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Sustainable
plus energy
neighbourhoods

WP3 - Technology Integration in Smart Managed Plus Energy Buildings and Neighbourhoods

D3.7 ARCHITECTURE DESCRIPTION OF SYN.IKIA ICT FRAMEWORK (FINAL)

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Executive Summary

The objective of this deliverable is to define the ICT architecture for accessing the building components that will be used actively to meet the energy demand shifting/synchronisation on neighbourhood level, to balance between the supply of sustainable energy, and the demand of the buildings and charging of electric vehicles on district level. The ICT architecture determines the required hardware infrastructure, as well as the communication between the edge computer and the syn.ikia cloud hub.

An ICT architecture is defined to make a scalable solution for a wide variety of demo projects to interact with the syn.ikia cloud hub. The structure is flexible in such a way that it enables to interface with different software and hardware solutions which are available in the field. In practice, each demo project will choose their own equipment and sensors and the local gateways or edge devices will also differ per country. The proposed software environment enables to interface between those different hardware and software solutions and the syn.ikia cloud hub in a uniform and scalable way.

An ontology is defined making use of project Haystack to describe both the monitoring data from the buildings/apartments and the control signals to the equipment. In practice, a specific building and the building services will have their own names for sensor and equipment data. A workflow for a smooth interaction between local data sets is described, and a scalable data structure is well defined by a common ontology.

A uniform data ontology is of utmost importance for a scalable solution of both the syn.ikia cloud hub as well as for the algorithms for balancing between local sustainable energy supply and building demand. A uniform data ontology enables queries to find those variables needed in algorithms for a specific building and a specific building service. This reduces time for the initialisation of the algorithms used in flexibility services on neighbourhood/district level, which reduces the costs to work with these algorithms. Reduction of costs and less need for skilled labour will accelerate the rapid market introduction of energy flexibility services.

The proposed ontology is implemented on different demo projects for validation and smooth installation of the selected components in WP 2 and the implementation of the flexibility services in WP 4.

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1. Roles and Responsibilities

Name	Role	Responsibility
TNO	Task 3.2 leader, coordinator of deliverable contents, contributor	Definition of the ICT architecture, definition of the ontology, inventory components for flexibilization and ontology for the Dutch demo project, coordination
IREC	Contributor	Inventory components for flexibilization and ontology for the Spanish demo project
ABUD	Contributor	Inventory components for flexibilization and ontology for the Austrian demo project
NTNU	Contributor	Inventory components for flexibilization and ontology for the Norwegian demo project
ENFOR	Contributor	ICT architecture and link to syn.ikia cloud hub
DTU	Reviewer	Review of the deliverable

2. Introduction

This deliverable describes the ICT architecture of syn.ikia to access the systems and components that will be used to arrive at plus energy neighbourhoods in four climatic zones. Some of these components (e.g. thermostat, ventilation unit, domestic equipment, HVAC systems, solar shading control) will be actively used by the buildings' energy manager, enabled by the syn.ikia cloud hub (T3.3) to meet the energy demand shifting/synchronisation requests, to balance between the supply of sustainable energy and the demand of the buildings and charging of electric vehicles on neighbourhood/district level.

An ICT architecture is defined for accessing global building components/devices (e.g. heat pumps, DHW buffers) via building level edge computers or a FOG server, as well as for accessing local apartment components (e.g. thermostats or domestic devices) via apartment level edge computers. Note that both types of components/devices have their own specific constraints on privacy and security. The edge computers or FOG server will be interfaced with the syn.ikia cloud hub (T3.3) that hosts, amongst others, the neighbourhood flexibility services. The syn.ikia cloud hub enables neighbourhood flexibility services that send requests to buildings and/or individual apartments.

Based on the interface of the syn.ikia cloud hub, an ontology is defined making use of existing standards as project Haystack. A uniform data ontology is of utmost importance for a scalable solution of both the syn.ikia cloud hub as well as for the algorithms for balancing between local sustainable energy supply and building demand.

Objective

The objective of this deliverable is to define the ICT architecture for accessing the building components that will be used actively to meet the energy demand shifting/synchronisation at neighbourhood level. The ICT architecture determines the required hardware infrastructure, as well as the communication between the edge computer and the syn.ikia cloud. Furthermore, an ontology is defined to create an unambiguous description of the different aspects of a component.

Description of the Deliverable

This deliverable describes the following topics:

- Chapter 3: ICT architecture
- Chapter 4: Components for flexibilization
- Chapter 5: Ontology
- Chapter 6: Conclusion
- Appendix A: Description of components for flexibilization and ontology for the Spanish demo case
- Appendix B: Description of components for flexibilization and ontology for the Dutch demo case
- Appendix C: Description of components for flexibilization and ontology for the Austrian demo case
- Appendix D: Description of components for flexibilization and ontology for the Norwegian demo case
- Appendix E: Variable name construction tool

3. ICT architecture

General set-up

In this chapter, the set-up of the ICT architecture is described. The general set-up is the same for all demo cases. The syn.ikia cloud is the central point in the set-up, and all measured data from the sensors will be send to this cloud. This communication will make use of a rest-API on the cloud server side. The definition of the communication, such as naming, and parameters is defined in the ontology (chapter 5). The actual settings and setpoints of the equipment can be requested from the cloud. Each demo project will have its own edge computer(s) or FOG server(s). This computer or server will translate the demo specific sensor names and data into the correct format as defined by the ontology. The format of the internal communication between the edge computer/FOG server and the sensors and actuator within a demo is free format and can be different for each demo project. This set-up gives a lot of freedom to choose which sensors, actuators and platform will be used.

The communication between the edge computer/fog server and the syn.ikia cloud must be initiated by the edge computer/FOG server which sends a API-request to the cloud server. The format of the API-request will be in JSON. A request to push data to the cloud will be a list of measurements. Each element in the list will contain the name, as defined in the ontology, and a list of data points. Each data point of this list will contain the time, in epoch seconds (number of seconds that have elapsed since 1-1-1970), and the value, while the unit is given by the ontology. To request data, settings or set points, the name of the data should be used in the API-request and epoch time can be add as an optional parameter. If the time is not given, the latest value will be returned by default. In the figure below a simplified scheme of the ICT architecture, which also indicates the split between task 3.2 and the tasks in work package 2, is given.

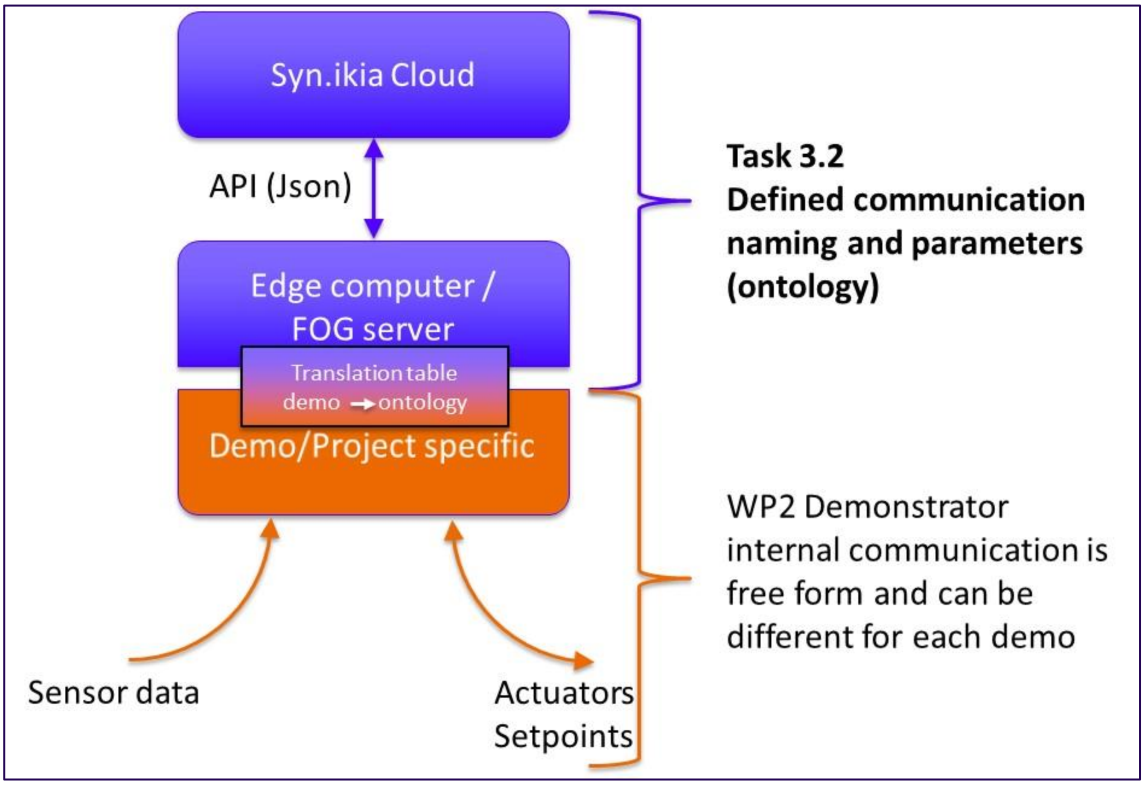


Figure 1. Simplified scheme of the ICT architecture.

Dutch demo case as an example

In this subsection, an example is given for the practical application of the ICT architecture in the Dutch demo case. The sensors, the parameter settings and actuators are connected to a third party (BeNext) gateway via several communication protocols, such as Z-wave and modbus. The gateway will send and receive data from a cloud service, in this case the BeNext cloud. Naming and unit of the sensors and actuators are compliant with the BeNext standard, which means that this naming is not in line with the syn.ikia ontology. To connect the third-party cloud to the syn.ikia cloud, an additional server is necessary. This FOG server will communicate with both cloud services and will translate the naming of the sensors and actuators. So that those are in line with the defined ontology. Also, the units of the measured or sent values should be converted to the correct unit, where necessary. In practice, this means that the FOG server will contain a translation table with both names for the same sensor or actuator and the conversion factor for the value. In the figure below, the layout of the Dutch demo case is shown.

