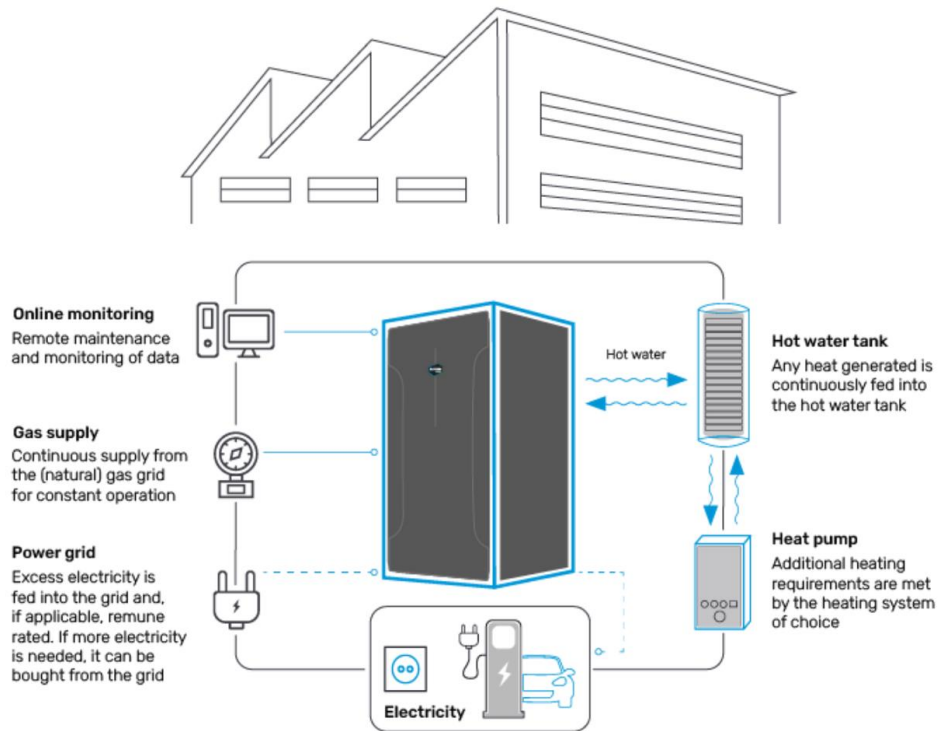


Figure 6: 'Domestic fuel cell at Ameland'

2.3.13.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the fuel cell which is available at the manufacturer of the fuel cell.

1. Make sure the fuel cell is up and running.
2. First install the network cable to the controller unit. The network cable must be connected to the internet and DHCP must be enabled on this network.
3. Use the correct memory card on which the correct software is installed. Check the right version of the memory card by reviewing the right house number where the heat pump is installed with the number on the memory card.

4. Connect the control points of the heat pump to the controller, see also Annex 2.
5. Connect the power to the controller.
6. Wait 20 seconds so that the controller can fully startup. The controller will try to reach the Neroa management server and if connected it will set up a data connection with our database.
7. Contact Neroa to check if the connection is ready and working

2.3.13.2 Integration and commissioning procedures

The controller will be pre-configured by Neroa and if the installation steps are completed the Pi will connect automatically to our Pi management system.

Afterwards the Pi will setup a data connection with the control system and the back office of Neroa (see figure 1, right side).

2.3.13.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Check if a wired (RJ45) network internet connection is available with DHCP enabled.
2. Check if the wires are connected between the control system of the heat pump and the controller.
3. Check if the memory card (on the side of the controller) is inserted correctly
4. Connect the controller to the electrical grid to power up the controller.

