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D3.9 – Services and Modules for Groningen ICT Platform

WP3; Task 3.7

November 2021 [M36]

Author(s): Coen van Leeuwen (TNO), Andries Nolles (GRO), Tuan Anh Nguyen (SB), Peter Hut (CGI)

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Abbreviations and Acronyms

Acronym	Description
API	Application Programming Interface
CKAN	Comprehensive Knowledge Archive Network, a web-based open-source management system for storage and distribution of open data.
EMS	Energy Management System
ESDL	Energy System Description Language
ESSIM	Energy System SIMulator
IoT	Internet of Things
OUP	Open Urban Platforms (also working group of EIP-SCC)
RES	Renewable Energy System
SAAS	Software-as-a-Service, delivery model for a software system.
SB	Sustainable Buildings
WP	Work Packet
XML	Extensible Markup Language. Structured, machine readable file format.
XSD	XML schema definition

Executive Summary

Objective of WP3 is delivering Lighthouse demonstration actions in Groningen, two Positive Energy Districts will be designed and validated, Groningen North and Groningen Southeast. These PEDs will be based on the development of high performance buildings (new, retrofitted) with different use (tertiary, residential) combined with very advanced energy systems, mainly based on RES. Advanced control strategies to manage the different energy flows, using very advanced storage systems will be also developed.

Task 3.7 involves developing and integrating services and modules to ensure the performance monitoring objectives and to improve city operation, decision making and citizen engagement (to ensure the interaction between the city of Groningen and its citizens). Open data, interoperability and the compliance of the brand new GDPR normative are considered. Big Data technologies (data mining, clustering, etc) are used to acquire information from the monitored data in the district.

This deliverable describes these services and modules developed for the Groningen Urban Data Platform as part of task 3.7.2. These services are closely aligned to the monitoring programme outlined in WP5 (Task 5.2). The Urban Data Platform, adapted from the existing ICT platforms, is the result of task 3.7.1.

Many different services around the collected data are developed, enabling consortium partners insight into the impact of the project supporting the monitoring programme. Additional services enable the publication of Open Data showing the impact of the project to a wider audience.

1 Introduction

1.1 Purpose and target group

This report constitutes the updated version leading to the final deliverable *"D3.9 Services and Modules for Groningen ICT Platform"* which is an outcome of the *"Subtask 3.7.2 New Services to integrate data and KPIs calculation on top of the Urban Platform."*.

The main objective of the deliverable is to describe the services and modules built on top or integrated with the Groningen Urban Data Platform as adapted from the existing ICT platforms in subtask 3.7.1.

1.2 Contribution partners

The following Table 1 depicts the main contributions from participant partners in the development of this deliverable.

Table 1: Contribution of partners

Partner nº and short name	Contribution
03-GRO	WP leaders and describing the Open Data Portal
04-TNO	Describe ESDL/ESSIM and HeatMatcher usage.
09-CGI	Main author and describing the Urban Data Platform and Energy Islands platform modules and services.
10-SB	Describe Sustainable Buildings modules and services.

1.3 Relation to other activities in the project

The following Table 2 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the MAKING-CITY Project and that should be considered along with this document for further understanding of its contents.

Table 2: Relation to other activities in the project

Deliverable nº	Relation
D3.3	*Simulation models of buildings, energy systems, storage and management of flows algorithms*. Describes one of the services mentioned in this deliverable in more detail.
D3.16	*Smart Energy Systems*. Describes the TNO HeatMatcher in more detail, which is only summarized in this deliverable.
D3.9	Final and previous version of this deliverable.
D3.8	*Adaptation of Groningen ICT platform*. Initial and final version of the deliverable that describes the adaptation of the ICT platform into an Urban Data Platform, on which the services described in this document are built.

D5.2	*Project level indicators*. Contains requirements for the Monitoring use case mentioned in this deliverable.
D5.5	*Data sets: Requirements collection and protection*. Contains requirements for the Monitoring use case mentioned in this deliverable.
D5.6	*Guidelines for definition of Monitoring Programmes*. Contains requirements for the Monitoring use case mentioned in this deliverable.
D5.8	*Groningen Monitoring Programme*. Contains requirements for the Monitoring use case mentioned in this deliverable.
D5.9	*ICT-City Platforms: common open specifications.* Describes standards and reference architectures used to adapt the existing ICT City Platforms into Urban Data Platforms.
D5.10	*Data collection and KPI calculation*. Contains requirements for the Monitoring use case mentioned in this deliverable.
Action 8	Demand Response. A smart grids solution for both PED's based on its energy island solution will be realised in order to use the available energy flexibility (storage, time shifting, et cetera). This solution will provide data insights to optimise the energy production and consumption within the PED's. The flexibility of the buildings and houses is communicated through the advanced energy metering from Action 7.
Action 34	The connection of the charging stations to the local demand response system. E.g. loading the Charge Point data into the Urban Data Platform.

2 Services Use Cases

The services that the Urban Data Platform will provide or support are determined by the the MAKING-CITY project requirements. This section provides an overview of the use cases derived from the other tasks in WP3 and tasks in WP5. The next section will give an overview of the Urban Data Platform itself.