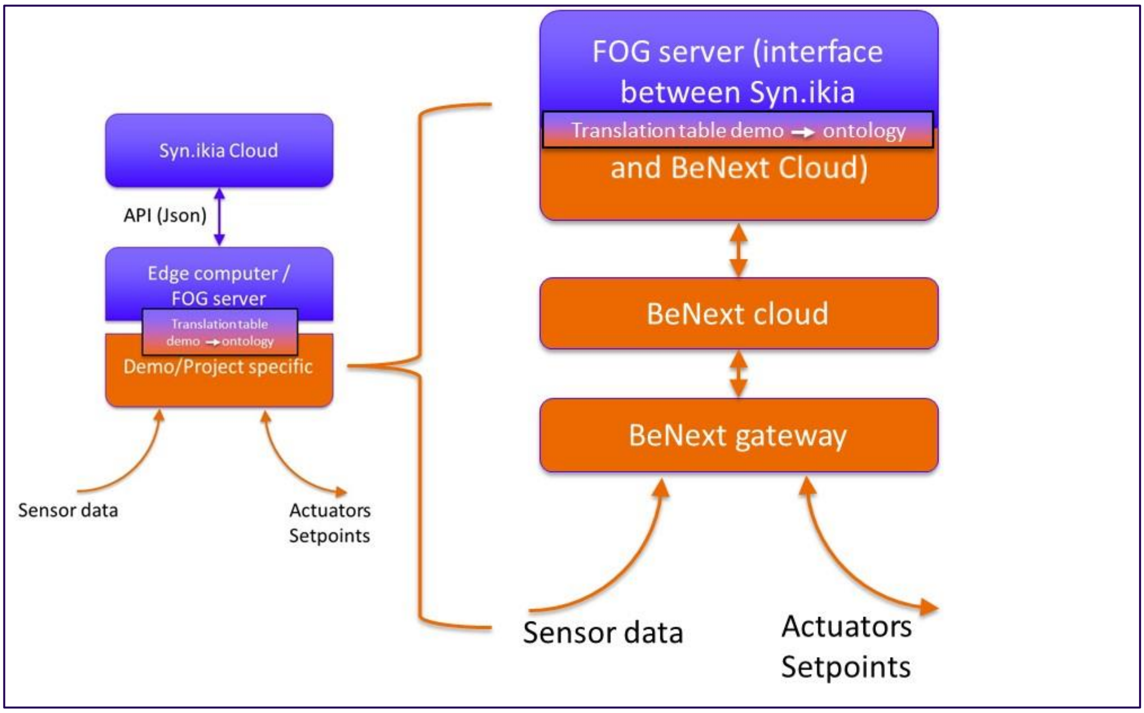


Figure 2. ICT architecture for the Dutch demo case.

4. Components for flexibilization

Within Task 3.2, an inventory is made for each demo project. The components for the flexibilization are organised per function and per level. The functions are space heating and space cooling, domestic hot water, ventilation, the PV-system, EV-charging points and household appliances. The components can be on three levels: the neighbourhood/district level, the building/block level or the apartment level.

In the Spanish demo case three heat pumps on building level will provide heat for space heating and domestic hot water. Each apartment is equipped with a heat exchanger that uses the heat from the heat pumps for one of the two functions. On the building 119 PV-panels are installed and 3 or 4 EV-charging points will be available. The household appliances will be measured as a whole (aggregated data), per apartment. A group of apartments will have a centralized ventilation system, however, there will be no control nor monitoring data from this device. The description of all components in the Spanish demo case can be found in Annex A.

In the Dutch demo case, each apartment will have a ground source heat pump installed to deliver space heating, space cooling and domestic hot water. On the top of the apartment building, solar panels are installed. However, each set of solar panels is connected to the electrical circuit of the individual apartments. Each apartment also has a ventilation system that is controlled based on the indoor CO_2 concentration. At district level, EV-charging points will be available. At apartment level, the in- and outgoing electricity, as well as the amount of electricity used by the heat pump and the electricity used by the ventilation system are monitored. Based on those measurements, the electricity use for household appliances is measured indirectly. The description of all components in the Dutch demo case can be found in Annex B.

In the Austrian demo case, the apartments are supplied with a central automatic solid fuel pellet boiler, while domestic hot water to the apartments is served by solar collectors on block level. To cater for the electricity needs, regular PV panels will also be installed on the roof of the blocks, and the produced energy will be distributed to the apartments. Ventilation on apartment level is supplied through natural ventilation via windows and doors. On apartment level, the IEQ data, thermal energy data and electricity usage will be collected. The description of all components in the Austrian demo case can be found in Annex C.

The Norwegian demo case will have a centralized ground source heat pump to deliver space heating and domestic hot water to the apartments. District heating will provide heat for auxiliary heating and DHW load. On each of the apartment buildings, there will be installed PV panels on the roof and facades. The produced energy will be shared between the apartments or buildings, this is dependent on whether the proposed new legislation on energy sharing between buildings will be implemented in time. If no changes are made to the current legislation before the detailed design of the systems is to be completed, the energy will only be shared between apartments within the same building. At the apartment block level, EV-charging points will be available for the inhabitants, and telemetry data will be collected from each charging point. On the apartment level, the electricity usage, IEQ data, and thermal energy data for DHW and heating will be collected. The description of all the currently designed components in the Norwegian demo case can be found in Annex D.

5. Ontology

Introduction

Within Task 3.2 an ontology is defined: a naming and structure convention to organize the numerous variables associated with readings, settings and set points related to appliances using energy and components producing energy, utilised within in the syn.ikia demo cases. The ontology forms a standardized way of defining variable names for all relevant values, which should lead to a clear understanding of the meaning of each variable name between parties.

In addition to defining variable names, the ontology is also intended to store metadata for each variable. Metadata deemed essential in this stage are unit, accuracy, measuring interval and variable type.

Several building ontologies already exist. Two of them were analysed and will be discussed briefly in this section. Although none of these existing ontologies were used directly in syn.ikia, elements of them have been used.

Project Haystack

Project Haystack is an open-source initiative used to standardize semantic data models focused on buildings. It uses a hierarchical approach consisting of entities and tags. An entity is a container of tags for a site (i.e. a building), a piece of equipment or a point (i.e. a data point such as a sensor or actuator). Each entity is then filled with tags which together define the entity. Example tags are:

- *geoCoord* for defining the geographical coordinates of a site;
- *heating* for identifying an appliance as a heating appliance;
- *sensor* for identifying a point as a sensor value.

A large collection of existing tags is available on the Project Haystack website, but each user is free to add tags if needed.

Figure 3 Example of Project Haystack ontology containing a site, equip and point entity. Source: Project Haystack; Reference Implementation – Applying Haystack Tagging for a Sample Building. *On: https://marketing.project-haystack.org/images/white-papers/Reference-Implementation--Applying-Haystack-Tagging-for-a-Sample-Building.pdf; accessed on 11-5-2021.*

Although Project Haystack appears to be a useful ontology for IoT in complex buildings with many sensors and actuators, their ontology only consist of tags and does not provide a framework for naming variables, see figure 3. However, the project has been inspirational in several occasions for coming up with a suitable term or abbreviation.

Energieprestatie Monitoring Norm (Stroomversnelling)

Energieprestatie Monitoring Norm (Dutch for energy performance monitoring norm) is an ongoing project that aims to define a standard for the Dutch built environment on energy performance monitoring. One of the outcomes is a monitoring matrix of variables relevant to the norm, supplemented with metadata such as necessity for legislation, monitoring frequency, unit, accuracy and a description. Variable names in the

Energieprestatie Monitoring Norm take the form of the symbol for dimension (e.g. E, T, Q) followed by an underscore (_) and an indicator for the function (such as sh for space heating).

The Energieprestatie Monitoring Norm contains only a part of the variables relevant for syn.ikia and does not provide a solution for dealing with structures where data points are related to specific appliances. However, collecting relevant metadata in an organized fashion is useful and will be implemented in the syn.ikia ontology as well.

Ontology definition

The syn.ikia ontology comes together in the 'architecture description' document for each demo project. The format for this document is provided by TNO as a template, ensuring consistent documentation for the different demo projects.

The document contains one chapter which serves as a brief overview of the demo project (location of the demo, main parties, document version) in addition to a table of appliances per *level* (district/neighbourhood, block and apartment) and *function* (e.g. space heating, domestic hot water production, PV-system). Each function is then described in one of the subsequent chapters of the document. A function chapter contains:

- Information regarding the appliances related to a function (e.g., for the function space heating the heat pump, heating buffer tank and weather station are relevant);
- **General information** summarizing essential specifications of the appliances;
- **Available readings** giving an overview of the relevant readings per appliance, together with the specified unit, measuring accuracy, measuring interval, variable name and variable type;
- **Settings and set points** giving an overview of the relevant settings and set points per appliance, together with the specified unit, setting accuracy, setting interval, variable name and variable type.

Typically, the ontology for a specific demo project consists at least of the functions space heating, domestic hot water (DHW) and PV-system.

