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D5.8 - Groningen Monitoring Programme

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Abbreviations and acronyms

Acronym	Description
ESSIM	Energy System SIMulator
EV	Electrical Vehicle
GDPR	General Data Protection Regulation
PED	Positive Energy District
SCIS	Smart Cities Information System
V2G	Vehicle to Grid





Executive Summary

WP5 aims to monitor and evaluate the effectiveness of the project actions and interventions, compared to the initial situation, initial objectives and expected results. The scope of the monitoring protocol will be twofold, firstly in order to measure the performance of the actions deployed to reach a validation of PED concept and secondly to evaluate the impact at city level.

Task 5.4 "Monitoring in Oulu and Groningen" deploys the Monitoring Programmes that was defined in Task 5.3. This is a cross-cutting activity among WP2, WP3 and WP5. Project level KPIs (defined in D5.2) are in the main focus in the monitoring programme. The data sets required for calculating these KPIs are defined in D5.5. The deliverable 5.6 produces guidelines to the monitoring programme, while the detailed monitoring programme is described in D5.7 for Oulu and in D5.8 for Groningen. This document constitutes deliverable D5.8; the Groningen monitoring programme.

This deliverable describes the methods for collecting both quantitative and qualitative data on the monitoring infrastructure that is specific to Groningen. It also discusses how to deal with the collection and processing of personal data. Finally, a method to extrapolate the building intervention results to the complete PED is presented.





1 Introduction

1.1 Purpose and target group

This deliverable, "D5.8 – Groningen Monitoring Programme", describes how the generic monitoring guidelines that were defined in D5.6 are applied to the specific situation in Groningen. There are two distinct parts of the monitoring programme:

- Monitoring of quantitative data. This describes how the data will be collected from the buildings and how this data is processed further to calculate the quantitative indicators
- Monitoring of qualitative data. This describes how data will be collected from (mainly) residents using questionnaires and how this data is processed further to obtain the qualitative indicators.

In addition to the parts mentioned above, this deliverable will also touch upon additional measures that need to be taken when processing personal data, which is the case in Groningen.

Another important aspect that is specific to Groningen, is that the geographical boundaries of the PED's include many more building than just the ones where the interventions take place. In order to get a good idea of the future potential of a PED, the intervention results need to extrapolated to the other buildings in the PED. The methodology for this extrapolation is also described in this deliverable.

1.2 Contribution partners

Table 1 provides an overview of the partners that contributed to this deliverable.

Partner nº and short name	Contribution
03-GRO	Input on GDPR and collection/processing of qualitative data
04-TNO	Main authors of the deliverable
09-CGI	Input on monitoring platform and processing of quantitative data
10-SB	Input on monitoring platform and collection of quantitative data
12-HUAS	Input on collection/processing of qualitative data
20-VTT	Provided the main structure of the document based on D5.6

Table 1: Contribution of partners

1.3 Relation to other activities in the project

Both monitoring programmes (Oulu and Groningen) are related to various other activities and deliverables in the MAKING-CITY project. These relations are depicted in Figure 1.







Figure 1: Relation to other activities in the project

Table 2 explains the nature of the relation between D5.8 and the main deliverables from the picture above.

Table 2: Relation	with other	deliverables

Deliverable nº	Relation
D5.1	D5.1 describes the definition and calculation of the KPI for city evaluation
D5.2	D5.2 defines project level KPIs that are calculable from outputs of monitoring programmes
D5.3	D5.3 describes the evaluation procedure for PED actions based on KPIs
D5.4	D5.4 describes the city impact evaluation procedure based on prioritized and weighted city level indicators
D5.6	D5.6 defines the guidelines for the Monitoring Programmes
D5.8	D5.7 describes monitoring programme of Oulu in detail





2 Introduction of the Groningen pilot setup

Groningen features two PED's in the MAKING-CITY project. One in the northern part of the city and one in the southeast.

The northern PED consists of many different types of buildings. The PED can be subdivided into three areas: Zernike science park, Paddepoel north and Paddepoel south. The Zernike science park mostly features university buildings of which the Energy Academy Europe building is the most relevant in this area. Paddepoel north features high-rise buildings and terraced house and was mainly constructed in the 1960s's. Paddepoel south is also a residential area but also features newly built houses.

The main interventions are the Energy Academy Europe building, a high rise building in Paddepoel north and terraced houses in both Paddepoel north and south. Actions that will take place in this district are the installation of solar panels, connection to a heating grid, installation of heat pumps, etc.

The southeast district is very different in its setup as it mostly consists of industrial and office buildings and only few residential ones, it also features a sports complex. For the newer buildings such as the sports complex and the Powerhouse office and apartment building the positive energy configuration is already in place. In addition to this there are also actions for a solar park and the extension of the local heating grid.

More information on the setup in Groningen can be found in D3.13

2.1 Data Quality

D5.6 outlines the different aspects that are important for ensuring that the quality of the collected data is adequate for the purpose of monitoring within MAKING-CITY. This way we can make sure that the indicators values based on the collected data are correct.