The services implemented in WP3 enable the following use cases:

1. Calculate and share Project Indicators
2. Support analysis of collected data by consortium partners
3. Provide insight into collected data for building owners
4. Local demand optimization

2.1 Calculate and share Project Indicators

Use case name	Calculate and share Project Indicators
Use case ID	UC_GRONINGEN_01
Actor(s)	External observers (e.g. citizens, decisions makers, etc.) and support for entry into SCIS.
Brief description	The goal of this use case is to demonstrate the impact of the project using the Project Indicators and enable further analysis after the project has completed. External observers can view reports of aggregated qualitative and quantitative data using the Urban Data Platform. This enables consortium partners to share the impact of the project with external stakeholders and public in general. The platform provides data for the needs of indicators and SCIS reporting upon request. For those indicator where all required data is available in the platform the indicators are fully calculated within the platform. The data is provided via an open interface for public accessibility. An important part of this use case (and the monitoring programme) is the collection of quantative data. The collected quantative data is the basis for the calculated Project Indicators. The consortium partners will send meter data as it is collected by meters in the buildings participating in the MAKING-CITY project. The list of buildings can be found in Task 3.3 of WP3. The design governing what data is collected is outlined in the monitoring programme. For more information about the monitoring programme see deliverables *D5.6 Guidelines for definition of Monitoring Programmes*, *D5.8 Groningen Monitoring Programme*, *D5.10 Data collection and KPI calculation*, *D5.2 Project level indicators* and *D5.5 Data sets: Requirements collection and protection.*

	The simulation, as part of calculating the PED wide metrics, is further described in *D3.3 Simulation models of buildings, energy systems, storage and management of flows algorithms.*
Preconditions	Necessary data for Indicator calculation is measured and/or available via external services. This includes: - Energy meters are deployed at the buildings/systems and the metered values are stored in the platform. - Historical data from buildings and systems - Data from other parties (city, energy company, housing company etc.) - Qualitative data (surveys, feedback etc.)
Post-conditions	1. Requested Project Indicators are returned to the client
Implementation	The use case is implemented using the following services and modules which are discussed in the mentioned section of this document: • 6.1 Sustainable Buildings – Data Collection • 6.2 Energy Islands – Connectivity • 4.2 TNO Energy System SIMulator (ESSIM) with ESDL • 5.1 Energy Islands – Metrics calculation • 5.2 Energy Islands – Metrics SensorThings API: to give ESSIM secure, standardized access to the raw data • 4.3 Groningen Open Data Portal • 6.5 Groningen Open Data – Platform/Storage

2.2 Support analysis of collected data by consortium partners

Use case name	Support analysis of collected data by consortium partners
Use case ID	UC_GRONINGEN_02
Actor(s)	Consortium Partners
Brief description	Consortium partners can retrieve, analyse and visualize the collected metrics to understand the impact of the project. Consortium partners will monitor impact and effectiveness of the interventions in de PED. In order to facilitate monitoring, a base line will be determined and logged, as well as the dates of interventions. Collected data is then evaluated in time against the baseline and interventions. These metrics are much more detailed (eg. have a higher resolution) than the Project Indicators enabling deeper analysis. This includes

	visually showing the impact of the project to all consortium partners in a clear manner.
Preconditions	The necessary data is available in the platform.
Post-conditions	Consortium partners securely see the data in a dashboard and retrieve data via an API.
Implementation	• 4.4.2 Energy Islands – Metrics dashboard • 5.1 Energy Islands – Metrics calculation • 5.2 Energy Islands – Metrics SensorThings API

2.3 Provide insight into the collected data for building owners

Use case name	Provide insight into the collected data for building owners
Use case ID	UC_GRONINGEN_03
Actor(s)	Building owners
Brief description	Building owners can see the metered data for their building as well as show a selection of the information on a public dashboard.
Preconditions	Data is being collected for the building and the owner has been given access to the Sustainable Buildings EMS.
Post-conditions	Building owner has a very detailed view on the data collected from their building.
Implementation	• 4.1.1 Sustainable Buildings Energy Management System • 4.1.2 Sustainable Buildings Public Dashboard

2.4 Local demand optimization

Use case name	Local demand optimization
Use case ID	UC_GRONINGEN_04
Actor(s)	Consortium partners, specifically decisions makers of the City of Groningen.
Brief description	The information collected in the Urban Data Platform about the demand will facilitate Demand Management on a tactical / strategical level by providing decision support for investment with extrapolation, simulation and reporting. The reports enable long term demand optimization by helping to plan new interventions, such as energy storage. The HeatMatcher provides

	realtime optimization of different energy sources available in an energy system, like for example a heat grid. The infrastructure within the PEDs is not fully prepared to facilitate demand response on an operational level. Only a few buildings are anticipated to support operational interaction for demand response (for example elevators and charging stations). In these cases demand response will be controlled on a local level using local tools. Additionally, demand/response optimization on a PED wide level will be investigated with the use of HeatMatcher for Warmtestad to facilitate demand management of the heat grid. Results of simulations of different scenarios are stored in the platform enabling comparisons that provide information on what planned actions for the PED have the biggest impact on energy demand.
Preconditions	Data is collected, used by ESSIM to calculate different scenarios and results are stored in the platform.
Post-conditions	Comparisons of different simulation scenarios give insight into optimization strategies for local energy demand.
Implementation	• 4.2 TNO Energy System SIMulator with ESDL • 4.4 CGI's Energy Islands services • Energy Islands Insights • 4.5 TNO HeatMatcher

3 Urban Data Platform

As part of task 3.7.1 the existing Energy Islands platform created by CGI and Open Data Platform of Groningen are adapted and integrated to create an Urban Data Platform. For a detailed overview of the platform see deliverable *D3.8 Adaptation of Groningen ICT platform*.