The Bluegen fuel cells are equipped with an RJ45/TCP/IP connection. We have developed software to read the device with certain data fields. A part of the source code is below in which you can see a part of the possible data point we can read.

```

42         // makes the var for the socket connection
43         Socket socket;
44         // start of the reading part
45         try {
46             // makes the settings class and the apiwriter class
47             // Settings settings = new Settings();
48             ApiWriter apiWriter = new ApiWriter(fuelcell);
49             // makes the socket connection with the fuelcell with the settings
50             // in settings
51             socket = new Socket(fuelcell.fuelcellIpadress,
52                                 fuelcell.fuelcellPort);
53
54             if (socket.isConnected()) {
55                 // if connected do:..
56                 System.out.println("connected to: fuelcell " + fuelcell.id);
57                 // makes a bufferreader to read data from fuel cell
58                 BufferedReader in = new BufferedReader(new InputStreamReader(
59                     socket.getInputStream()));
60                 // prints an empty line for nice looking output
61                 // System.out.println("");
62                 // loop for input
63                 while (running) {
64                     String inputString = in.readLine();
65                     // System.out.println(inputString);
66                     String[] inputArray = inputString.split("\\t");
67                     if (!inputString.contains("Date Time")) {
68                         dateTime = inputArray[0];
69                         state = inputArray[1];
70                         opHours = Double.parseDouble(inputArray[2]);
71                         air = Double.parseDouble(inputArray[3]);
72                         steam = Double.parseDouble(inputArray[4]);
73                         fuel = Double.parseDouble(inputArray[5]);
74                         elecEfficiency = Double.parseDouble(inputArray[6]);
75                         exportEnergy = Double.parseDouble(inputArray[7]);

```

The software must be installed on hardware which is located on the same network as the Bluegen. This hardware must also have a connection to the internet to be able to upload the data received from Bluegen.

The next steps to complete the monitoring:

1. Decide which hardware we will use for monitoring the device
2. Prepare the hardware with the OS and framework
3. Finish the software by making the connection to the Energy Service Bus of IANOS.
4. Install the software
5. Prepare the Bluegen that it is connected to a (local) network
6. Connect the monitoring device to the Bluegen

2.3.14 A-R-3 Hybrid heat pumps

Connection type: Direct

At Ameland 136 Hybrid heat pumps are installed. The heat pumps are of different brands and are situated at different locations in Ameland. We analysed the physical location of the heat pumps to deduct which (group of) hybrid heat pumps will have an impact on the low-voltage grid.

The conclusion was that 9 heat pumps of the same brand/type were installed at one low-voltage grid.

2.3.14.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the heat pumps which is available at the manufacturer of the battery.

1. Make sure the fuel cell is up and running.
2. First install the network cable to the controller unit. The network cable must be connected to the internet and DHCP must be enabled on this network.
3. Use the correct memory card on which the correct software is installed. Check the right version of the memory card by reviewing the right house number where the heat pump is installed with the number on the memory card.
4. Connect the control points of the heat pump to the controller, see also Annex 2.
5. Connect the power to the controller.
6. Wait 20 seconds so that the controller can fully startup. The controller will try to reach the Neroa management server and if connected it will set up a data connection with our database.
7. Contact Neroa to check if the connection is ready and working

2.3.14.2 Integration and commissioning procedures

The controller will be pre-configured by Neroa and if the installation steps are completed the controller will connect automatically to our management system. Afterwards the controller will setup a data connection with the control system and the back office of Neroa (see figure 1, right side).

2.3.14.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

5. Check if a wired (RJ45) network internet connection is available with DHCP enabled.
6. Check if the wires are connected between the control system of the heat pump and the controller.
7. Check if the memory card (on the side of the controller) is inserted correctly
8. Connect the controller to the electrical grid to power up the controller.

2.3.15 A-R-4 1MW Residential PV

Connection type: TBD

The PV production of the 1MW PV at Ameland is installed throughout the Islands in many different and small configurations. Monitoring the PV production will be done by the AEC and the municipality of Ameland by making an inventory of the PV production. The estimated PV production will be calculated based on the findings of this inventory.



2.3.16 *A-M-1 Public charging stations (Ameland)*

Connection type: API

New charging stations are to be installed in Q1 2023. Discussions with the contractor/manufacture are held to connect the charging stations to the iVPP.

