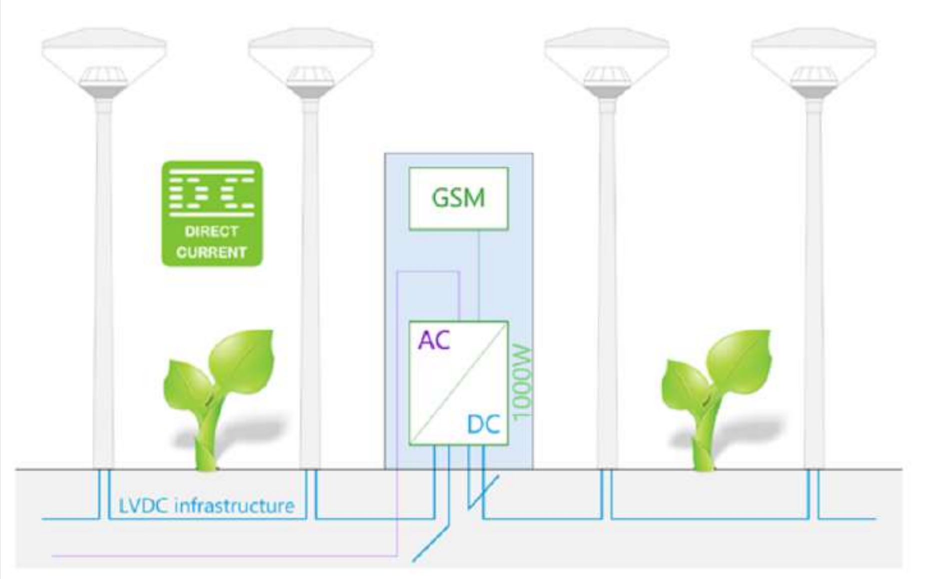
ETT2 - Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions

DC lighting with EV charging



DESCRIPTION

In Oranjebuurt, a neighbourhood in Alkmaar, a fully operating DC grid is installed, consisting of 92 DC lampposts. Experiences in the pre-pilot in the neighbourhood Rietland, that showed malfunctioning, led to de decision to non install smart LED drivers inside the lampposts.
The main objective for the installation of the DC drivers is ensuring stability of the DC grid of Oranjebuurt. The lampposts are being monitored as a group to ensure they are functioning correctly. The lampposts cannot be monitored individually. Communication and continuous DC feeding over the cabling will be tested as well.

In comparison with an AC grid, the short-circuit protection within a DC grid (with fast switch electronics) is faster, safer and easier to realize.

For a AC grid to cope with a high current, the cable of a AC cable needs to be thick. Within a DC grid, the short-circuit problem is far easier and much faster detected then in a AC grid. Fast switch electronics located in the electrical feeding cabinet monitors the power amount continuously. Even before a high current is present, the electronic safety device has already shut down the DC-voltage. Therefor a DC cable does not have to take into account short-circuit failures and can be a lot thinner than a regular AC cable.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

High. When new lamp posts are being planned, an AC network can be installed.

Already demonstrated in Lighthouse cities No

Cultural heritage compliance Context depended

PERFORMANCE

Energy savings: 5% (compared to an AC grid)

COST

Cable: 3,70 €/m

DC electrical feeding cabinet: approx. €40.000

DIMENSION

Cable: 4 wires of 4,0 mm^2 each, 1600m

TIME

IE is implemented in Q1 2021 and fully operational.

SAFETY

Safety inspection/maintenance is once a year.

SUSTAINABILITY

Energy savings: 5% (compared to an AC grid)

In comparison to an AC grid, less copper is needed.

The existing poles of the existing lampposts were being re-used.

KEY REQUIREMENTS

In Oranjebuurt a fully operating DC grid is installed, consisting of 92 DC lampposts. As the technology of the smart lamppost in the pre-pilot Rietland was not properly in operation and the smart LED drivers inside the lampposts were malfunctioning, the lampposts in Oranjebuurt do not have these (expensive) prototypes of smart LED drivers.

Main priority for the pilot is stability of the DC grid of Oranjebuurt. The lampposts are being monitored as a group monitored by their grid to ensure they are functioning correctly. The lampposts cannot be monitored individually. Communication and continuous DC feeding over the cabling will be tested as well in Oranjebuurt.

In Oranjebuurt the DC technology inside the lamppost is from Schreder. The electronics located in the feeding cabinet are from Phoenix. A reason to choose another supplier than in the prepilot is to gain experience with two suppliers in order to have more competition in the future. The suppliers can learn and the technology can evolve faster in this way.

The existing poles of the lampposts are being re-used, these are tapered poles with a 4 meter height.

The cable used in Oranjebuurt consist of 4 wires, each $4mm^2$ thick. These wires are thicker than needed for a DC grid (normally $2{,}5mm^2$), but temporary it was necessary to still use the grid as AC with a limited amount of AC fed lampposts.

In Oranjebuurt there are three cables installed (three chains) each with approx. 30 lampposts. The cable length of each chain is approx. 1600 meter.

The goal of this pilot is to have experience with a successful DC grid with lampposts. No smart LED drivers will be installed in Oranjebuurt.