3.1 Current data platforms

The ICT platforms in Groningen that will form the Urban Data Platform for the MAKING-CITY project are:

- Sustainable Buildings platform
- CGI's Energy Islands platform
- Civity Data Platform for Groningen

As part of the adaptation in task 3.7.1 these platforms are integrated to form the Urban Data Platform for Groningen. Data, such as metering data from the Sustainable Buildings platform, is processed by the Energy Islands Platform. From there it is made available via the Open Data Platform of Groningen.

3.2 Context

Services and modules are added to the data platforms that support specific stakeholders, both in- and outside the MAKING-CITY project. The following diagram gives an overview of the stakeholders and the systems they use to connect to the Urban Data Platform.

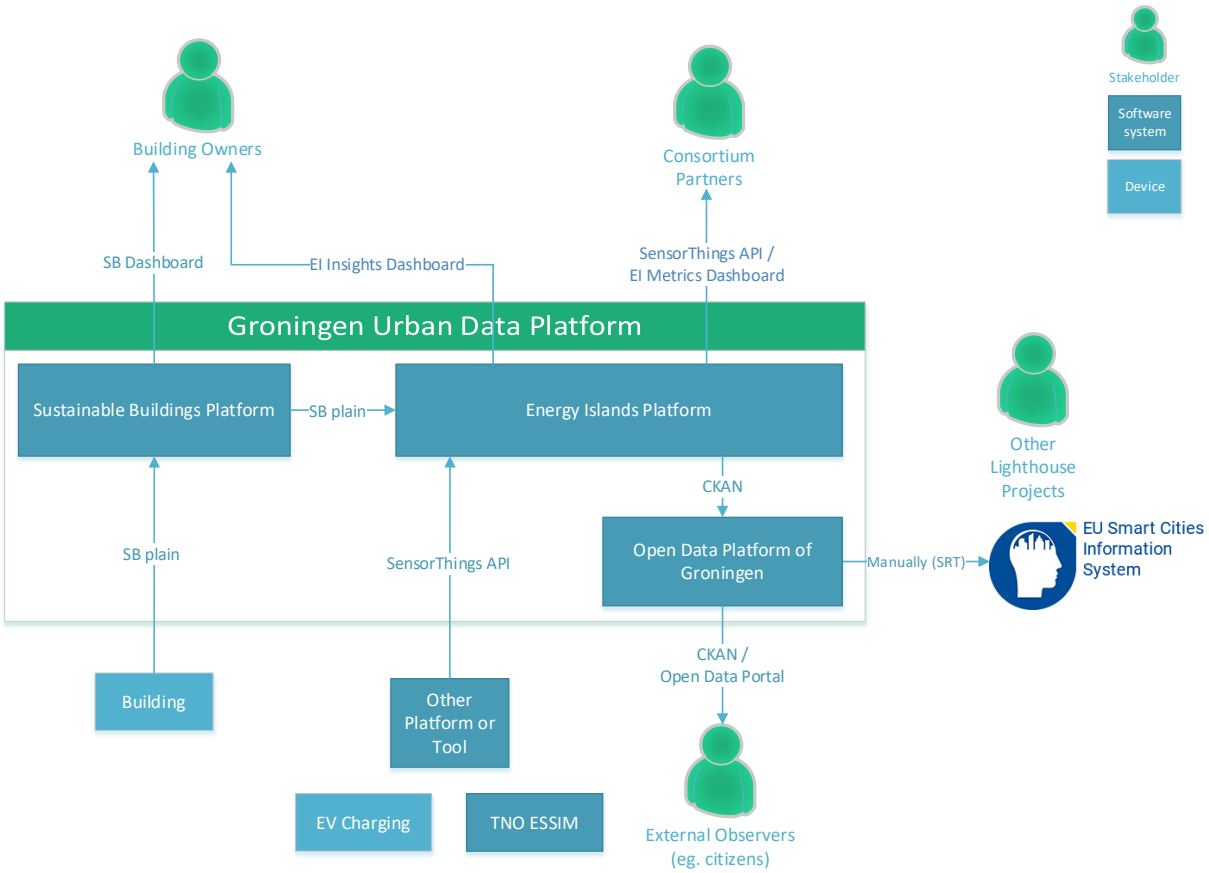

Figure 1: Context Diagram of the Urban Data Platform for Groningen

Details about the interfaces can be found in section 3.4.

3.3 Services and Modules

Integrating the modules of the different platforms will result in a complete Urban Data Platform that enables the services that are required for the MAKING-CITY project.