Naming convention

The variable names for the readings and settings for each function is constructed using a naming convention, which defines the names of all the relevant variables in the system. The convention used within syn.ikia uses a structure on 4 levels:

- Dimension
- Equipment
- Node name
- Node type

A variable name is always composed of the dimensions, in combination with all or a selection of the remaining levels. In a variable name, the levels are separated by an underscore (_). Some notable examples:

Variable name	Definition
RH_ODA	Relative humidity (RH) of outdoor air (ODA)
T_HP_HC_In	Temperature at the heat pump (HP) inlet (In) of the heating circuit (HC)
Oper_HP_Mode_Set	Setting (Set) of the operational (Oper) mode (Mode) of the heat pump (HP), such as heating, cooling, DHW-production or off.

Common terms and abbreviations on each level are already collected in an Excel spreadsheet (see Annex E). This spreadsheet aids in the construction of the variable names. The abbreviations chosen for each dimension are based on the EN ISO 52000 family of EPB standards when available. Each participant within syn.ikia can use this spreadsheet to set-up variable names for each reading, setting or setpoint. Participants are free to add abbreviations to each level on their discretion and inform the syn.ikia partners about the added abbreviations.

In the case of multiple buildings, apartments, appliances or sensors, overlap of variable names could occur. This could happen for instance when multiple heat pumps are servicing the same building, or when several temperature sensors are present in the same buffer tank. This can be solved by adding a number to the appropriate level. When there are several apartments or buildings, the prefixes Ap and Bui can be added. Some examples:

- Temperatures at inlet of multiple heat pumps on the source: T_HP1_Srce_In, T_HP2_Srce_In…
- Temperatures at different locations of the DHW buffer tank: T_Tank_Sensor1, T_Tank_Sensor2…
- Power produced by the PV system on different buildings: Bui1_P_PV, Bui2_P_PV…
- Flow rate of the heat pump to the heating circuit on different apartments: Ap1_q_HP_HC, Ap2_q_HP_HC…

It must be noted that the prefixes Ap and Bui need to be added only if it is necessary from a modelling and control perspective. For instance, in the Dutch demo case the control algorithm will be ran for each apartment individually. The controller does not 'need' input from other buildings or apartments, and it can be assumed that all variables being fed into the controller only relate to the apartment of interest. Consequently, the prefixes Ap and Bui can be omitted in the ontology.

Use of ontology in the demo cases

For all demo cases the ontology is defined in the Annexes of this report:

- Annex A: Spanish demo case of INCASOL and IREC, located in Santa Coloma de Gramenet, Spain.
- Annex B: Dutch demo case of Area and TNO, located in Uden, The Netherlands.
- Annex C: Austrian demo case of SIR and ABUD, located in Salzburg, Austria.
- Annex D: Norwegian demo case of Arca Nova and NTNU, located in Fredrikstad, Norway.

Note: At this point in time (June 2022) not all details of the Austrian and Norwegian demo case are known yet. Therefore not all details of the components and ontology could be specified in the Annexes of this report.

6. Conclusion

In Task 3.2 an ICT architecture and an ontology are defined. The ICT architecture is flexible, enabling the syn.ikia cloud hub to interface with different software and hardware solutions available in the demo cases. The defined ontology forms a standardized way to define variable names to describe both the monitoring data coming from the buildings/apartments and the control signals to the equipment. Although in practice a specific demo project will have its own software and hardware solutions and its own names for sensor and equipment data, a workflow is described for a smooth interaction between local data sets and the syn.ikia cloud hub. The proposed ontology is implemented in several demo projects and further optimized based on the interaction with the demos.

A uniform data ontology is of utmost importance for a scalable solution of both the syn.ikia cloud hub as well as for the algorithms for balancing between local sustainable energy supply and building demand. A uniform data ontology makes it possible to quickly find the variables needed in algorithms for a specific building and a specific building service. This reduces the initialisation time of the algorithms used in flexibility services on district level and hence reduces the costs. Reduced costs and less need for skilled labour will accelerate the rapid market introduction of energy flexibility services.

The proposed ontology is implemented on different demo cases for smooth installation of the selected components in WP 2 and the implementation of the flexibility services in WP 4.

7. References

EN ISO 52000 family of EPB standards (2017), available at www.iso.org

Project Haystack, as found on https://project-haystack.org. This website contains several useful resources for using and implementing the Project Haystack ontology, such as (all accessed on 26-5-2021):

- Docs section on the website, containing an overview of all available tags in Project Haystack, on https://project-haystack.org/doc/index;
- Whitepaper “Reference Implementation – Applying Haystack Tagging for a Sample Building” on https://marketing.project-haystack.org/images/white-papers/Reference-Implementation--Applying-Haystack-Tagging-for-a-Sample-Building.pdf;
- Whitepaper “CABA White Paper on Project Haystack” on https://marketing.project-haystack.org/images/white-papers/CABA-White-Paper-on-Project-Haystack.pdf.

Stroomversnelling, *Energieprestatie Monitoring Norm v1.0.* On https://monitoringnorm.nl. Accessed on 27-5-2021.

Appendix A – Description of components for flexibilization and ontology for the Spanish demo case

General information demo case

Information demo case

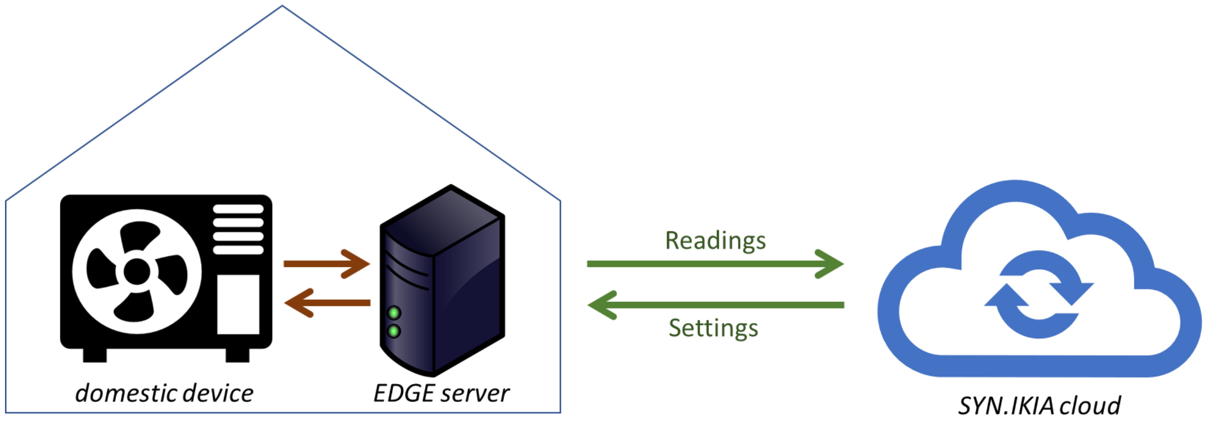
Country	Spain
Location of demo	Santa Coloma de Gramenet
Project developer	INCASOL
Project RTO	IREC
Version	0.1

Function and appliances table

	Level		
Function	***District***	***Block***	***Apartment***
Space heating	None	Air-to-water Heat Pump - LG	Substation Heat exchanger - LEAKO
Space cooling	None	None	None
Domestic hot water (DHW)	None	Air-to-water Heat Pump - LG	Substation Heat exchanger - LEAKO
Ventilation	None	None	None
PV-system	None	BAXI - KIT FOTON	None
EV-Charging point	None	EV-Charging point	None
Appliances & electric devices	None	Electric meters	Electric meters

Data exchange

For control purposes, readings are (sensor) data from the domestic device which are transferred by the EDGE-pc ***to*** the syn.ikia cloud hub. Settings are data (settings and setpoints) resulting from the control algorithm from the cloud ***to*** the EDGE server which are then transferred to the domestic device.



Function: Space Heating

Function	Space Heating	
Level	Building	Apartment
Equipment type	Weather station Heat pump (Air-to-water) Heating water tank	Substation Heat exchanger Emitters Thermostat

Of interest for the *space heating* function of the *heat pump*, are:

- Weather station
- Heat pump
- Heating water tank
- Substation heat exchanger
- Emitter
- Thermostat

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Weather station (building level)		
Information type	Value	Unit or options
Manufacturer	N/A	[-]

Heat pump (building level)		
Information type	Value	Unit or options
Outdoor unit		
Source	Air-to-water source	Air-to-water source
Manufacturer	LG	[-]
Type	ARUM 180LTE5	[-]
Number of units	3	units
Max Capacity (rated)	56.7	kW
Min Capacity (rated)	50.4	kW
COP (rated)	4.98	[-]
Inverter compressor	Inverter	Fixed capacity; inverter
Indoor unit		
Type	ARNH08GK3A4	[-]
Number of units	6	units
Capacity (rated)	25.2	kW

Heating water tank (building level)		
Information type	Value	Unit or options
Manufacturer	Baxi	[-]
Type	1000-IN	[-]

Buffer volume	1000	L
Maximum storage temperature	95	°C
Stationary heat loss		W
Location temperature sensor 1		L or m
Tank diameter		m
Tank height		m
Heating coil location from bottom		m
Inlet location from bottom		m
Outlet location from bottom		m

Substation Heat Exchanger (apartment level)		
Information type	**Value**	**Unit or options**
Manufacturer	LEAKO	[-]
Type	4-pipes substation CUD T-30HR-SA10CL	[-]

Emitter (apartment level)		
Information type	**Value**	**Unit or options**
Emitter type	Low temperature radiator	Underfloor heating; Radiator; Convector; Fan Convector; Other (specify)
Manufacturer	jaga	[-]

Thermostat (apartment level)		
Information type	**Value**	**Unit or options**
Manufacturer	LEAKO	[-]
Type	PMTAC	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Weather station (building level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Outdoor temperature	°C			T_ODA	instant
Outdoor relative humidity	%			RH_ODA	instant
Wind velocity	m/s			u_ODA	instant
Wind direction	°			angle_ODA	instant
Rain	mm			prec_ODA	instant
CO_2 concentration	ppm			CO2_ODA	instant
Solar radiation				I_ODA	instant