The focus has been mainly on the "accuracy," "relevance" and the "coverage/amount of data" quality attributes. The accuracy comes from the use of professional meters and sensors that capture the data. With respect to the "relevance" attribute an analysis was made to determine which data/metrics have to be collected to determine the various city and project indicators. These metrics are collected with a much greater frequency than strictly required for the indicators to make sure that a more than sufficient "amount of data" will be available. This will also allow for an early detection of missing data so that counter measures can be taken to prevent quality issues on the indicator level.

2.2 GDPR

Some of the data that is collected for the monitoring of the PED's is personal data as described in the context of the General Data Protection Regulation. This is especially relevant for the terraced houses in district North were individual households will be monitored.

The residents have given their consent to the collection and processing of data for the purpose of the MAKING-CITY project. This has been laid down in a contract that can be found in "Annex A: Participant Contract".

In addition to the contract with the residents, all parties involved in the processing of personal data should sign a data processing agreement. The template for this agreement can be found in "Annex B: Data Processing Agreement template".

Apart from the terraced houses no personal data will be collected or processed. The other buildings in the PED's are either office buildings or high-rise buildings that contain multiple apartments. The only data collected from these buildings is from the building level itself and not that of individual residents or households.





3 Monitoring phases of quantitative data in Groningen

This section describes how the guidelines (that were introduced in D5.6) of quantitative data monitoring are applied in Groningen. The quantitative monitoring consists of the following four phases:

- 1. Defining the indicators and monitoring concept
- 2. Implementing data collection pipeline
- 3. Monitoring the energy supply and consumption
- 4. Voluntary long-term monitoring

These monitoring phases are depicted in Figure 2 (taken from D5.6). The following sub-sections shall cover the phases in more detail.



Figure 2: Monitoring phases of quantitative data

3.1 Phase 1 - Defining the indicators and the monitoring concept

In this step, it is fundamental to identify the requirements and metrics that have be monitored in order to calculate the KPIs. Moreover, all technical (quantitative) KPIs are based on the baseline figures. Therefore, setting a baseline and calculating the baseline performance is essential part of this phase. Exact baseline calculations shall be presented in the deliverable 2.2 (M36) and later in deliverable 5.10. The generic guidelines for the baseline calculation are given in deliverable 5.6.

For quantitative data, the following indicators have been defined in the deliverable "D5.2 - Project Level Indicators":





Table 3: Energy & Environmer	nt indicators
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ENERGY & ENVIRONMENT		
PED Energy Profile		
Indicator	Unit	Description
E1: Final energy consumption	kWh/month; kWh/a; kWh/(m2month); kWh/(m2a)	Annual final energy consumption divided for all uses and forms of energy (electricity/thermal/gas). Transportation and public lighting excluded. Buildings combined to area level. No separate apartments reported. Monitoring on the building level, but final KPI on PED area level. Final energy used in buildings defined as in the BEST tables: electricity for lighting, ventilation, space heating and cooling, hot water, for heat: heating, cooling and domestic hot water.
E2: Primary energy consumption	kWh/month; kWh/a; kWh/(m2month); kWh/(m2a)	This indicator corresponds with the primary energy consumed inside the PED boundaries that is the energy forms found in nature (e.g. coal, oil, gas, biomass, nuclear, wind, solar, hydro) which have to be converted (often with subsequent losses) to useable forms of energy. Excluding transportation and public lighting.
E3: Energy imported to PED	kWh/15min(/day) ; kWh/month; kWh/a; kWh/(m2month); kWh/(m2a)	The amount of electricity and thermal energy (district heating, gas and other sources) imported to the PED area from outside the PED boundaries.
E4: Energy exported from PED	kWh/15min(/day) ; kWh/month; kWh/a; kWh/(m2month); kWh/(m2a)	The amount of electricity and thermal energy exported outside the PED boundaries from the demonstration area.
E5: RES production	kWh/month; kWh/a; % of final energy consumption	Amount of RES production inside PED boundaries , and share (compared to final energy consumption in the area.) Divided into electricity (solar) and thermal energy (including geothermal, waste/excess heat etc. energy produced with heat pumps).
E6: PED energy balance	kWh/month; kWh/a; (surplus + or deficit -); %	The overall primary energy balance of the PED area considering demand-consumption, energy flows, storage, RES.
E7: Energy savings in the PED	kWh/(m2a); %	Total annual saved primary energy in the PED compared to situation without any interventions (baseline).
S1: Energy poverty	% of households, or % share of income	Percentage of households by definition (described further in the Annex), or energy bill as % of total household disposable income.
Environmental effect		
Indicator	Unit	Description





E8: GHG emissions	kgCO2-eq/ (m2month); kgCO2-eq/ (m2a) kgCO2-eq/ (kWh a)	The GHG emissions (converted in CO2-eq.) generated over a calendar year by the same activities included in the primary energy related KPIs inside the PED boundaries.
E9: Reduction of emissions	kgCO2-eq/a; %	Reduction of CO2-eq. emissions in the PED area achieved by the project actions and interventions.

Table 4: Mobility indicators

MOBILITY					
Mobility related technologies					
Indicator	Unit	Description			
M1: Number of public EV charging stations	# of installed stations	Number of EV charging station inside the PED that are available for the public use.			
M2: Energy delivered for EV charging	kWh/month; kWh/a; charging time; # of charges	Energy consumption (energy delivered) by the EV charging stations in PED, and if available, the total number of charges, or the total charging time.			