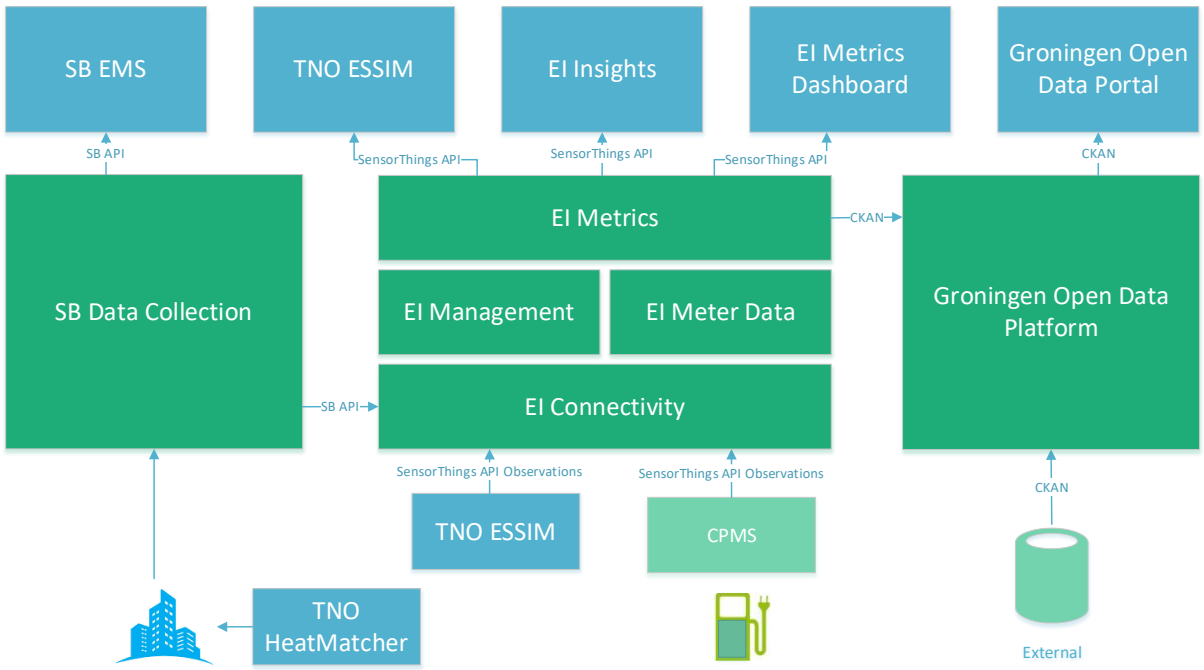

Figure 2: Overview of the Services and Modules

The services and modules are described in detail in chapter 4 of this document, the mentioned interfaces are described in the next section.

3.4 Interfaces

External interfaces of the Urban Data Platform follow the standards as described in deliverable *D5.9 ICT-City Platforms: common open specifications*.

The OGC SensorThings API is an OGC standard specification for providing an open and unified way to interconnect IoT devices, data, and applications over the Web. (Liang, 2021) The full specification can be found at SensorThings API Part 1: Sensing 1.1.

Table 3 contains a full list of external interfaces.

Table 3: Interfaces of the Urban Data Platform

Interface	URL	Description	Authorization
SensorThings API	Shared with consortium partners.	Only the part for requesting data is available. No data can be updated using this interface.	Requires a subscription key. Access for consortium partners only.
SensorThings API Observations	Shared with consortium partners.	Secured interface to upload sensor data.	Requires a subscription key. Access for

			consortium partners only.
CKAN API	https://ckan.dataplatform.nl/	Interfaces to access datasets containing Open Data.	Open, accessible for everyone.
Sustainable Buildings API	Internal	Internal API used by Sustainable Buildings.	Access controlled by Sustainable Buildings.

The interfaces that require authorization are secured and require authentication to use. Information about the security of the platform can be found in deliverable *D3.8 Adaptation of Groningen ICT platform*.

4 Provided Services

This section lists the services developed or adapted for the Urban Data Platform in Groningen.

4.1 Sustainable Buildings services

Sustainable Buildings B.V. (SB) is a software company based in Groningen, The Netherlands. Sustainable Buildings provides an energy management system (EMS) and supporting services to help companies and organizations make their buildings more energy efficient and sustainable.

4.1.1 Sustainable Buildings Energy Management System

Sustainable Buildings Energy Management System (SB EMS) provides visibility into the energy usage for the participating buildings in MAKING-CITY. The application leverages machine learning to analyse building energy data, detect anomalies, predict energy savings opportunities, and help facility managers take action in near real time.

The online web application tracks, monitors, and manages energy data, including gas and electricity consumption, electricity generation. The software also collects and monitors indoor climate data of buildings, both historically as well as in real-time.

Key features of SB EMS relevant to MAKING-CITY are:

- A dashboard to get an overview and monitor one or more of the participating buildings
- Electricity and gas consumption data monitoring
- Monitoring of occupancy, temperature, humidity, air quality and light levels
- Data in different frequencies: Live (real-time), 5-minutes, 15-minutes, 1-hour
- Aggregated data: per day, per week, per month, per year
- Period summary: min, max, avg values
- Energy consumption inside and outside working hours
- Building energy information and profile
- Energy savings actions tracking for building owners
- Manage and optimize peak power demand

4.1.2 Sustainable Buildings Public Dashboard

SB Public dashboard and Narrowcasting system (SB PD) is a self-service narrowcasting software designed for public spaces with a goal of sharing information both internally with colleagues, and externally, with clients and visitors.

The SB Public Dashboards will display energy and indoor climate data.

- Energy data: electricity and gas consumption, solar or wind production, energy balance between consumption and production
- Indoor climate data: temperature, humidity, air quality, light level, etc.

The goal of SB PD is to give real-time feedback to building users and increase awareness of users regarding energy saving actions.

4.2 TNO services

The TNO ESSIM tool together with the EDSL modelling language enable insight into impact of interventions for the whole PED energy system (see also section 2.1).