Heat Pump (building level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	Heating, DHW, Off			Oper_HP1_Mode	enum
Supply water temperature (heat pump outlet)	°C			T_HP1_Out	instant
Return water temperature (heat pump inlet)	°C			T_HP1_In	instant
Water flow rate	L/s			q_HP1	instant
Pump status of the primary side	ON/OFF			Oper_HP1_Pump	instant
Distribution valve position	Heating / DHW			Oper_HP_Valve	enum
Power consumption	Wh			P_HP	Cum

Heating water tank (building level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Tank water temperature	°C			T_TankSH	instant
Inlet water temperature – Primary side	°C			T_TankSH_HP_In	instant
Outlet water temperature – Primary side	°C			T_TankSH_HP_Out	instant
Water flow rate – Primary side	L/s			q_TankSH_HP	instant
Thermal energy meter – Primary side	Wh			Q_TankSH_HP	cum
Inlet water temperature – Secondary side	°C			T_TankSH_HC_In	instant
Outlet water temperature – Secondary side	°C			T_TankSH_HC_Out	instant
Water flow rate – Secondary side	L/s			q_TankSH_HC	instant
Thermal energy meter –Secondary side	Wh			Q_TankSH_HC	cum
Pump status of the secondary side	ON/OFF			Oper_HeatDis_Pump	enum

Substation Heat Exchanger (apartment level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Thermal energy - Household	Wh			Ap1_Q_House_HC	cum
Water supply temperature	°C			Ap1_T_House_HC_In	instant
Water return temperature	°C			Ap1_T_House_HC_Out	instant
Water flow	L/s			Ap1_q_House_HC	instant

Emitter (apartment level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Thermostat (apartment level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
All the apartments					
Indoor air temperature	°C			Ap1_T_House	instan
Indoor air humidity	%			Ap1_RH_House	instan
10 apartments – Detailed monitoring					
Indoor air temperature - 1	°C	0.5 °C		Ap1_T_House_Sensor1	instan
Indoor air temperature - 2	°C	0.5 °C		Ap1_T_House_Sensor2	instan
Indoor air humidity - 1	%	5 %		Ap1_RH_House_Sensor1	instan
Indoor air humidity - 2	%	5 %		Ap1_RH_House_Sensor2	instan
CO2 concentration - 1	ppm	100 ppm		Ap1_CO2_House_Sensor1	instan
CO2 concentration - 2	ppm	100 ppm		Ap1_CO2_House_Sensor2	instan
Illuminance - 1	lux			Ap1_E_House_Sensor1	instan
Illuminance - 2	lux			Ap1_E_House_Sensor2	instan
Presence - 1	1/0				enum
Presence - 2	1/0			Ap1_o _House_Sensor2	enum
Window sensor - 1	1/0			Ap1_Oper_House_Sensor1	enum
Window sensor - 2	1/0			Ap1_Oper_Window_Sensor2	enum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Weather station (building level)					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Heat pump (building level)					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
Operating mode	Heating, Domestic Hot water, Off			Oper_HP1_Mode_Set	setpoint
Forced operation[1]					
Smart Grid (SG)[2]					
Set-point supply water temperature for heating	°C			T_HP_Set	setpoint
TH on/off variable heating water[3]					
Flow-rate	L/s			q_HP1	setpoint
Pump status of the primary side	ON/OFF			Oper_HP1_Pump	setpoint
Distribution valve position	Heating / DHW			Oper_HP_Valve	setpoint

[1]Forced operation: It is a function to deactivate the logic that drives the water pump itself.
[2]Smart Grid (SG): The function to enable / disable the SG Ready function and to set the reference value at the step 2.
[3]TH on/off variable heating water: The temperature of the heating water can be adjusted according to the field environment preparing for heating claims.

Heating water tank (building level)					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
Set-point water tank temperature	°C			T_TankSH_Set	setpoint
Pump status of the secondary side	ON/OFF			Oper_HeatDis_Pump	setpoint

Substation Heat Exchanger (apartment level)					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
Set-point Temp DHW				Ap1_T_House_HC_Set	instant
Priority DHW / Heating				Ap1_Oper_House	enum

Emitter (apartment level)					
Settings	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Thermostat (apartment level)					
Settings	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Set-point room thermostat	ºC			Ap1_T_House_HC_Set	setpoint

Function: Domestic hot water

Function	Domestic hot water	
Level	Building	Apartment
Equipment type	Weather station Heat pump (Air-to-water) DHW water tank	Substation Heat exchanger

Of interest for the *domestic hot water* function of the *heat pump*, are:

- Weather station
- Heat pump
- DHW water tank
- Substation heat exchanger

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Weather station (building level)		
Information type	**Value**	**Unit or options**
Manufacturer	N/A	[-]

Heat pump (building level)		
Information type	**Value**	**Unit or options**
Outdoor unit		
Source	Air-to-water source	Air-to-water source
Manufacturer	LG	[-]
Type	ARUM 180LTE5	[-]
Number of units	3	units
Max Capacity (rated)	56.7	kW
Min Capacity (rated)	50.4	kW
COP (rated)	4.98	[-]
Inverter compressor	Inverter	Fixed capacity; inverter
Indoor unit		
Type	ARNH08GK3A4	[-]
Number of units	6	units
Capacity (rated)	25.2	kW

DHW water tank (building level)		
Information type	Value	Unit or options
Manufacturer	Baxi	[-]
Type	2000-IN	[-]
Buffer volume	2000	L
Maximum storage temperature	95ºC	°C
Stationary heat loss		W
Location temperature sensor 1		L or m
Tank diameter		m
Tank height		m
Heating coil location from bottom		m
Inlet location from bottom		m
Outlet location from bottom		m

Substation Heat Exchanger (apartment level)		
Information type	Value	Unit or options
Manufacturer	LEAKO	[-]
Type	4-pipes substation CUD T-30HR-SA10CL	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Weather station (building level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Outdoor temperature	°C			T_ODA	instant
Outdoor relative humidity	%			RH_ODA	instant
Wind velocity	m/s			u_ODA	instant
Wind direction	°			angle_ODA	instant
Rain	mm			prec_ODA	instant
CO_2 concentration	ppm			CO2_ODA	instant
Solar radiation				I_ODA	instant

Heat Pump (building level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	Heating, Domestic hot water, Off			Oper_HP1_Mode	enum
Supply water temperature (heat pump outlet)	°C			T_HP1_Out	instant
Return water temperature (heat pump inlet)	°C			T_HP1_In	instant
Water flow rate	L/s			q_HP1	instant
Pump status of the primary circuit	ON/OFF			Oper_HP1_Pump	instant
Distribution valve position	Heating / DHW			Oper_HP_Valve	enum
Power consumption	Wh			P_HP	Cum

DHW water tank (building level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Tank water temperature	°C			T_TankDHW	instant
Inlet water temperature – Primary side	°C			T_TankDHW1_HP_In	instant
Outlet water temperature – Primary side	°C			T_TankDHW_HP_Out	instant
Water flow rate – Primary side	L/s			q_TankDHW_HP	instant
Thermal energy meter – Primary side	Wh			Q_TankDHW_HP	cum
Inlet water temperature – Secondary side	°C			T_TankDHW_DHW_In	instant
Outlet water temperature – Secondary side	°C			T_TankDHW_DHW_Out	instant
Water flow rate – Primary side	L/s			q_TankDHW_DHW	instant
Thermal energy meter –Secondary side	Wh			Q_TankDHW_DHW	cum
Pump status of the secondary side	ON/OFF			Oper_DHWdis_Pump	instant

Substation Heat Exchanger (apartment level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Thermal energy - Household	Wh			Ap1_Q_House_DHW	cum
Water supply temperature	°C			Ap1_T_House_DHW_In	instant
Water return temperature	°C			Ap1_T_House_DHW_Out	instant
Water flow	L/s			Ap1_q_House_HC	instant
DHW valve position	%			Ap1_Oper_House_DHW	enum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Weather station (building level)					
Settings	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Heat pump (building level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	Heating, Domestic Hot water, Off	-		Oper_HP1_Mode_Set	setpoint
Forced operation[1]					
Smart Grid (SG)[2]					
Set-point supply water temperature	°C			T_HP_Set	setpoint
TH on/off Variable, DHW[3]					
Flow-rate	L/s			q_HP1	setpoint
Pump status of the primary side	ON/OFF			Oper_HP1_Pump	setpoint
Distribution valve position	Heating / DHW			Oper_HP_Valve	setpoint

[1]Forced operation: It is a function to deactivate the logic that drives the water pump itself.
[2]Smart Grid (SG): The function to enable / disable the SG Ready function and to set the reference value at the step 2.
[3]TH on/off variable heating water: The temperature of the heating water can be adjusted according to the field environment preparing for heating claims.