Table 5: Economy indicators

ECONOMY		
Economic performance		
Indicator	Unit	Description
C1: Total investments	€/m2; €/kW(h)	How much money is invested in total to PED interventions. Subdivision of the sources (EU funding, (local) government funding, private investment by companies and other private investment.
C2: Payback time	Years	Economic payback period of (selected, most impactful?) investments.
C3: Economic value of savings	€ / saved kWh (or reduced kgCO2- eq)/a	Total investments combined with the output results (in terms of energy savings or reduction in GHG emissions (CO2-eq.)) on a project level, this KPI tells something about the effectiveness per saved amount of (primary) energy / reduced emissions, or contribution into new energy generation.





Table 6: Flexibility indicators

FLEXIBILITY					
Performance based on flexibility					
Indicator	Unit	Description			
F1: System flexibility for energy players	%; kWh; Likert	Flexibility of the whole energy system in PED by means of smart solutions. Demand response management and smart controls for the energy system. Additional flexibility capacity gained for energy players. KPI measures the progress brought by R&I activities relative to the new clusters and functional objectives, assessing the additional electrical power that can be modulated in the selected framework, such as the connection of new RES generation, to enhance an interconnection, to solve congestion, or even all the transmission capacity of a TSO.			
F2: RES storage usage	%; kWh	The combined usage of energy storage capacity in the PED area. The aim is to increase energy system flexibility with local energy storages for electricity and heat.			
F3: Peak load reduction	%; # of peaks (congestion), duration of peaks and size of peaks; MHDx maximum hourly deficit	The indicator is used to analyse the maximum power demand of a system in comparison with the average power. With the correct application of ICT systems, the peak load can be reduced on a high extent and therefore the dimension of the supply system. E.g., Peak load is the maximum power consumption of a building or a group of buildings to provide certain comfort levels.			

This deliverable describes the monitoring procedures only for the metrics that are needed to calculate the key performance indicators. Other possible metrics that will be collected from the demos are excluded from this deliverable.

3.1.1 Baseline

In D5.6 a distinction is made between determining the baseline for renovated buildings and new buildings. Each type of building has its own method for collecting the baseline. Buildings that are to be renovated during the project should be monitored for at least a year before the interventions will be implemented so that the baseline can be established.

For new buildings the interventions will already be part of the building during the construction. In this case the baseline cannot be determined by monitoring, but it will be derived from similar buildings that do not feature the interventions of the building under consideration. Existing buildings with interventions that were already installed prior to the start of the MAKING-CITY project will also be considered new buildings.

Table 7 provides an overview of the baseline types for the pilot buildings in Groningen.

Building	PED	Туре
Nijestee highrises (A and B)	District North	Renovated building

Table 7: Overview of baseline types in Groningen





Terraced houses (A,B and C)	District North	Renovated building
Energy Acadamy Europe	District North	New building
Mediacentrale	District Southeast	New building
Powerhouse apartments	District Southeast	New building
Sportcomplex Europahal	District Southeast	New building

The PED's also include buildings that are not part of the pilot. Simulations will be used to determine the baseline for these buildings (see also section 3.3.3).

3.2 Phase 2 - Implementing data collection pipeline

The monitoring platform in Groningen has been described in full detail in D3.19. This section briefly highlights the key components involved in the monitoring process.

Figure 3 shows an overview of the monitoring architecture that is used in Groningen. The following paragraphs describe the individual components.



Figure 3: Monitoring platform architecture (picture taken from D3.19)

3.2.1 Building

These are the buildings in the Groningen PED's in which the interventions are planned. The buildings are/will be equipped with sensors/meters to measure the parameters from which the effect of the





interventions can be derived. Examples of such meters are: electricity meters, gas meters, PV production meters, etc.

3.2.2Sustainable Buildings Platform

The measurements from the buildings will be collected by Sustainable Buildings. For this purpose they will use their own platform. This platform also provides a dashboard that can provide direct feedback to a building owner/user. The data format that is used to collect the sensor information is specific to Sustainable Buildings.

3.2.3 Energy Islands Platform

This is the core component of the monitoring platform and has been built by CGI. It collects all the data in a central place, performs the indicator calculations and communicates with the dashboard so that the indicators can be presented to the consortium partners and other stakeholders. It will also forward the indicator information to the open data platform of the municipality of Groningen.

3.2.40pen Data Platform of Groningen

The indicator values will be forwarded to the open data platform of the municipality of Groningen. Via the open data portal the indicators will be presented to observers/stakeholders external to the project, such as citizens.

3.2.5TNO ESSIM

This simulation tool is used to simulate different scenarios in the PED's. The simulation results of these scenarios will be loaded into the Energy Islands Platform with a REST API. The API for importing data on the Energy Islands Platform is based on the SensorThings API.

3.3 Phase 3 - Metrics monitoring of the demo

The next paragraphs show which metrics are being collected for each building in the pilot, starting with the buildings in the district north PED and then followed by the southeast PED.