4.2.1 Energy System Description Language

The Energy System Description Language (ESDL) is an open source modeling language created for modeling the components in an energy system and their relations towards each other. (TNO, 2021) Technically it is an XML schema definition (XSD) for formally describing energy assets in an XML format. This allows ESDL to be used as a formal specification of an energy grid for unambiguous interpretation by experts. Moreover, the language is machine readable so makers of energy transition calculation tools, simulations and GIS applications can support ESDL in order to enforce the interoperability of their products.

ESDL is capable of expressing the dynamic behavior of components in the energy system. For instance, the power consumption of a neighborhood. ESDL describes components by their basic functionality (Energy Capabilities), these are modeled in 5 abstract categories: Production, Consumption, Storage, Transport and Conversion. Aggregation and composition principles of ESDL enables energy modelers to model a complex energy system in a generic way.

ESDL can be in various ways, for example:

- By energy transition calculation tools. ESDL acts as a common language for different energy transition calculation tools, specifying the format of the inputs and outputs of such tools. This allows for integration of multiple tools.
- In an Energy Information System. ESDL can be used as a basis for a central energy information system where the energy system of a certain region is registered.
- As a language for (local) governments to model, reason about and share their (local) energy system.
- To monitor the evolution of an energy system: multiple ESDL snapshots of a certain area over time provide insight in the evolution of an energy system.
- As a format to share data relevant to energy systems or the energy transition. Examples:
    - CO_2 emissions per energy carrier
    - Technology factsheets for specific components, brands, types (e.g. a heat pump factsheet that describes its typical parameters)
    - Cost information of assets, or expected cost developments in future
    - Standard configurations or templates of typical parts of the energy system (e.g. a house with a heat pump, solar panels and an EV charging station)

A fully detailed description of ESDL, both technical and pragmatic, can be found as an on-line gitbook on https://energytransition.gitbook.io/esdl.

4.2.2 Energy System SIMulator

ESSIM (Energy System SIMulator) is a tool that simulates network balancing in an ESDL-defined energy system comprising of interconnected multi-commodity energy networks. It takes into account energy system information, data profiles and control strategies configured by the user to simulate dynamics in the energy system over a user-defined time period (in user-defined time steps). The simulator generates a dashboard visualising energy mixes in the networks, imbalances and emissions.

The Urban Data Platform would act as a source for data profiles to be used in an ESSIM simulation and also as a platform to store the relevant KPIs calculated by it.

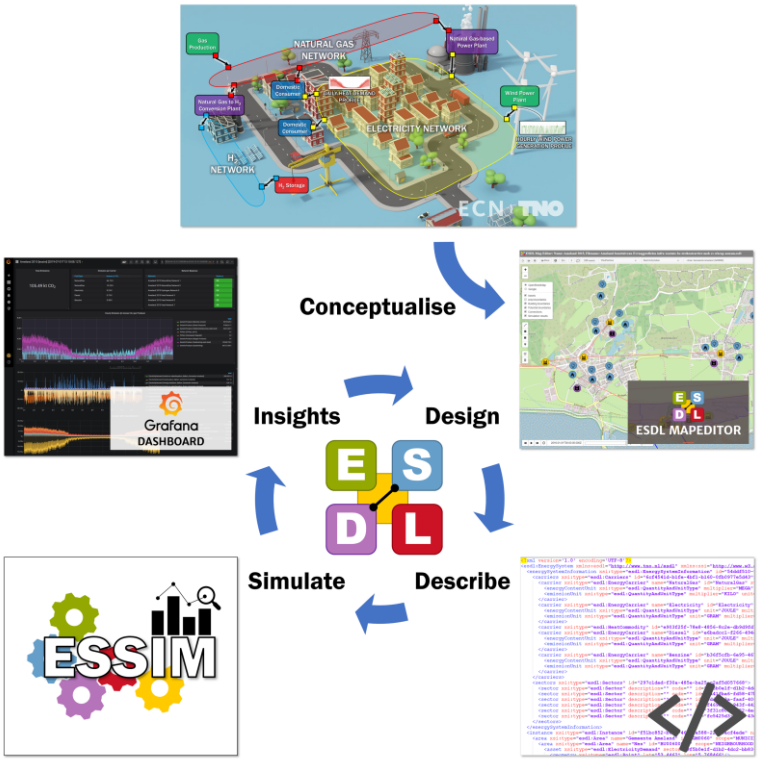

Figure 3: ESSIM as part of the ESDL toolchain for modelling and simulating energy systems

ESSIM is a part of the ESDL toolchain which will be used in modelling and simulating the energy systems. ESSIM is used in conjunction with the ESDL MapEditor which is a web-based tool used to create and edit ESDL definitions of energy systems. Under the hood, the simulation engine parses the user-fed control strategies to determine the order of solving the networks and then for each network, applies the Fast-LMP (Kok, 2019) principle to aggregate flexibility from energy assets and control dispatch.

4.3 Groningen Open Data Portal

The Municipality of Groningen services several data sets using an Open Data Portal at https://groningen.dataplatform.nl.