DHW water tank (building level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Set-point water tank temperature	°C			T_TankDHW_Set	setpoint
Pump status of the secondary side	ON/OFF			Oper_DHWDis_Pump	setpoint

Substation Heat Exchanger (apartment level)					
Settings	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
max flow rate DHW					
Set-point Temp DHW				Ap1_T_House_DHW_Set	instant
Priority DHW / Heating				Ap1_Oper_House	enum
Mode DHW					

Function: PV system

Function	PV system
Level	Building
Equipment type	Weather station PV panels Inverter

Of interest for the *PV system* function of the *PV system*, are:

- Weather station
- PV panel
- Inverter

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Weather station		
Information type	**Value**	**Unit or options**
Manufacturer	N/A	[-]

PV panel		
Information type	**Value**	**Unit or options**
Manufacturer	Baxi	[-]
Type	Kit Foton	[-]
Technology	Monocrystalline	[-]
Rated power	335	Wp
Area	1.66	m^2
Size	1675 x 992 x 35	mm
Number of PV panels	119	units

Inverter		
Information type	**Value**	**Unit or options**
Manufacturer	Baxi	[-]
Type	Solar PV BOX 10kW and 8kW	[-]
Maximum voltage	1000	V
Maximum PV power installed	15000	Wp
Maximum direct current	10	A
Maximum ouput power (AC)	10000	VA
Number of inverters	3 x 10kW and 1 x 8kW	units

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Weather station					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Outdoor temperature	ºC			T_ODA	instant
Outdoor relative humidity	%			RH_ODA	instant
Wind velocity	m/s			u_ODA	instant
Wind direction	º			angle_ODA	instant
Rain	mm			prec_ODA	instant
CO_2 concentration	ppm			CO2_ODA	instant
Solar radiation				I_ODA	instant

PV panel					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Inverter					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Power	W			P_PV	cum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Weather station (building level)					
Settings	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

PV panel					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Inverter					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Function: EV-Charging point

Function	EV charging point
Level	Building
Equipment type	EV charging point

Of interest for the *EV Charging point* function of the *EV Charging point*, are:

- EV Charging point

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

EV Charging point		
Information type	Value	Unit or options
Manufacturer	N/A	[-]
Battery capacity	N/A	
Number of EV	3 or 4	

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

EV Charging point					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Power	W			P_EV	cum
Status vehicle	YES/NO			Oper_EV	instant
State of charge of EV battery	%				instant

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

EV Charging point					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Function: Appliances & electric devices

Function	Appliances
Level	Apartment
Equipment type	Electric meters

Of interest for the *Appliances* function of the *electric meter*, are:

- Electric meters

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Electric meter		
Information type	Value	Unit or options
Manufacturer	N/A	[-]
Maximum power		kW
Number of meters	Building level: 1 x community services (lift, lighting) 1 x Heating and DHW centralized system 1 x parking lots Apartment level: 1 x apartment 2-4 apartments will have submetering (lighting, stove and oven, dishwasher, washing machine and drier)	

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Electric meter					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Power	W			P_CommunServ P_HP P_Parking Ap1_P_House Ap1_P_House_Sensor1 Ap1_P_House_Sensor2 Ap1_P_House_Sensor3 Ap1_P_House_Sensor4	cum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Electric meter					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Appendix B – Description of components for flexibilization and ontology for the Dutch demo case

syn.ikia

General information demo case

Information demo case

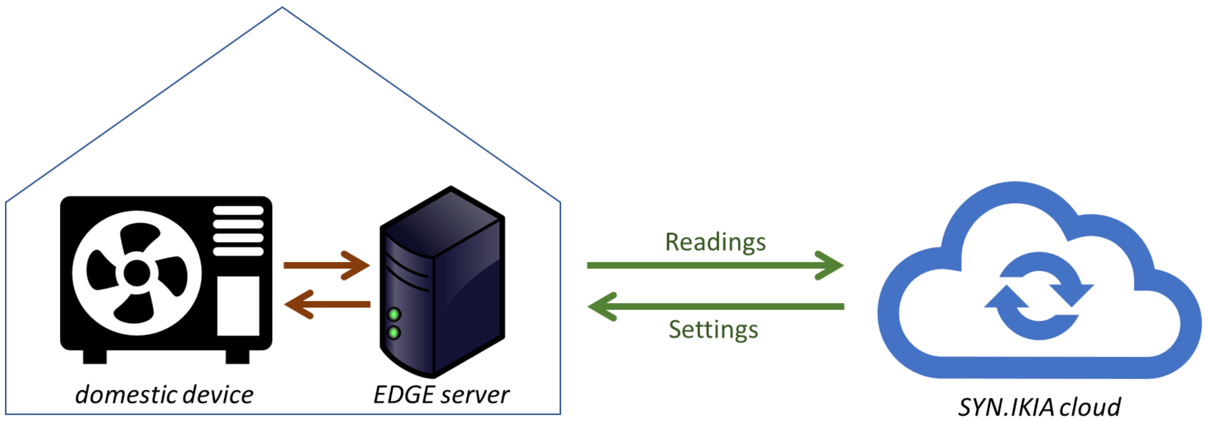
Country	Netherlands
Location of demo	Uden
Project developer	Area
Project RTO	TNO
Version	0.3

Function and appliances table

	Level		
Function	***District***	***Block***	***Apartment***
Space heating	None	None	Itho Daalderop Heat Pump
Space cooling	None	None	Itho Daalderop Heat Pump
Domestic hot water	None	None	Itho Daalderop Heat Pump; buffer tank
Ventilation	None	None	Orcon C4a MVS-15
PV	None	None	LONGi Solar
EV-Charging point	None	None	N/A
Household appliances	None	None	N/A

Data exchange

For control purposes, readings are (sensor) data from the domestic device which are transferred by the EDGE-pc *to* the SYN.IKIA cloud. Settings are data (settings and setpoints) resulting from the control algorithm from the cloud *to* the EDGE server which are then transferred to the domestic device.



Function: Space heating

Function	Space heating
Level	Apartment
Equipment type	Heat Pump (ground source) Building heat emitter Building

Of interest for the *space heating* function of the *heat pump*, are:

- Heat pump appliance
- Building heat emitter
- Building details

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Heat Pump		
Information type	**Value**	**Unit or options**
Source	Ground-source	Air-source; ground-source
Manufacturer	Itho Daalderop	[-]
Type	WPU 35 5G	[-]
Max Capacity (label)	3,3 (W10/W35 EN14511)	kW
Min Capacity (label)	N/A	kW
COP (label)	6,0 (W10/W35 EN14511)	[-]
Inverter compressor	Fixed capacity	Fixed capacity; inverter

Building heat emitter		
Information type	**Value**	**Unit or options**
Emitter type	Underfloor heating	Underfloor heating; Radiator; Convector; Fan Convector; Other (specify)

Building		
Information type	**Value**	**Unit or options**
IFC File	Attached to document	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Heat Pump					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	Heating, Cooling, Tap water production, Off	N/A	60 s	Oper_HP_Mode	enum
Source temperature (inlet)	°C	1 °C	60 s	T_HP_Srce _In	instant
Source temperature (outlet)	°C	1 °C	60 s	T_HP_Srce _Out	instant
Temperature to heating circuit (heat pump outlet)	°C	1 °C	60 s	T_HP_HC_Out	instant
Temperature from heating circuit (heat pump inlet)	°C	1 °C	60 s	T_HP_HC_In	instant
Flow-rate source	L/s	0,01 L/s	60 s	q_HP_Srce	instant
Flow-rate heating circuit[1]	L/s	0,01 L/s	60 s	q_HP_HC	instant
Current heat production[1]	W	50 W	60 s	Phi_HP	instant
Power consumption	Wh	10 Wh	60 s	P_HP	cumulative

[1] Dedicated heat flow meter

Building heat emitter				
Reading	**Unit**	**Accuracy**	**Interval**	**Remarks**
N/A				

Building					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Outside temperature[2]	°C	0,5 °C	15 min	T_ODA	instant
Room temperature	°C	0,3 °C	10 min	T_LivingRoom	instant
Room temperature	°C	0,3 °C	10 min	T_BedRoom1	instant
Room temperature	°C	0,3 °C	10 min	T_BedRoom2	instant
Setpoint room thermostat	°C	0,5 °C	10 min	T_LivingRoom_Set	instant
Power consumption of house	W	10 W	10 min	P_House	instant

[2] Data from the nearest weather station (KNMI - Volkel)

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Heat pump					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Heating mode	Free, Blocked	N/A	60 s	Oper_HP_HC_Set	enum
Setpoint supply temperature of heating circuit	°C	0,5 °C	60 s	T_HP_HC_Set	setpoint
Setpoint heat demand	%	1 %	60 s	Q_HP_ Hc_Set	setpoint

Building heat emitter					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Building					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Function: Domestic Hot Water

Function	Domestic hot water
Level	Apartment
Equipment type	Heat Pump (ground source) Hot water tank

Of interest for the *domestic hot water* function of the *heat pump*, are:

- Heat pump appliance;
- Hot water tank.

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Heat Pump		
Information type	**Value**	**Unit or options**
Source	Ground-source	Air-source; ground-source
Manufacturer	Itho Daalderop	[-]
Type	WPU 35 5G	[-]
Max Capacity (label)	3,3 (W10/W35 EN14511)	kW
Min Capacity (label)	N/A	kW
COP (label)	3,9 (NEN7120 class 4)	[-]
Inverter compressor	Fixed capacity	Fixed capacity; inverter

Hot water tank		
Information type	**Value**	**Unit or options**
Manufacturer	Itho Daalderop	[-]
Type	WPV 150L 2g	[-]
Buffer volume	150,0	L
Maximum storage temperature	95	°C
Stationary heat loss	27,4 (Tank 65°C / Ambient 20 °C)	W
Location temperature sensor 1	30 L	L or m
Location temperature sensor 2	56 L	L or m
Location temperature sensor 3	N/A	L or m
Tank diameter	t.b.d.	m
Tank height	t.b.d.	m
Heating coil location from bottom	xxx.x – xxx.x	m
Inlet location from bottom	t.b.d.	m
Outlet location from bottom	t.b.d.	m