2.3.16.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the charging stations which is available at the manufacturer of the stations.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

4. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
5. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
6. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.16.2 Integration and commissioning procedures

The installer must take care that the charging stations are connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.16.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

4. Determine the API interface
5. Sent the technical specifications of the interface to Neroa
6. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.17A-M-2 charging stations busses

Connection type: API

New charging stations are to be installed in Q1 2023. Discussions with the contractor/manufacture are held to connect the charging stations to the iVPP.

2.3.17.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the charging stations which is available at the manufacturer of the stations.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

7. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
8. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
9. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.17.2 Integration and commissioning procedures

The installer must take care that the charging stations are connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.17.3 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.



2.3.18 A-M-3 Heat Grid NES

Connection type: API

The goal is to install a heat grid in NES. The assumption is that we will monitor this grid with an API connection. If this assumption is correct, we will initiate the following steps to complete monitoring.

2.3.18.1.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the heat grid which is available at the manufacturer of stations.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

1. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
2. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
3. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.18.1.2 Integration and commissioning procedures

The installer must take care that the cheat grid is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.18.2 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

1. Determine the API interface
2. Sent the technical specifications of the interface to Neroa
3. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.19 A-M-4 Heat Grid Buren

Connection type: API

The goal is to install a heat grid in Buren. The assumption is that we will monitor this grid with an API connection. If this assumption is correct, we will initiate the following steps to complete monitoring.

2.3.19.1.1 Installation procedures

Local installers must follow the installation and pre-configuration procedures of the heat grid which is available at the manufacturer of stations.

First we need to analyse possible communication protocols. This needs to be discussed when the information about the assets is available. In case of a back office installation the following steps must be taken:

4. Determine the exact data points we need to monitor. The KPI's are an important input to deduct the datapoints which needs to be monitored.
5. Determine the frequency. This is depending for instance of the KPI's and the technical possibilities of the assets.
6. Installation of the API interface with the Azure Integration platform (see figure 1) with the back office of the installer.

2.3.19.1.2 Integration and commissioning procedures

The installer must take care that the cheat grid is connected to the back office of the manufacturer or installer itself. After following this installation, the equipment will be ready to acquire and send the collected data to the Azure integration platform, which will then deliver the data to the Enterprise Service Bus (ESB), as defined on the Ameland Island simplified diagram. The integration and commissioning procedures with the IANOS iVPP components will be done remotely by the Neroa's team.

2.3.19.2 Check list

The local installers will be provided with the following check list table, for fast acknowledgement

4. Determine the API interface
5. Sent the technical specifications of the interface to Neroa
6. Neroa will make a match with the KPI's and will inform the installer which data point we need. Based on this output, the installer will enable the interface and offer the data to Neroa.

2.3.20 *A-M-5 H2 Water Taxi*

Monitoring the performance of the H2 Water Taxi will not be done by ICT and therefore not further mentioned in this document.

2.3.21A-M-6 H2 infrastructure

Monitoring the performance of the H2 Water Taxi will not be done by ICT and therefore not mentioned in this document.



3 Annex

3.1 Annex 1 preparation of the flexibility of the heat pumps

The challenge is to deal with the different brands and models. To analyse the monitoring and steering possibilities, we have made an overview of the different types and combinations of Heat Pump – Boiler.

We have also plotted the location of the heat pumps on the (low voltage) grid of the grid operator and discussed with the grid operator the positions of the heat pumps.

Together with the grid operator and knowing the locations of the hybrid heat pump, we have made an [1] analyse of the locations of the hybrid heat pumps on [2] different low-voltage grids, preferably connected to one 'string' (electricity cable). After this step, we [3] analysed the heat pumps in which manufacturers are involved on that specific low-voltage cable. The result was that the heat pump brand which was used at one low-voltage grid is the Elga.