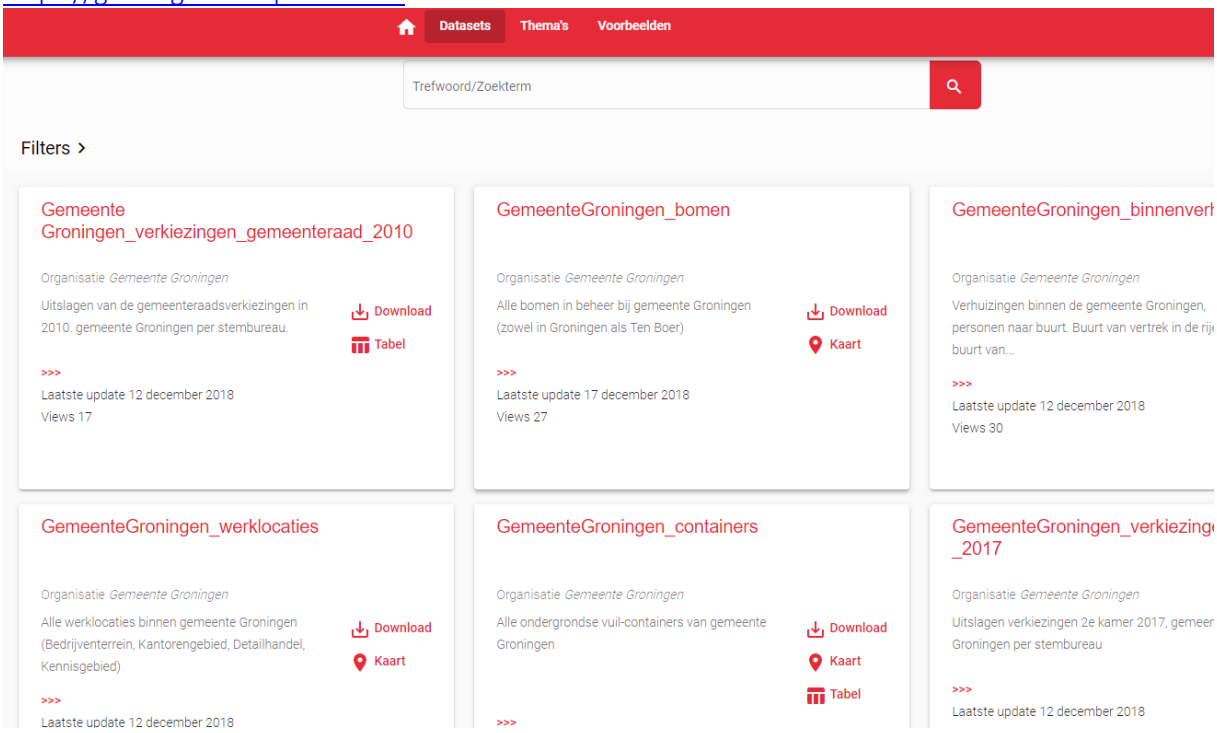

Figure 4: Groningen Open Data Portal website

The Groningen Open Data Portal is the main access point for residents of Groningen and other stakeholders interested in information about the city.

The portal is hosted by Civity, a Dutch IT company which specialises in data gathering and services. It is mainly active in the government market (and especially municipalities).

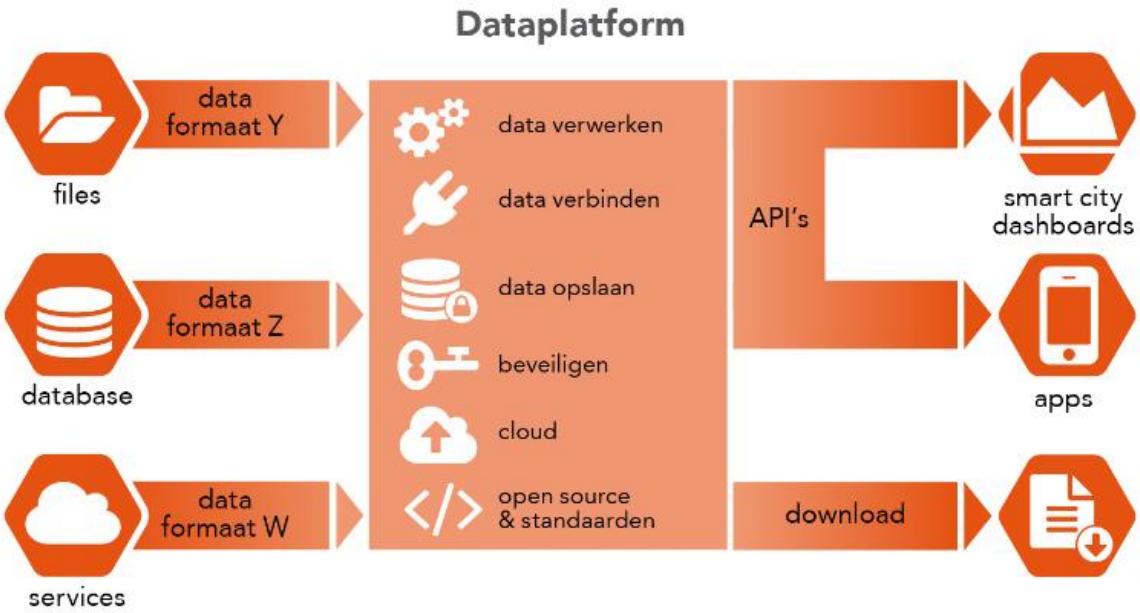

Figure 5: Civity data flow (source: https://www.dataplatform.nl/)

The CKAN registry and storage form part of the Urban Data Platform. Open Data collected and calculated for MAKING-CITY is published to this registry. The data can be found and downloaded via the portal.