3.3.1 District North

3.3.1.1 Nijestee highrise A

Table 8: Nijestee highrise A metrics

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Net lighting electricity consumption	kWh	10 seconds	For common areas only
Electricity consumption elevators	kWh	10 seconds	
Electricity consumption water pressure maintenance	kWh	10 seconds	
Electricity consumption for ventilation			Not available yet





Electricity production PV	kWh	10 seconds	Solar panels are not yet installed
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Total gas consumption	m^3	10 seconds	
Gas consumption gas boiler	m^3	10 seconds	
Gas consumption from grid	m^3	1 hour	Measuring company API
Thermal energy consumption form heat grid	kWh	1 year	

3.3.1.2 Nijestee highrise B

Table 9: Nijestee highrise B metrics

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Net lighting electricity consumption	kWh	10 seconds	For common areas only
Electricity consumption elevators	kWh	10 seconds	
Electricity consumption water pressure maintenance	kWh	10 seconds	
Electricity consumption for ventilation			Not available yet
Electricity production PV	kWh	10 seconds	Solar panels are not yet installed
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Total gas consumption	m^3	10 seconds	
Gas consumption gas boiler	m^3	10 seconds	
Gas consumption from grid	m^3	1 hour	Measuring company API
Thermal energy consumption form heat grid	kWh	1 year	





3.3.1.3 Terraced house A

Table 10: Terraced house A metrics

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Electricity consumption per device	kWh	10 seconds	
Electricity production PV	kWh	10 seconds	
Total gas consumption	m^3	10 seconds	
Gas consumption from grid	m^3	1 hour	Measuring company API

3.3.1.4 Terraced house B

Table 11: Terraced house B metrics

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Electricity consumption per device	kWh	10 seconds	
Electricity production PV	kWh	10 seconds	
Electricity consumption heat pump	kWh	10 seconds	
Heat/cold production heat pump	kWh	10 seconds	
Total gas consumption	m^3	10 seconds	
Gas consumption from grid	m^3	1 hour	Measuring company API





3.3.1.5 Terraced house C

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Electricity production PV	kWh	10 seconds	
Electricity consumption heat pump	kWh	10 seconds	
Heat/cold production heat pump	kWh	10 seconds	
Total gas consumption	m^3	10 seconds	
Gas consumption from grid	m^3	1 hour	Measuring company API

Table 12: Terraced house C metrics

3.3.1.6 Energy Academy Europe

Table 13: Energy Academy Europe metrics

Metric	Unit	Interval	Remarks
Electricity production PV	kWh	Unknown	Collected by Building Management System
Electricity consumption ventilation	kWh	Unknown	Collected by Building Management System
Electricity consumption lighting	kWh	Unknown	Collected by Building Management System
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Gas consumption from grid	m^3	1 hour	Measuring company API
Heat consumption from grid	kWh	Unknown	





3.3.2District Southeast

3.3.2.1 MediaCentrale

Table 14: Mediacentrale metrics

Metric	Unit	Interval	Remarks
Total electricity consumption	kWh	10 seconds	
Electricity consumption per building wing (3)	kWh	10 seconds	
Electricity consumption old kitchen	kWh	10 seconds	
Electricity consumption new kitchen	kWh	10 seconds	
Electricity consumption heat pump	kWh	10 seconds	
Heat/cold production heat pump	kWh	10 seconds	
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Total gas consumption	m^3	10 seconds	
Gas consumption from grid	m^3	15 minutes	Measuring company API

3.3.2.2 Powerhouse apartments

Table 15: Powerhouse apartments metrics

Metric	Unit	Interval	Remarks
Electricity consumption (example penthouse)	kWh	10 seconds	
Electricity consumption from grid (example penthouse)	kWh	15 minutes	Measuring company API
Heat consumption from grid (example penthouse)	kWh	Unknown	
Electricity consumption (example apartment)	kWh	10 seconds	
Electricity consumption from grid (example apartment)	kWh	15 minutes	Measuring company API





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3.3.2.3 Sportcomplex Europahal

Table 16: Sportcomplex Europahal metrics

Metric	Unit	Interval	Remarks
Electricity consumption ventilation	kWh	Unknown	Collected by Building Management System
Electricity consumption lighting	kWh	Unknown	Collected by Building Management System
Electricity consumption from grid	kWh	15 minutes	Measuring company API
Gas consumption from grid	m^3	1 hour	Measuring company API
Heat consumption from grid	kWh	Unknown	

3.3.3 Simulating the energy behaviour with digital twins

The PED's also include non-pilot buildings that are not monitored with sensors/meters. This is especially true for the district North PED where the majority of the buildings is not part of the pilot. These buildings are simulated with digital twins to determine their baseline. The ESSIM tool will be used for this purpose. It will use yearly consumption data of similar buildings as input and derive hourly values for the buildings in the PED.

In a later stage the ESSIM simulations will also be used to determine the potential effect that an intervention will have on a non-pilot building. Initial ideas for the methodology to be used for this extrapolation of interventions can be found in chapter 6.





4 Monitoring phases of qualitative data

Qualitative data is monitored in two levels; city level and project (PED area) level. Both levels consist of two iterations.