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Heat Pump					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	Heating, Cooling, Tap water production, Off	N/A	60 s	Oper_HP_Mode	enum
Source temperature (inlet)	°C	1 °C	60 s	T_HP_Srce _In	instant
Source temperature (outlet)	°C	1 °C	60 s	T_HP_Srce _Out	instant
Temperature to tank (heat pump outlet)[3]	°C	1 °C	60 s	T_HP_Coil_Out	instant
Temperature from tank (heat pump inlet)[3]	°C	1 °C	60 s	T_HP_Coil_In	instant
Flow-rate source	L/s	0,01 L/s	60 s	q_HP_Srce	instant
Flow-rate tank coil[3]	L/s	0,01 L/s	60 s	q_HP_Coil	instant
Current heat production[3]	W	50 W	60 s	Phi_HP	instant
Power consumption	W	10 W	60 s	P_HP	Cumulative

[3] Dedicated heat flow meter

Hot water tank					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Inlet water temperature [4]	°C	1 °C	60 s	T_Tank_DHW_In	instant
Outlet water temperature [4]	°C	1 °C	60 s	T_Tank_DHW_Out	instant
Tank temperature 1	°C	1 °C	60 s	T_Tank_Sensor1	instant
Tank temperature 2	°C	1 °C	60 s	T_Tank_Sensor2	instant
Tapping flow rate [4]	L/s	0,01 L/s	60 s	q_Tank	instant

[4] Dedicated heat flow meter

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Heat pump					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
DHW mode	ECO, Comfort, Blocked	N/A	60 s	Oper_HP_DHW_Set	enum
DHW temperature setpoint	°C	1 °C	60 s	T_HP_DHW_Set	setpoint
Hysteresis setpoint for DHW tank	°C	1 °C	60 s	T_HP_DHW_Hyst	setpoint

Hot water tank				
Setting	Unit	Accuracy	Interval	Remarks
N/A				

Function: Space cooling

Function	Space cooling
Level	Apartment
Equipment type	Heat Pump (ground source) Building heat emitter Building

Of interest for the *space cooling* function of the *heat pump*, are:

- Heat pump appliance;
- Building heat emitter;
- Building details.

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Heat Pump		
Information type	**Value**	**Unit or options**
Source	Ground-source	Air-source; ground-source
Manufacturer	Itho Daalderop	[-]
Type	WPU 35 5G	[-]
Max Capacity (label)	N/A	kW
Min Capacity (label)	N/A	kW
COP (label)	N/A	[-]
Inverter compressor	Fixed capacity	Fixed capacity; inverter

Building heat emitter		
Information type	**Value**	**Unit or options**
Emitter type	Underfloor heating	[-]

Building		
Information type	**Value**	**Unit or options**
IFC File	Attached to document	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Readings for Function: Space cooling are identical to those of Function: Space heating.

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Settings and setpoints for Function: Space cooling are identical to those of Function: Space heating.

Function: Ventilation

Function	Ventilation
Level	Apartment
Equipment type	Fan unit; type C

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Fan unit		
Information type	Value	Unit or options
Type	C	A; B; C; D
Manufacturer	Orcon	[-]
Type	C4a MVS-15	[-]
Control variables	CO_2 in single room	CO_2, RH, manual
Maximum air flow	435 (@ 200 Pa)	m^3/h
Maximum power consumption	86	W

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Fan unit					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
CO_2-concentration	ppm	50 ppm	60 s	CO2_LivingRoom	instant
Relative humidity	%	5%	60 s	RH_LivingRoom	instant

Settings and setpoints

There are no setting and setpoints available for Function: Ventilation.

Function: PV-system

Function	PV-system
Level	Apartment
Equipment type	4 panels per apartment; inverter

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

PV-system		
Information type	Value	Unit or options
Manufacturer PV-panels	LONGi Solar	[-]
Type PV-panels	backsheet, mono	[-]
PV-panel power	390	Wp
Number of panels (per apartment)	4	[-]

Panel orientation	180°	° with respect to North
Panel tilt angle	20°	° with respect to horizontal
Manufacturer inverter	Solis	[-]
Type inverter	Solis mini 1500-4G	[-]
Inverter power	1800	W

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

PV-panels					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Inverter					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Produced power	W	1 W	60	P_PV	instant

Settings and setpoints

There are no setting and setpoints available for Function: PV-system.

Appendix C – Description of components for flexibilization and ontology for Austrian demo case

General information demo case

Information demo case

Country	Austria
Location of demo	Salzburg
Project developer	SIR - Salzburger Institut für Raumordnung & Wohnen
Project RTO	ABUD
Version	0.1

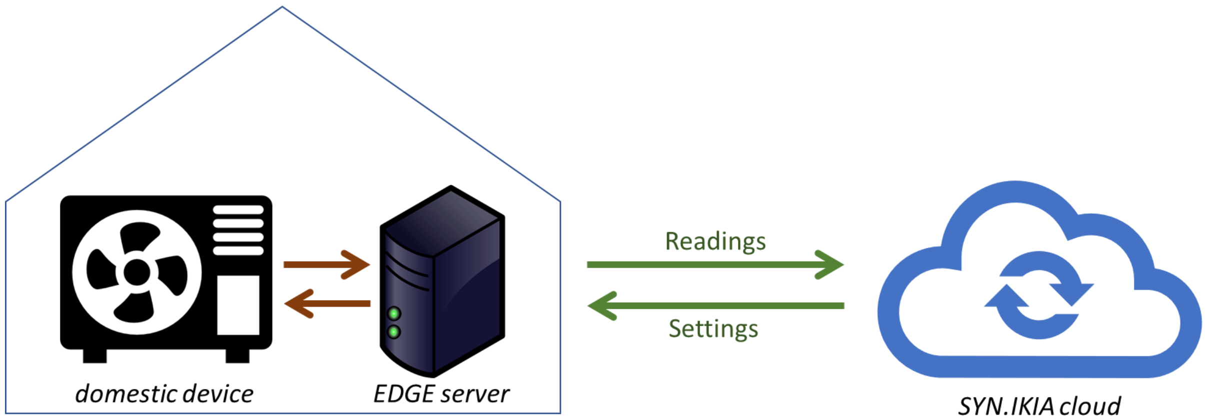
Function and appliances table

	Level		
Function	***District***	***Block***	***Apartment***
Space heating	None	Automatic solid fuel boiler (pellets)	None
Space cooling	None	None	None
Domestic hot water	None	Solar collector Automatic solid fuel boiler (pellets)	None
Ventilation	None	None	None
PV-system	None	PV panels	None
EV-Charging point	None	None	None
Household appliances	N/A	N/A	Electric meters

Note: At this point in time (June 2022) not all details of the Austrian demo case are known yet. Therefore not all details of the components could be specified in this Annex. Details in this annex are about the Berchtesgadenerstraße 70-72.

Data exchange

For control purposes, readings are (sensor) data from the domestic device which are transferred by the EDGE-pc ***to*** the SYN.IKIA cloud. Settings are data (settings and setpoints) resulting from the control algorithm from the cloud ***to*** the EDGE server which are then transferred to the domestic device.



Function: Space heating

Function	Space heating	
Level	Block	Apartment
Equipment type	Automatic solid fuel boiler (pellets) Heating water tank	Radiators Thermostat

Of interest for the *space heating* function are:

- Automatic solid fuel boiler (pellets)
- Heating water tank
- Radiators
- Thermostat

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Automatic solid fuel boiler (pellets) (block level)		
Information type	**Value**	**Unit or options**
Source	Pellets	[-]
Manufacturer	TBD	[-]
Type	TBD	[-]
Number of units	1	pcs
Max capacity	100	kW
COP	TBD	[-]

Heating water tank (block level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	[-]
Type	TBD	[-]
Buffer volume	8800	L
Max storage temperature	62	°C
Heat loss	TBD	W
Number of temp sensors	5	pcs

Emitter (apartment level)		
Information type	**Value**	**Unit or options**
Emitter type	Radiator	Underfloor heating; Radiator; Convector; Fan Convector; Other (specify)

Thermostat (apartment level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	[-]
Type	TBD	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Automatic solid fuel boiler (pellets) (block level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	On, Off	N/A	TBD	Oper_Pellet_Mode	enum
Source temperature (inlet)	°C	TBD	TBD	T_Pellet_Srce_In	instant
Source temperature (outlet)	°C	TBD	TBD	T_Pellet_Srce_Out	instant
Flow rate tank to coil	L/s	0,01 L/s	TBD	q_Pellet	instant
Power consumption	W	10 W	TBD	P_Pellet	Cumulative

Heating water tank (block level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Tank temperature 1	°C	TBD	TBD	T_Tank_Sensor_1	instant
Tank temperature 2	°C	TBD	TBD	T_Tank_Sensor_2	instant
Tank temperature 3	°C	TBD	TBD	T_Tank_Sensor_3	instant
Tank temperature 4	°C	TBD	TBD	T_Tank_Sensor_4	instant
Tank temperature 5	°C	TBD	TBD	T_Tank_Sensor_5	instant

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Automatic solid fuel boiler (pellets) (block level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Setpoint boiler	°C	TBD	TBD	TBD	setpoint

Hot water tank (block level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Emitter (apartment level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Function: Domestic Hot Water

Function	Domestic hot water	
Level	Block	Apartment
Equipment type	Automatic solid fuel boiler (pellets) Solar collector Heating water tank	-

Of interest for the *domestic hot water*, are:

- Automatic solid fuel boiler (pellets)
- Heating water tank
- Solar collector

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Automatic solid fuel boiler (pellets) (block level)		
Information type	**Value**	**Unit or options**
Source	Pellets	[-]
Manufacturer	TBD	[-]
Type	TBD	[-]
Number of units	1	pcs
Max capacity	100	kW
COP	TBD	[-]

Heating water tank (block level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	[-]
Type	TBD	[-]
Buffer volume	8800	L
Max storage temperature	62	°C
Heat loss	TBD	W
Number of temp sensors	5	pcs

Solar collector (block level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	TBD
Area covered	77	m^2
Nominal volume	5000	l