4.4 CGI's Energy Islands services

4.4.1 Energy Islands Insights

Based on the existing dashboard for Energy Islands. The dashboard provides insight into energy consumption and production for communities. The added reports will use the relevant metrics from the monitoring program as well as different scenarios simulated with ESSIM to help plan interventions that optimize demand and make use of available flexibility.

The service integrate with the Urban Data Platform via the Sensor Things API interface.

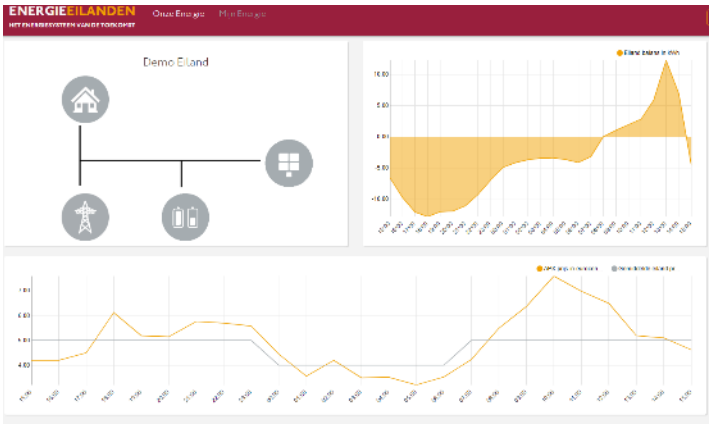

Figure 6: The current Energy Islands Dashboard

4.4.2 Energy Islands - Metrics dashboard

This dashboard enables visualization and comparison of the metrics collected and calculated by the Energy Islands platform for the MAKING-CITY monitoring programme. It also visualizes interventions as annotations in the charts to help see the impact of these interventions.

Figure 7: EI Metrics dashboard

Access to the metrics dashboard requires a personal account obtained after invitation by Groningen as the Data Owner. Permission is required because it provides access to all building and PED level metrics.

4.5 TNO HeatMatcher

HeatMatcher is a real-time matching solution for heating and cooling systems. It utilizes a matching algorithm to optimize the dispatch of different flexible sources of heat, in order to meet the objectives set by the user. These objectives include, but are not limited to: user comfort, financial impact, CO2 emissions, renewable energy used or own energy used. In earlier field tests, it was demonstrated that by using HeatMatcher, a reduce in gas consumption of up to 28% is conceivable, while reducing maintenance costst by up to 18%.

In HeatMatcher, consumed and produced heat (or cold) is traded on a virtual heat market (or multiple linked markets). Agents representing devices such as gas heaters, heat pumps, heat buffers or heat consumers (rooms), place bids on this market, in order to find an optimal solution where production and consumption are in equilibrium. Contracts are created to make sure agents know how the physical heat should be controlled in the upcoming time period. The process is then repeated for every time new time period.

Details on this use of the HeatMatcher can be found in *D3.16 Smart Energy Systems*.

4.5.1 HeatMatcher for heat grids

In the MAKING-CITY project, HeatMatcher was initially planned to be installed at two locations: the Nijestee highrise (A1) and the Mediacentrale (A4). However during the project we came to conclude that for the Nijestee buidling, there is only one source of heating, and no buffering. Without any room for control Heatmatcher cannot improve on the efficiency or cost of the energy usage, since there are no degrees of freedom. Furthermore, for the Mediacentrale there have been some efforts in the first part of the project to work on the implementation. However, due to lack of investors and COVID-19, the implementation has halted until further notice.

Another possibility is to use Heatmatcher to optimize the heat flow of a heat grid itself. Especially in the North PED, the heat grid is a very complex system with multiple heat sources being: residual heat from two server parks, several CHPs, a large heat buffer, and solar heat collectors. Currently the heat grid only utilizes the CHPs for providing heat and a gas heater for peak production; starting next year the server parks' residual heat sources will be added. The solar collectors are planned for the upcoming years. Combined with the fact that there are many different heat sources, there are many optimization constraints, e.g. contracts for heat intake and delivery, balancing of ATES's, and here are also different and goals that are to be optimized: operational costs, fraction renewable energy used, greenhouse gas emissions etc.

TNO is currently investigating the potential of applying Heatmatcher to heat grids in a simultaneous project. In the current context, especially in the North PED, Heatmatcher could be utilized to control an operational heatgrid. A particularly interesting challenge is that it should take into account actual fluctuating energy prices, which is currently not taken into account in Heatmatcher.

Warmtestad is working on implementing the heat grid, and recognize that heating dispatch is a serious issue, that the problem can be very complex and that mismanagement can be very expensive. Since the heat grid plays a major role in both PEDs, there is a lot of room for potential energy saved.

5 Added Modules

This section lists the Modules integrated in the Urban Data Platform during the project. The modules are built with access to all the raw data enabling advanced analytics or providing secure access to parts of the data.

5.1 Energy Islands - Metrics calculation

Metrics are calculated based on the measurements by Sustainable Buildings. The metrics form the basis for the Monitoring Programme implemented in WP5 and will be the input for Project Indicator calculations. Additionally selected metrics are published as Open Data in the Groningen Open Data platform if they are considered relevant for a wider audience.