Monitoring of qualitative data consists of the following phases (as depicted in Figure 4):

- 1. Context definition
- 2. Selecting the techniques, approaches, and tools
- 3. Collecting the data
- 4. Analyzing the data



Figure 4: Phases and steps of qualitative monitoring

4.1 Phase 1 - Context definition

4.1.1 Identifying the goals for data collection

For qualitative data, the following indicators have been defined in deliverables "D5.1 - City Level Indicators" and "D5.2 - Project Level Indicators":

4.1.1.1 Qualitative city level indicators

Table 17: Governance indicators

GOVERNANCE			
Initiatives and Strategies of the Public Administration			
Indicator	Unit	Description	
Smart city factor in a city development strategy	Likert scale	Inclusion and level of detail of smart cities strategies in the urban strategic plans of the city. Likert scale: Not at all $-1 - 2 - 3 - 4 - 5 - Very$ detailed	





Public ICT / Data		
Indicator	Unit	Description
Quality of open data	Likert scale	The extent to which the quality of the open data produced by the city was increased. Likert scale: Not at all $-1 - 2 - 3 - 4 - 5$ – Excellent

Table 18: Society and Citizens indicators

SOCIETY AND CITIZENS			
Citizen Engagement and Empowerment			
Indicator	Unit	Description	
Citizen engagement/empowerment to climate conscious actions	Likert scale	Appreciation of the benefits of city actions; Energy empowerment at home, satisfaction, happiness of people. Likert scale: Not at all $-1 - 2 - 3 - 4 - 5$ – High engagement	
Encouraging a healthy lifestyle	Likert scale	The extent to which policy efforts are undertaken to encourage a healthy lifestyle. Likert scale: Not at all $-1 - 2 - 3 - 4 - 5$ – Excellent	

4.1.1.2 Qualitative Project (PED) level indicators

SOCIAL AND RESIDENTS			
Social and resident related indicators			
Indicator	Unit	Description	
S1: Energy poverty	% of households, or % share of income	Percentage of households by definition (described further in the Annex), or energy bill as % of total household disposable income	
S2: Consciousness of residents	Likert scale: No consciousness – 1 – 2 – 3 – 4 – 5 – High consciousness	Increased consciousness of residents of the area on the defined issues (project interventions, energy, environment, climate, personal/communal consumption, carbon footprint and handprint, etc.). Communal consciousness and social coherence are the foundations of a healthy and democratic society (ITU). Civic consciousness is the people's awareness of their civic rights and responsibilities, their role in the community and their involvement in its holistic development, thereby increasing social capital (Ng, 2015). This includes:	

Table 19: Social and Residents indicators





		 Personal identity and citizenship: awareness, pride, obedience to the law, equality National identity: respect for the national authorities,
		country
		3. Moral consciousness: being a good citizen in public and private, trusting that others are too
		4. Ecological consciousness: awareness of the finite nature of resources, thinking about environmental consequences of actions
		5. Social citizenship: family values and virtues, actively concerned with others at home and abroad
		Appreciation of the benefits of project actions; Energy empowerment at home, satisfaction, happiness of people.
		The indicator provides a qualitative measure and is rated on a five-point Likert scale:
		No increase – 1 – 2 – 3 – 4 – 5 – High increase
		1. No increase: The project has not increased civic/resident engagement.
	Likert scale:	2. Small increase: The project has increased civic/resident engagement with regards to one of the five factors mentioned.
S3: Resident engagement / empowerment to climate conscious actions	engagement -1-2-3-4	3. Some increase: The project increased civic/resident engagement with regards to two of the factors mentioned.
– 5 – H engagemer	– 5 – High engagement	4. Significant increase: The project has increased civic/resident engagement with regards to three of the factors mentioned.
		5. High increase: The project has increased civic/resident engagement with regards to four or more of the factors mentioned.
		Note: during the testing phase it will be seen whether it is possible to measure actual impact of projects on civic/resident engagement, or that we may need to rephrase the indicator to just include actions taken by the project to increase civic/resident engagement.

4.1.2 Selecting the sources of data

The relevant data sources, i.e. the stakeholders for the qualitative data collection, must be identified. The stakeholders can be, for example, the residents of the buildings, larger property owners, city policymakers, etc. The classification of the stakeholders must be done, and the required number of stakeholders must be defined for each stakeholder class.

In the city level, the data sources will be residents of the city and the relevant city policymakers and city decision makers, which are familiar with the project and its goals for each PED areas, and are aware of the development of the whole city.





In the PED level, the data sources will be the residents of the monitored buildings. The data collected from these residents is based on their own habits, awareness and everyday life observations. Also, larger property owners can provide this kind of data in a wider perspective.

4.2 Phase 2 - Selecting the techniques, methods and tools

The municipality of Groningen started in 2005 with a panel of residents. This panel can be used to ask residents about their opinion on a whole range of subjects. The panel currently consists of 9000 residents and if necessary specific selection can be made, e.g. on age or neighborhood. Questionnaires for this panel can include both multiple choice and open questions. Residents will receive an invitation to participate in a questionnaire via email. In general out of the 9.000 members, 3.000 to 4.000 fill in a questionnaire. This panel will be used for the questionnaires to obtain the qualitative indicators.