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Automatic solid fuel boiler (pellets) (block level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Operating mode	On, Off	N/A	TBD	Oper_Pellet_Mode	enum
Source temperature (inlet)	°C	TBD	TBD	T_Pellet_Srce_In	instant
Source temperature (outlet)	°C	TBD	TBD	T_Pellet_Srce_Out	instant
Flow rate tank to coil	L/s	TBD	TBD	q_Pellet	instant
Power consumption	W	TBD	TBD	P_Pellet	cumulative

Heating water tank (block level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Tank temperature 1	°C	TBD	TBD	T_Tank_Sensor_1	instant
Tank temperature 2	°C	TBD	TBD	T_Tank_Sensor_2	instant
Tank temperature 3	°C	TBD	TBD	T_Tank_Sensor_3	instant
Tank temperature 4	°C	TBD	TBD	T_Tank_Sensor_4	instant
Tank temperature 5	°C	TBD	TBD	T_Tank_Sensor_5	instant

Solar collector (block level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Outlet temperature	°C	TBD	TBD	T_SC_Out	instant
Inlet temperature	°C	TBD	TBD	T_SC_In	instant
Flow rate	L/s	TBD	TBD	q_SC	instant
Yield	kWh	TBD	TBD	Y_SC	cumulative
Power consumption	W	TBD	TBD	P_SC	cumulative

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Automatic solid fuel boiler (pellets) (block level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Setpoint boiler	°C	TBD	TBD	TBD	setpoint

Hot water tank (block level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
N/A					

Solar collector (block level)					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Setpoint	°C	TBD	TBD	TBD	setpoint

Function: PV-system

Function	PV-system
Level	Block
Equipment type	TBD

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

PV-system		
Information type	**Value**	**Unit or options**
Manufacturer PV-panels	TBD	[-]
Type PV-panels	TBD	[-]
PV-panel power	TBD	Wp

Number of panels	TBD	[-]
Panel orientation	TBD	° with respect to North
Panel tilt angle	TBD	° with respect to horizontal
Area covered	TBD	m2
Inverter type	TBD	[-]
Inverter power	TBD	W

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

PV-panels					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
TBD					

Inverter					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
TBD					

Settings and setpoints

There are no settings and setpoints available for Function: PV-system.

Appendix D – Description of components for flexibilization and ontology for Norwegian demo case

General information demo case

Information demo case

Country	Norway
Location of demo	Fredrikstad
Project developer	Arca Nova
Project RTO	NTNU
Version	0.1

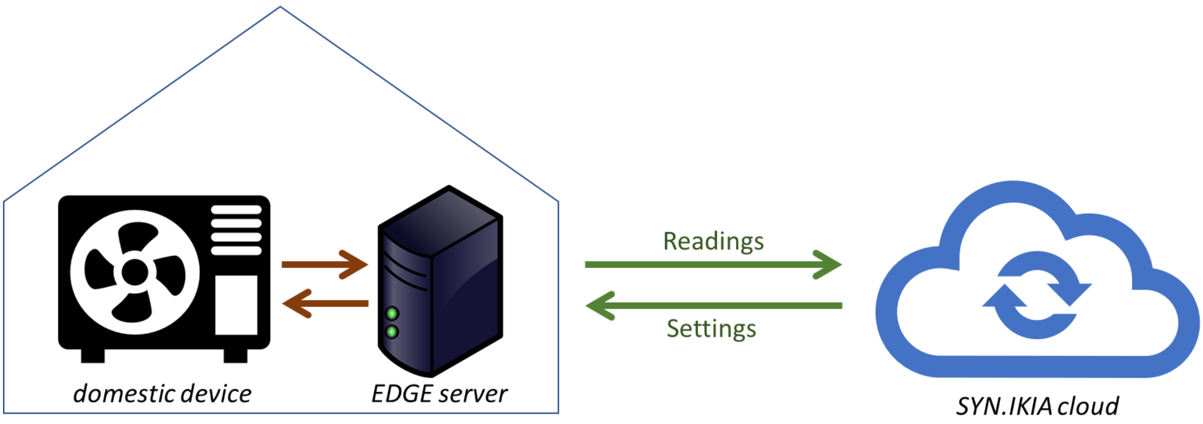
Function and appliances table

	Level		
Function	***District***	***Block***	***Apartment***
Space heating	Heat pump (geothermal)	None	Underfloor heating
Domestic hot water	Heat pump (geothermal)	None	None
Ventilation	None	None	Systemair
PV-system	None	JASolar[1]	None
EV-Charging point	None	EV-charging point	None
Appliances & electric devices	None	Electric meters	Electric meters

Note: At this point in time (June 2022) not all details of the Norwegian demo case are known yet. Therefore not all details of the components could be specified in this Annex.

Data exchange

For control purposes, readings are (sensor) data from the domestic device which are transferred by the EDGE-pc ***to*** the SYN.IKIA cloud. Settings are data (settings and setpoints) resulting from the control algorithm from the cloud ***to*** the EDGE server which are then transferred to the domestic device.



[1] This might be changed to the district level dependent on the outcome of upcoming changes to legislation.

Function: Space heating

Function	Space Heating	
Level	District	Apartment
Equipment type	Heat pump (geothermal) Heating water tank	Emitter (underfloor heating) Thermostat

Of interest for the *space heating* function of the *heat pump*, are:

- Heat pump
- Heating water tank
- Emitter (underfloor heating)
- Thermostat

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Heat pump (district level)		
Information type	**Value**	**Unit or options**
Source	Geothermal (brine to water)	[-]
Manufacturer	TBD	[-]
Type	TBD	[-]
Number of units	1	
Max capacity (design point)	TBD	kW
Max capacity (design point)	TBD	kW
COP (design point)	TBD	[-]
Number of compressors	TBD	[-]
Number of compressors with inverter	TBD	[-]

Heating water tank (district level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	[-]
Type	TBD	[-]
Buffer volume	TBD	L
Maximum storage temperature	TBD	°C
Stationary heat loss	TBD	W
Location temperature sensor 1	TBD	L or m
Tank diameter	TBD	m
Tank height	TBD	m
Heating coil location from bottom	TBD	m
Inlet location from bottom	TBD	m
Outlet location from bottom	TBD	m

Emitter (apartment level)		
Information type	**Value**	**Unit or options**
Emitter type	Underfloor heating	Underfloor heating; Radiator; Convector; Fan Convector; Other (specify)

Thermostat (apartment level)		
Information type	**Value**	**Unit or options**
Manufacturer	TBD	[-]
Type	TBD	[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Heat pump (district level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
TBD					

Heating water tank (district level)					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Tank water temperature	°C		15min	T_Tank_Sensor	instant
Inlet water temperature – District heating	°C		15min	T_Tank_DH _IN	instant
Inlet water temperature – Geothermal heat pump	°C		15min	T_Tank_ GT _IN	instant
Inlet water flow rate – District heating	L/s		15min	q_Tank_DH_IN	instant
Inlet water flow rate – Geothermal heat pump	L/s		15min	q_Tank_GT_INL	instant
Outlet water temperature	°C		15min	T_Tank_Out	instant
Outlet water flow rate	L/s		15min	q_Tank_Out	instant
Return water temperature	°C		15min	T_ Tank_In_Return	instant
Return water flow rate			15min	q_Tank_IN_Return	instant
Pump status of the secondary side	ON/OFF		NA	Mode_PUMP	enum

Emitter (apartment level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Inlet water temperature	°C		15min	Ap1_T_House_UFH_IN	instant
Inlet water flow rate	L/s		15min	Ap1_q_House_UFH_IN	
Return water temperature	°C		15min	Ap1_T_ House_UFH_Out	
Return water flow rate	L/s		15min	Ap1_q_ House_UFH_Out	

Apartments – Detailed monitoring					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Indoor air temperature - 1	°C		15min	Ap1_T_House_LivingRoom	instant
Indoor air temperature - 2	°C		15min	Ap1_T_ House_BedRoom	instant
Indoor air humidity - 1	%		15min	Ap1_ RH_ House_LivingRoom	instant
Indoor air humidity - 2	%		15min	Ap1_ RH_ House_BedRoom	instant
CO_2 concentration - 1	ppm		15min	Ap1_ CO2_ House_LivingRoom	instant
CO_2 concentration - 2	ppm		15min	Ap1_ CO2_ House_Bedroom	instant
Illuminance - 1	lux		15min	Ap1 _E_ House_LivingRoom	instant
Illuminance - 2	lux		15min	Ap1_ E_ House_BedRoom	instant
Presence - 1	1/0		NA	Ap1_o _House_LivingRoom	enum
Presence - 2	1/0		NA	Ap1_o _House_BedRoom	enum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Heat pump (district level)					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
TBD					

Heating water tank (district level)					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
TBD					

Emitter (apartment level					
Setting	Unit	Accuracy	Interval	Var Name	Var Type
TBD					

Function: Domestic hot water

Function	Space Heating	
Level	District	Apartment
Equipment type	Heat pump (geothermal)	None

Of interest for the *domestic hot water* function of the *heat pump*, are:

- Heat pump
- District heating (auxiliary heat)

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Heat pump		
Information type	**Value**	**Unit or options**
Source	Geothermal (brine to water)	[-]
Manufacturer	TBD	[-]
Type	TBD	[-]
Max capacity (design point)	TBD	kW
Max capacity (design point)	TBD	kW
COP (design point)	TBD	[-]
Number of compressors	TBD	[-]
Number of compressors with inverter	TBD	[-]

Available readings

Available readings contain (sensor) data in the direction from appliance to cloud.