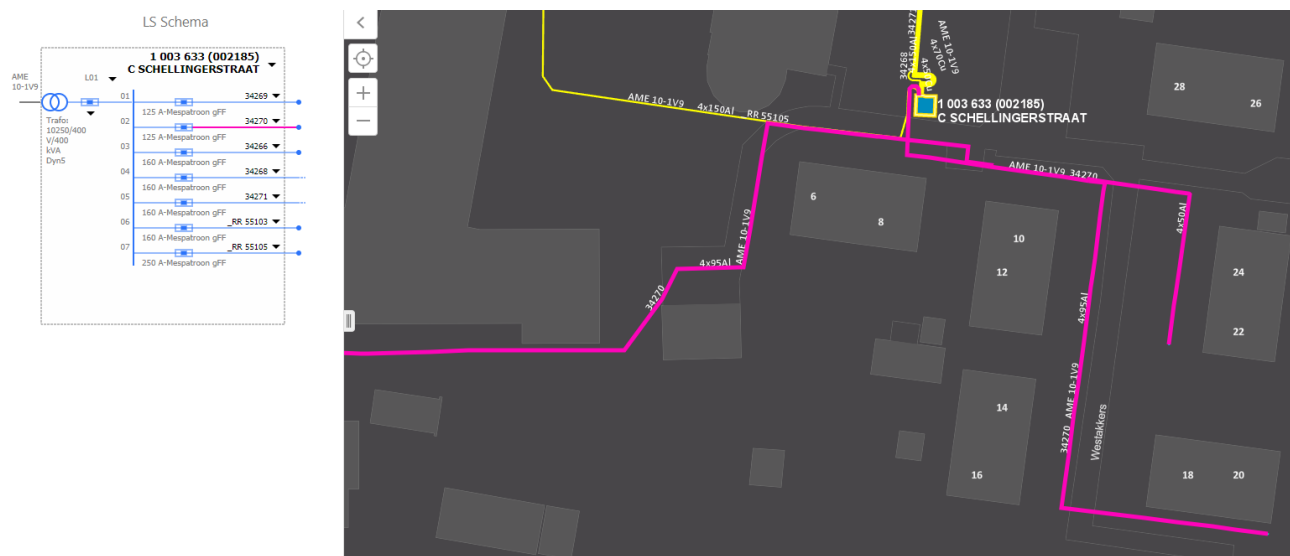


Figure 7: analyse the hybrid heat pumps and the grid

We arranged that this heat pump to be installed at the HESI lab of TNO in Groningen, see (first) picture below. We analysed the control settings of

the heat pump and configured and installed hardware that can manage the heat pump (2nd picture). Via an app we can manage the heat pump via de phone (or tablet), see picture 3.

Lab test configuration

The first installation was done in the HESI lab of TNO. The goal is to test if the control mechanism will work and if the hybrid system still offers comfort to the end user. We need to make sure that the comfort of the end-users is guaranteed and tested before we will deploy the system in different households in the field.



4.14.2 installation of the heatpump



4.14.3 installation of the control hardware



4.14.4 installation of the control hardware

3.1.1 Technical specifications

Specification of the tested devices:

- Elga heat pump: Techneco Elga 3.0, fabrikagenummer: TELG30304 459818
- Toshiba Outdoor Unit: Toshiba air conditioner RAV-SM304ATP-E
- Remeha Tzerra ACE: Remeha Tzerra M 28c ACE – 1805218211390
- Honeywell thermostat: Chronotherm Touch – TH8210M1003

The Elga heat pump must be equipped with the Smart Grid Ready (SGR) cable to be able to receive external signals.

TNO supplied technical information about the Elga heat pump by sharing the final document: “TNO 2019 R11976 | Final report”. In this survey, TNO tested different heat pumps and their ability to be controlled externally.