4.3 Phase 3 - Collecting the data

For the collection of the qualitative data a questionnaire has been designed that tackles the collection of both City and PED level data. The questionnaire is aimed at residents and features the following modules:

- General section. This section focuses on generic information about respondents, such as age, type of house, education, income, etc. It includes questions about the awareness of energy saving measures and the willingness to actively take such measures. The role of the municipality also plays an important part in this section; how should it inform its residents, how much open energy data is available, etc.
- Energy Consumption. This module looks at how often respondents check their monthly energy consumption and whether they have equipment in place to brake the consumption down to individual device level. It also takes potential energy savings into account.
- Energy efficiency of the building. Questions in this module are centred around the efficiency of the building. It informs about the awareness in the interest in energy efficient technology such as: energy management, Smart/LED lighting, heat pumps, connection to a heat grid, floor heating and heat recovery from mechanical ventilation.
- Energy generation. This module asks respondents about the possibilities to generate energy in/on/near their building. Generation technologies that are covered are: PV panels (both roof mounted and vertical panels), solar collectors, small rooftop wind turbines, hydro power, bioenergy solutions and waste heat recovery solutions.
- Energy flexibility. Respondents are asked whether they are aware/interested in energy markets, trading platforms and variable energy tariffs. Besides these commercial aspects there is also attention for technical flexibility solutions such as power storage. This can be in the form of a home battery or a V2G EV.
- **Mobility.** The main focus of this module is about EV's. Respondents are asked about their opinions on EV's and whether they currently own an (ICE) car. There are also questions about alternatives to owing a car such as the use of (neighbourhood) taxis or shared cars.
- (Local) Energy communities. This module asks respondents about the various aspects of energy communities. One such important aspect is the service portfolio that is being offered by the energy community. The following services could be part of the portfolio: energy supply, collective ownership of energy production installations, advice on energy saving measures, p2p trading and car sharing. The social cohesion that is offered through an energy community is another important aspect of this module of the questionnaire.





4.4 Phase 4 - Analysing the data

The questionnaires will be analysed in close cooperation with the organisation behind the Groningen residents panel.





5 Residents' participation

As described in the previous section, residents will be able to provide feedback/input by filling in questionnaires, but their participation does not stop there. In additions to the panel of residents, other initiatives will/have been deployed to inform residents about and involve them in the MAKING-CITY project. Examples of such initiatives are publications in local media and information meetings.





6 Extrapolation of intervention data to PED level

The boundaries that have been defined for both PEDs in Groningen are such that they also include buildings were no MAKING-CITY interventions will take place. The impact of interventions as proposed in the project is assessed on the building and district level. In the initial phase, the impact on the district is assessed when only the proposed buildings implement the interventions. For future scenarios, it is of interest to explore how the proposed interventions can be applied to other buildings in the district, and what impact this extrapolation would have on the proposed indicators. As this depends on a number of different factors concerning both the intervention buildings, as well as the types of interventions themselves, a methodology for intervention data and KPI extrapolation and aggregation is needed. In the context of this methodology, only the building-level physical interventions (e.g. PV installations, heat pumps) are considered. This means that the interventions proposed in the project, which are already on the level of a district (such as district heating grids in the two districts) are outside the scope of this methodology due to complex modelling and quantification.

This section proposes an initial version of a methodology to extrapolate building-level physical interventions to reach a PED. The proposed methodology groups buildings in a district into groups (*clusters*), depending on a number of characteristics. Within those clusters, interventions are extrapolated from intervention buildings to other buildings. Extrapolation entails proper intervention dimensioning, based on a number of identified building and intervention characteristics. Finally, KPIs are calculated for buildings, clusters and the district itself.

The design of this methodology is complex, as it requires a number of considerations, such as:

- Identifying building characteristics
- Identifying intervention characteristics
- Identifying intervention criteria for buildings
- Identifying building grouping criteria
- Estimating energy demand
- Dimensioning interventions to other buildings

Figure 5 shows the conceptual model of the proposed methodology. The process starts by identifying intervention buildings and the area to extrapolate the interventions to (e.g. district), including its buildings. In case of Groningen, the area information (including buildings and their categories) can be obtained from the Dutch key register of addresses and buildings (Basisregistratie Adressen en Gebouwen - BAG).

The next step is to group similar buildings and perform extrapolation in those clusters. Clustering can be performed using different clustering methods, and based on a number of characteristics, such as:

- Category: residential/office/sports/education/prisons/hotel etc. (ideally, these categories would correspond to those of the project intervention buildings)
- Age
- Structural characteristics
- Volume
- Occupancy
- Energy consumption by occupants
- Inclination of roof
- Energy label
- Insulation





Type of glazing

Different clustering characteristics depend on the available data on buildings. Generated clusters should contain at least one intervention building. It can happen that clustering generates outliers, singlemember clusters with unique buildings based on chosen characteristics (such as, for example, Energy Academy Europe). It should be determined whether and how these interventions can be extrapolated.



Figure 5: A conceptual model of the methodology to extrapolate building-level physical interventions to reach a PED

Once the clusters with intervention buildings are identified, energy data of the buildings within the clusters should be determined. Ideally, energy data should be obtained from existing monitoring/smart meter data, both for intervention buildings and the other ones in the district. However, in most of the cases, this data is scarce, and has to be estimated. Estimating energy data depends on the available data sources on buildings and energy consumption of the selected areas. If existing monitored data from intervention buildings is available, energy data of other buildings in the cluster can be estimated using simple linear approximation, based on building characteristics. Otherwise, a number of external sources can be used. In case of Groningen, these include:

- Dutch key register of addresses and buildings (Basisregistratie Adressen en Gebouwen BAG)
- ECN tool that estimates gas and electricity consumption per square meter of floor for Dutch service sector consumers.1
- Central Bureau of Statistics (Centraal Bureau voor de Statistiek CBS)
- MAKING-CITY technical documentation
- Discussions and interviews with Groningen intervention partners

After energy data is estimated, interventions from intervention buildings should be extrapolated to other cluster buildings. Depending on the number of interventions, all or a selection of interventions can be made. Intervention extrapolation requires identifying a number of intervention characteristics, such as:

¹ <u>https://publicaties.ecn.nl/PdfFetch.aspx?nr=ECN-E--15-068</u> (In Dutch)





- Intervention type
- ► Intervention scope: building/district/etc.
- Existing/planned interventions
- Energy carrier: electricity/heat/gas
- Intervention dimensions: e.g. capacity, peak production, energy demand, number of panels etc.