Heat pump					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
TBD					

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Heat pump					
Setting	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
TBD					

Function: Ventilation

Function	Ventilation
Level	Apartment
Equipment type	Fan ventilation with rotary heat exchanger

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Fan unit		
Information type	**Value**	**Unit or options**
Type	TBD	
Manufacturer	Systemair	
Type	SAVE VTR 300B & VSR 150B	
Control variables	TBD	
Maximum air flow	TBD	
Maximum power consumption	TBD	

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Ventilation					
Reading	**Unit**	**Accuracy**	**Interval**	**Var Name**	**Var Type**
Ventilation fan	Power	-	15min	Apt1_P_House_Fan	instant

Settings and setpoints

There are no settings and setpoints available for Function: Ventilation

Function: PV-system

Function	PV-system
Level	Block
Equipment type	TBD

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

PV-system		
Information type	**Value**	**Unit or options**
Manufacturer PV-panels	JASolar	[-]
Type PV-panels	TBD	[-]
PV-panel power	TBD	Wp
Number of panels (per apartment)	TBD	[-]
Panel orientation	TBD	° with respect to North
Panel tilt angle	TBD	° with respect to horizontal
Manufacturer inverter	TBD	[-]
Type inverter	TBD	[-]
Inverter power	TBD	W

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

PV-panels					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
TBD				N/A	

Inverter					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Produced power			15min	PV_W	instant

Settings and setpoints

There are no settings and setpoints available for Function: PV-system.

Function: EV-Charging point

Function	EV charging point
Level	Block
Equipment type	TBD

Of interest for the *EV Charging point* function of the *EV Charging point*, are:

- EV Charging point

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

EV Charging point		
Information type	Value	Unit or options
Manufacturer	TBD	[-]
Battery capacity	TBD	
Number of EV	TBD	

Available readings

Available readings contain (sensor) data in the direction from appliance to cloud.

EV Charging point					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Power	W			P_EV1	Instant
Status vehicle	YES/NO			ONOFF_EV1	Instant
State of charge of EV battery	%			PERC_EV1	instant

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

EV Charging point					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
TBD					

Function: Appliances & electric devices

Function	Appliances
Level	Apartment/block
Equipment type	Electric meters

Of interest for the *Appliances* function of the *electric meter*, are:

- Electric meters

The information for each component will be collected in separate tables in this document.

General information

Relevant characteristics for control and flexibility of the appliances are collected in this paragraph.

Electric meter		
Information type	Value	Unit or options
Manufacturer	TBD	[-]
Maximum power	TBD	kW
Number of meters	Block level: 1 Common Area 1 Parking lots Apartment level: 1 per apartment monitored	

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Electric meter					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Power	W			APT1_P_House P_CommonArea P_Parking	cum

Settings and setpoints

Settings and setpoints are values that can be pushed from cloud to appliance.

Electric meter					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
TBD					

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Function: Weather station

General information

Function	Weather station
Level	District
Equipment type	Weather station

Of interest for the *space heating* function of the *heat pump*, are:

- Weather station

The information for each component will be collected in separate tables in this document.

Weather station (district level)		
Information type	Value	Unit or options
Manufacturer TBD		[-]

Available readings

Available readings contain (sensor) data in direction from appliance to cloud.

Weather station (district level)					
Reading	Unit	Accuracy	Interval	Var Name	Var Type
Outdoor temperature	°C		15min	T_ODA	instant
Outdoor relative humidity	%		15min	RH_ODA	instant
Wind velocity	m/s		15min	u_ODA_Wind	instant
Wind direction	°		15min	angle_ODA_Wind	instant
Rain	mm		15min	prec_ODA	instant
CO_2 concentration	ppm		15min	CO2_ODA	instant
Solar radiation	W/m^2		15min	I_ODA	instant

Settings and setpoints

There will not be any opportunity to push values from the cloud to this appliance.

Weather station					
Settings	Unit	Accuracy	Interval	Var Name	Var Type
N/A					

Appendix E – Variable name construction tool

Sheet VarNames

Example of how variable names can be constructed using the pre-defined values for dimension, equipment, node name and node type.

BuildingNr	Apartment Nr	Dimension	Equipment	Equipment nr	Node	Nodenr	Node type		Resulting ID / var-name	Preferred unit
Examples										
1	1	T	HP		Srce		In		Bui1_Ap1_T_HP_Srce_In	°C
2		P	PV						Bui2_P_PV	W
		T	HP		DHW		Hyst		T_HP_DHW_Hyst	°C

Sheet *VarName Elements Lookup Table*

Containing pre-defined values for dimension, equipment, node name and node type. Can be extended if desired.

Dimension	Definition dimension	Preferred unit	Equipment	Definition equipment	Node name	Definition node	Node type	Definition node type
T	temperature	°C	HP	Heat pump	Mode	Operating mode	In	At inlet w.r.t. equipment
I	solar irradiance	W/m2	PV	Solar panels (photovoltaic)	Srce	Source	Out	At outlet w.r.t. equipment
P	power (electrical)	W	HRU	Heat recovery unit	HC	Heating circuit	Set	For setpoints (i.e. input *to* equipment)
p	pressure	Pa	House	Variable applicable for house	ODA	Outdoor air	Supply	Supply side of equipment
Q	heat	J	Tank	DHW Tank	Coil	Heat exchanger coil in DHW-tank	Return	Return side of equipment
q	volume flow	L/s	PV	Photovoltaic / solar panels	Sensor	Sensor	Hyst	Hysteresis setpoint *to* equipment
U	voltage	V			DHW	In the domestic hot water path		
Oper	operational mode or sta	-			LivingRoom	Living Room		
Phi	Heat flux	W			Pump	Pump of equipment		
RH	Relative humidity	%			Valve	Valve setting of equipment		
u	Velocity	m/s						
angle	Angle	°						
prec	Precipitation per day	mm/day						
CO2	CO2 concentration	ppm						

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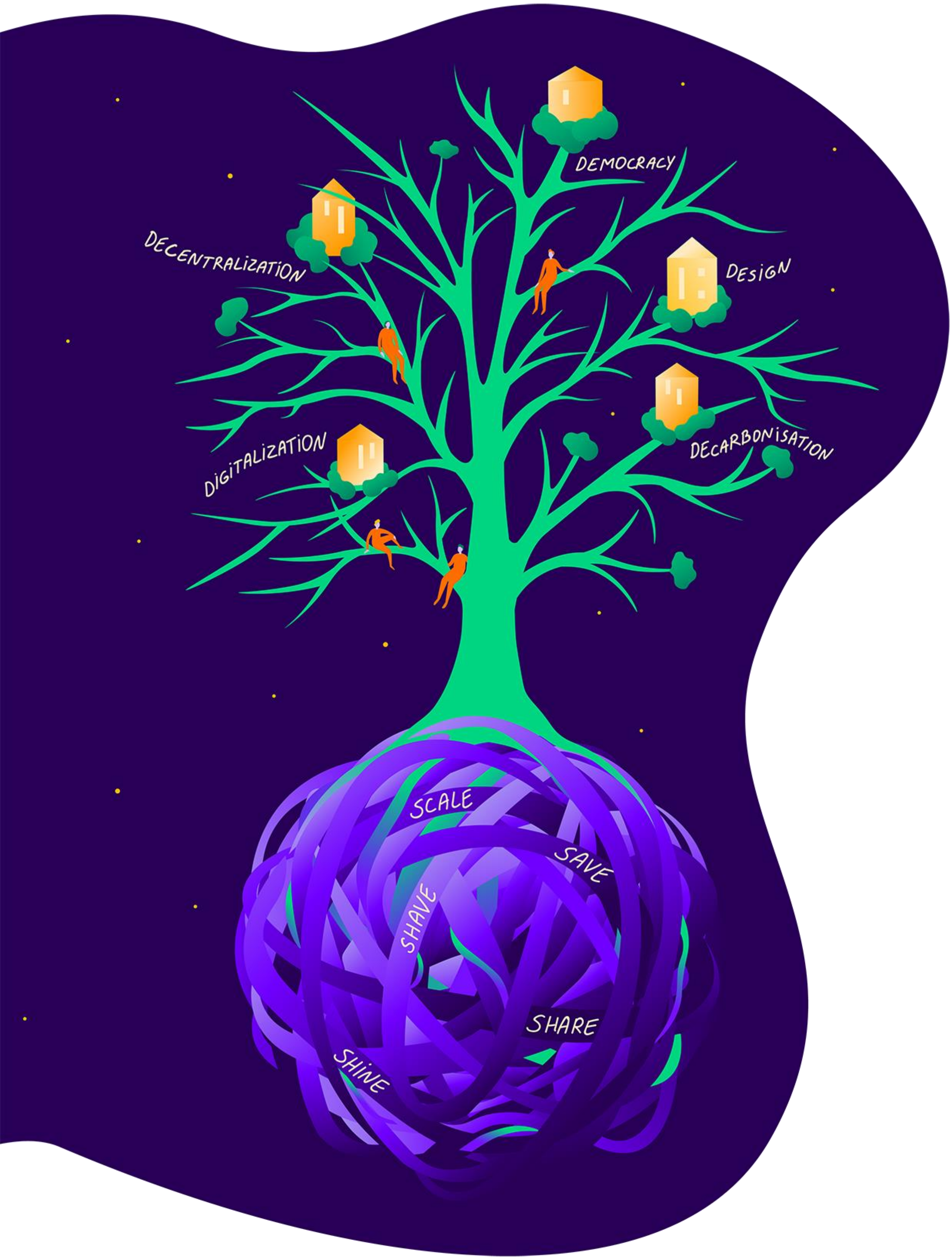
DEMOCRACY
DECENTRALIZATION
DESIGN
DIGITALIZATION
DECARBONISATION
SCALE
SAVE
SHAVE
SHARE
SHINE