4.14.4 installation of the control hardware

3.1.2 Possible flexibility

If the hybrid heat pump will be powered by gas instead of electricity, the end-user will miss certain benefits. On the other hand, switching the input of the heat pump from electricity to natural gas can support the quality of the low-voltage grid. A calculation of the missed benefit when the heat pump is switched to use natural gas is calculated below. To understand the calculation model, we included some slides.

Calculation missed benefit in curtailment period with hybrid heatpump

Variables			Heat pump specifications		
t1	02:30	HH:MM	Small	Medium	
t2	04:00	HH:MM	KWe	4,14	6,14
Gas Price	€ 2,00	€/ m3	KWth	0,92	1,35
Electricity price	€ 0,50	€/ kw/h	COP	4,5	4,55
t2 - t1	01:30:00				
Curtailment time in minutes	90				
Curtailment time in hours	1,5		Only modify the cells with this color, the rest is calculated		
1m3 natural gas =	9,769	kw/h			
Heat generated by condensing during curtailment period					
	Small HP	4,14 kw/th =	0,42	m3 natural gas needed in curtailment periode	Natural Gas price
	Medium HP	6,14 kw/th =	0,63	m3 natural gas needed in curtailment periode	price per hour
					price in period
					€ 2,00 € 0,85 € 1,27
					€ 2,00 € 1,26 € 1,89
Heat generated normally by heat pump during curtailment period					
	small HP	4,14 kw/th =	0,92	kw/e	electricity tariff
	Medium HP	6,14 kw/th =	1,35	kw/e	price per hour
					price in period
					€ 0,50 € 0,46 € 0,69
					€ 0,50 € 0,68 € 1,01
Conclusion					
missed savings during curtailment period (t2 - t1)			missed savings using condensing boiler		
small heat pump	€ 0,58		Small HP	€ 0,58 € 0,39	
medium heat pump	€ 0,87		Medium HP	€ 0,87 € 0,58	

The process shown in the excel sheet above is described in the slides below.

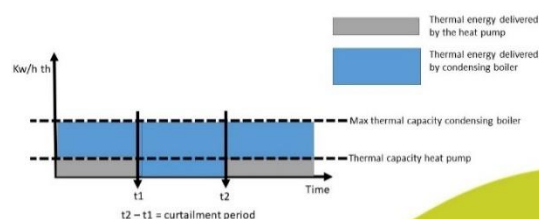
How to flex and determine the value for hybrid heat pumps

- Situation**
 - Heat pumps are installed at households.
 - Together with the condensing boiler, the heat pumps are connected as a hybride system that act as one heating system.
- Assumptions**
 - Thermal capacity of the heat pump is not necessary needed for comfort (thermal capacity of the condensing boiler is sufficient for the comfort of the household).
 - During the curtailment period, thermal heat is needed during the whole period (t2 - t1)

Data needed (input)

- External data**
1. Outside temperature
 2. Energy tariffs (kw/h_e and m3 gas price)
 3. Heat pump power
- Internal data**
1. Status curtailment (yes/no)
 2. Curtailment periode (t)
 3. Gas usage (via gas meter, optional)

Overview Curtailment periode hybrid heatpump



How to determine the value

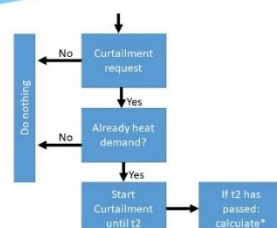
- Heat pump specs used at Ameland

Specs	Small Heat Pump	Larger Heat Pump
KWth	4,14	6,14
KWe	0,92	1,35
COP	4,50	4,55
Used COP in calcs	4,50	4,50

- Other data used in calculation

Gas Tariff	€ 2,00	
Electricity Tariff	€ 0,50	
Energy	1 M3 natural gas =	9,769 Kw/h

Decision tree



t2 - t1 = curtailment period

*a = (t2-t1) * heat produced by condensing boiler
b = (t2-t1) * heat produced by heat pump

Avoided benefit by using condensing boiler = (a-b) * (t2-t1)

See excel sheet for example calculation