Details about the metrics and calculations can be found in *D5.8 Groningen Monitoring Programme*.

5.2 Energy Islands - Metrics SensorThings API

Additional API added to the existing platform to conform to the Reference Architecture described in deliverable D5.9. This API will be the interface used by the services described in the Services section of this document to request data stored in the Urban Data Platform. This module only implements the data request part of the API. Consortium partners can update metrics via the EI Connectivity module described in section 6.2.

The full API is described in the specification at SensorThings API Part 1: Sensing 1.1 and an easier to read overview of can be found at http://opengeospatial.github.io/e-learning/sta/text/main.html

6 Standard Modules

These modules are the basis of the existing ICT platforms that will form the Urban Data Platform for Groningen.

6.1 Sustainable Buildings - Data Collection

Within the context of MAKING-CITY project, Sustainable Buildings (SB) is responsible to a Advanced Energy Metering solution, starting with data collection. More specifically, at each intervention, the following real-time of 1-minute frequency data is collected:

1. Real-time electricity consumption and demand for the whole building
2. Real-time sub-metering for electricity consumption and demand
    a. Elevators
    b. Lighting of shared spaces
    c. Ventilation of shared spaces
    d. Consumption of all residents combined
    e. Heating and cooling
3. Real-time gas consumption and demand for the whole building
4. Real-time sub-metering for gas consumption and demand for hot water
5. Real-time electricity generation from solar panels on the roof of the building

SB realizes a software platform that is able to collect the data according to the requirements of the MAKING-CITY project. Futhermore, the SB platform satisfy the requirements of a big data collection and processing platform, such as device heterogeneity, system scalability, dynamic adaptability, and sensor data fault tolerance, just to name a few.

6.2 Energy Islands - Connectivity

Internal module responsible for connectivity to measuring platforms or devices. Added connectivity for the MAKING-CITY project is:

- Sustainable Buildings platform (section 6.1)
- SensorThings API Observations dataArrays
    - To receive TNO ESSIM simulation results as SensorThings API Observations (section 4.2)
    - To receive EV Charging related metrics
- EV Charging logs
    - Converts logs into SensorThings API Observations dataArrays withEV Charging metrics

6.3 Energy Islands - Management

Internal module responsible for the management of the Energy Island configuration and participating users.

6.4 Energy Islands - Meter Data

Internal module responsible for the ingestion and storage of energy related meter data.

6.5 Groningen Open Data - Platform/Storage

Platform storing Open Data about the city of Groningen, which is exposed via the Open Data portal explained in section 4.3. The platform has been created by Civity for the City of Groningen.

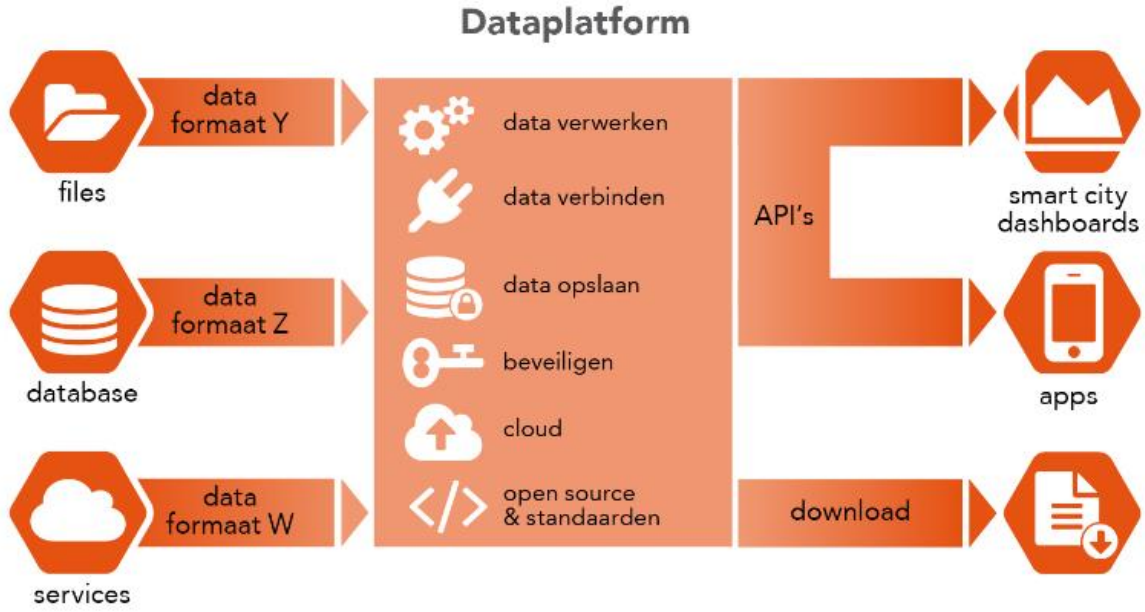

Figure 8: Civity data flow (source: https://www.dataplatform.nl/)

Conclusions

The adapted ICT platforms will form an Urban Data Platform that enables use cases and services around energy data collected for the MAKING-CITY project. These services will provide further insight into the energy balance of the PED and will be used to analyse the effectiveness of the actions as part of MAKING-CITY.

The services described in this deliverable depend on the metered data stored in the Urban Data Platform retrieved from disparate connected devices and platforms. The services demonstrate the essential role of the Urban Data Platform in combining and standardizing the data for monitoring and development of PEDs in a city.

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