Finally, interventions are extrapolated to other buildings in the district. Although this step is abstracted, it requires complex analysis of intervention choice and dimensioning with respect to building properties. As a simple approach, a linear extrapolation can be applied. For example, PV sizing can be determined based on rooftop area and energy consumption of the building.

Finally KPIs are calculated on the level of buildings, clusters and the area (district). Calculating KPIs for higher levels of aggregation requires aggregating energy data (demand and production) of individual buildings.

Developing such a methodology that determines different types of buildings and an estimation of intervention dimensioning, based on a number of criteria, can result in a catalogue of benchmark buildings for future reference as well as a generalized approach to determine a topology of a PED.





7 Smart Cities Marketplace Data Exchange

The KPI's that will be shared with the Smart Cities Marketplace have a fairly static character, most of which have a yearly frequency only some are more frequently e.g. monthly. It would be relatively much effort to automate this process since there is not that much data to be exchanged. For this reason the updates towards Smart Cities Marketplace will be a manual process for which their self-reporting tool will be used.





Conclusions

Based on the structure that was put forward by D5.6, this deliverable describes the Groningen monitoring programme in detail.

All main components of the Groningen Monitoring Programme are in place and the monitoring process for almost all the locations in the Groningen PED's started earlier this year.





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Annex A: Participant Contract

The inhabitants of the terraced houses in PED north have signed a contract in which they agree with the processing of their data for the purposes of the MAKING-CITY project. The contract (in Dutch is shown below):

Beste Deelnemer,

Binnen het Europese H2020 Smart Cities and Communities programma lopen een aantal Lighthouse projecten. Het MAKING-CITY project is hier een van. Dit project is een groot demonstratieproject met als doel om nieuwe innovatieve strategieën te ontwikkelen die bijdragen aan de stedelijke energietransitie die uiteindelijk moet leiden tot een CO2 neutrale stad. Centraal hierbij staat de ontwikkeling van Positieve Energie Districten (PEDs). In een PED gebied (wijk of buurt) is het jaarlijkse gebouwgebonden² energiegebruik positief, oftewel er wordt binnen de grenzen van het gebied meer energie geproduceerd dan gebruikt.

Het project wil graag zoveel mogelijk bewijs verzamelen over de potentie van het PED concept, dat als basis kan dienen voor een verdere efficiënte en duurzame stedelijke transformatie route.

In het project zijn drie grondgebonden woningen geselecteerd waar innovatieve toepassingen geïmplementeerd worden. Dit zal gemonitord worden gedurende de looptijd van het project. Ook de niet innovatieve energie gerelateerde acties zullen gevolgd worden. Het energie gebruik en consumptie zal gemeten worden om te bepalen hoe effectief de maatregelen zijn en zodat bepaald kan worden in hoeverre het mogelijk is om energiepositief te worden.

Bij project deelname krijgt de deelnemer toegang tot energiecoaching, energiebesparende maatregelen en subsidie voor de innovatieve maatregelen. De data die verzameld wordt in het project zal gebruikt worden om de energiebalans in het hele PED gebied te kunnen simuleren, waarbij er zorgvuldig en volgens de privacy regels omgegaan zal worden met persoonsgebonden data. De lijst die is bijgevoegd aan het einde van dit contract geeft aan welke data verzameld zal gaan worden. Tevens zal de verkregen informatie gebruikt wordt voor de project rapportage. De naam en identiteit van de deelnemer zal hierbij anoniem blijven.

Deelname aan het project is vrijwillig. Mocht de deelnemer op enig moment besluiten niet langer meer deel te willen nemen aan het project dan zal in overleg data vernietigd kunnen worden.

Mocht er gedurende de looptijd van het project niet relevante privé gerelateerde gegevens opgedaan worden dan zal deze data in overeenstemming met de privacy regels behandeld worden. In het geval de opgedane data wel relevant is, maar niet op de data lijst vermeld staat, zal in overleg met de deelnemer besloten worden of deze data toegevoegd mag worden aan de lijst.

Lees alstublieft de volgende verklaringen goed door:

- Ik heb de hierboven beschreven projectomschrijving gelezen en heb hierover vragen kunnen stellen.
- Ik heb voldoende informatie om over projectdeelname te besluiten.
- Ik begrijp dat het mij vrij staat om op elk moment terug te trekken uit het project.

² 1: Gebouwgebondeen energiegebruik: Het energiegebruik gerelateerd aan verwarmen, koelen, ventileren, heet water en verlichting. Het overige gebruik, bijvoorbeeld van apparaten of koken word niet gezien als gebouwgebonden.





- Ik begrijp dat de informatie die ik beschikbaar stel vertrouwelijk behandeld zal worden.
- Ik ga akkoord met deelname.
- Ik begrijp dat de verkregen data, zoals hieronder beschreven, gebruikt zal worden door het MAKING-CITY project in de realisatie van de hierboven beschreven doelen en dat de gegevens anoniem en indien nodig geaggregeerd gebruikt zullen worden.

Volledige naam:

Datum:

Plaats:

Handtekening:

Lijst met data die verzameld zal worden:

- Alle energie gebruiksgegevens op basis van minuutwaarden, hieronder valt te verstaan:
 - Energiegebruik voor verwarmen
 - o Energiegebruik voor verlichting
 - o Energiegebruik voor ventilatie
 - o Energiegebruik voor warmt tapwater
 - o Energiegebruik voor eventuele koeling
 - o Energiegebruik voor koken
 - o Energiegebruik voor overige apparaten
- Alle energie opwekgegevens, zoals bijvoorbeeld zonne-energie.
- Technische gegevens van de apparaten die energie gebruiken of opwekken.
- Gezinssamenstelling
- Gezamenlijk inkomen
- Woongedrag in relatie tot energiegebruik:
 - Temperatuur instellingen in de woning gedurende dag/nacht, week/weekend.
 - o Mate van gebruik douchen.
 - o Gebruik van natuurlijke ventilatie, zoals luchten met open ramen.
- Constructieve gegevens van de woning.
- ...





Annex B: Data Processing Agreement template

This annex shows the template of the Data Processing Agreement that needs to be in place with all parties in the Groningen consortium that process personal data.

The template (in Dutch) is shown below. Confidential parts have been left out.

Versie: december 2021

OVEREENKOMST GEZAMENLIJKE VERWERKINGSVERANTWOORDELIJKHEID

Datum: [X]

De Partijen:

 Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO, een publiekrechtelijke rechtspersoon overeenkomstig de TNO-wet, gevestigd te Delft, adres houdende aan het Anna van Buerenplein 1, 2595 DA Den Haag, Nederland, ingeschreven bij de Nederlandse Kamer van Koophandel onder nummer X, hierna te noemen "TNO", rechtsgeldig vertegenwoordigd door [____] handelend in volle hoedanigheid namens de Raad van Bestuur van TNO;

en

 Gemeente Groningen, een publiekrechtelijke rechtspersoon, gevestigd te Groningen, adres houdende aan de Grote Markt 1, 9712 HN Groningen, hierna te noemen Gemeente Groningen, ingeschreven bij de Nederlandse Kamer van Koophandel onder nummer X, rechtsgeldig vertegenwoordigd door X

hierna tezamen te noemen de "Partijen" en elk afzonderlijk een "Partij".

OVERWEGENDE DAT

- A. Partijen wensen samen te werken aan het project dat in Bijlage 1 nader wordt omschreven;
- **B.** Partijen op [DATUM] een Hoofdovereenkomst, zoals hierna gedefinieerd, hebben gesloten met betrekking tot de uitvoering van het project 'Energy efficient pathway for the city transformation: enabling a positive future'- 'Making City' [];
- **C.** het Verwerken en uitwisselen van bepaalde Persoonsgegevens tussen Partijen noodzakelijk is om het Project zoals nader omschreven in Bijlage 1 te kunnen uitvoeren. Partijen bepalen gezamenlijk het doel van de Gegevensverwerkingsactiviteiten en de daarbij gebruikte middelen en zijn derhalve gezamenlijk Verwerkingsverantwoordelijken in de zin van artikel 26 van de AVG;
- D. om een zorgvuldige Verwerking van de Persoonsgegevens te waarborgen, Partijen afspraken wensen te maken over de Verwerking van Persoonsgegevens en de respectieve verantwoordelijkheden van de verschillende Partijen ten opzichte van elkaar en Partijen deze Overeenkomst Gezamenlijke Verwerkingsverantwoordelijkheid wensen te sluiten;

komen de partijen derhalve als volgt overeen.

Artikel 1. Definities

Artikel 2. Reikwijdte van de Overeenkomst

Artikel 3. Verplichtingen van de Partijen





Artikel 4. Toegang tot Persoonsgegeve	ens
Artikel 5. Niet-openbaarmaking en geh	eimhouding
Artikel 6. Aansprakelijkheid	
Artikel 7. Inbreuk in verband met Perse	oonsgegevens
Artikel 8. Duur en beëindiging	
Artikel 9. Overige bepalingen	
ALDUS is deze Overeenkomst onderteke	end door de gevolmachtigde(n) van elke Partij
тло	Gemeente Groningen
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handtekening	handtekening
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handtekening	handtekening
LIJST BIJLAGES	
Bijlage 1: Specificatie van het Samenwer	kingsverband tussen de Partijen
Bijlage 2: Specificatie van de verantwoor verdeling van taken	delijkheden van de Partijen ten opzichte van elkaar en de
Bijlage 3: Specificatie van de uit te voere	n Verwerkingsactiviteit(en
Bijlage 4: Specificatie van de technisc genomen door de Partijen	he en organisatorische beveiligingsmaatregelen die zijn