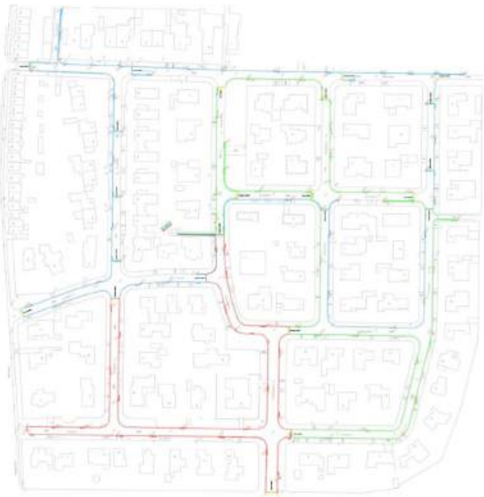
ENVISAGED DEMONSTRATION IN POCITYF

LOCATION

Oranjebuurt is a neighbourhood situated in the South of Alkmaar.

TIMELINE

In 2021 the lampposts were installed.



DETAILS

The grid consists of:

- 92 DC lampposts
- Cable consists of 4 wires, each $4mm^2$ thick.
- There are three cables installed (three chains) each with approx. 30 lampposts; see Figure left.
- The cable length of each chain is approx. 1600 meter.

TARGETED OUTPUT

- Reducing the amount of cables from 1 cable with 4 wires of $10mm^2$ to 1 cable with 4 wires of $2{,}5mm^2$ (in this case 4 mm^2) . Thus enabling a reduction of copper material by 75% and strong reduction in investment costs in the infrastructure of lampposts by more than 60%.

- The smart-grid possibility: the lampposts can be controlled and monitored on a distance. The use of dynamic lighting is possible: In the middle of the night, the lampposts could be set up to automatically reduce the amount of light to e.g. 50% for energy savings. Another future opportunity would be to automatically change the colour of the light to green, as green light is calmer for nocturnal animals and reduces city light pollution.

- Communication and monitoring of the smart lamppost by the cloud will create additional benefits as the maintenance efforts and costs could be reduced. As the DC system is continuous active, a malfunctioning is detected immediately. With a AC fed lamppost, malfunctioning can only be detected in the evening as the lamppost is activated. The maintenance personnel has to work during the evening/night to repair the lamppost. This is not needed in a DC system as the malfunctioning is detected immediately during the day. Local maintenance checks are also not required anymore due to the monitoring information from a distance.

- Future additional monitoring systems can be added to the DC grid lampposts. As the DC system is active continuously 24hr/day with 350Volt, the DC network could be equipped with local 5G hotspots, camera's or additional monitoring (air pollution, humidity, temperature, etc.).

IMPACT ON COMMUNITY

The DC installed lampposts can have a high impact on the community. The settings of the lampposts can be adjusted though dynamic lightning. Local residents will have less nuisance from the lampposts.

Because of the additional monitoring feature of the lampposts, the posts can easily be equipped with for example 5g hotspots. This will enhance the connectivity of local residents.

CULTURAL HERITAGE BUILDINGS COMPLIANT

The usage potential in cultural heritage districts is high. All types of lamppost can be installed via a DC instead of an AC network.

OTHER COMMENTS – OPEN CONSIDERATIONS

This innovative element of the DC lighting consist of several components:

- An electrical feeding cabinet consisting of a smart AC/DC convertor with transformer and other components like the short circuit protection. The smart aspect of the component is that it can communicate by internet connection; in this way the public lighting system can be monitored and controlled on a distance (management via cloud).
- A thin DC cable (4 wires of 4,0mm2) which establishes communication between the electrical feeding cabinet and the smart DC LED driver. The DC grid shall be continuous 24hr/day active/ 350 voltage.
- A smart DC LED driver in the foot of each lamppost. This smart DC driver controls the lamppost and collects the monitoring data from the lamppost. The following information from the lamppost is possible: misalignment of the lamp, location (GPS coordinates), temperature of the lamp, ON/OFF.
- A DC grid is laid down in chain shape and the DC cable is installed between two lampposts; thus creating a large chain. To investigate the location of the malfunctioning in a DC grid, the chain is interrupted at the lamppost furthest away from the electrical feeding cabinet (step 1). It is easy to detect which side of the chain (which lampposts) is still in operation and which side of the chain is malfunctioning. Step 2 is to interrupt the lamppost in the middle of side of the chain which is not in operation. In an iterating way the exact location of the malfunctioning can easily be detected without using measuring devices.

Li-ion Battery De Meent

DESCRIPTION

A lithium-ion battery or Li-ion battery (LIB red.) is a type of rechargeable battery. Battery Energy Storage Systems (BESS) stores electricity locally, for later consumption. The stored energy commonly originates from:

1. on-site solar photovoltaic panels, generated during daylight hours
2. The electricity connection from the Meent (936kW) when the demand for power from the sports complex is lower than what the electricity connection can supply.

A BESS can serve as a technology to reduce the amount of imported electricity, leading to a reduction of the associated CO2 emissions.
When a battery is installed with monitoring and smart control (BEMS/CEMS), a complete smart grid can be realized. This smart grid can balance the produced electricity by the solar panels with energy consuming installations like heat pumps (ATES. Excessive energy can be sold.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

High. When a building is being equipped with solar roofs and has a high demand on energy, a battery with BEMS system can balance the electricity net and resuce the amount of imported electricity.

Already demonstrated in Lighthouse cities Y

Cultural heritage compliance N

PERFORMANCE

Capacity: 240 kW h

Charging rate: 240kW max, 120kW advised

Efficiency complete cycle of charging and discharging: 96%

COST

Investment cost: € 203,000.00

Installation cost: € 5,000.00

DIMENSION

1x 10-foot container with air conditioning and 8x 19" cabinets each equipped with 1x 30kW converter, 13 battery modules, and 1x Battery Management System.

Size: 600 x 700 x 1800 mm (w x h x d) per battery rack

Weight: 75 kg per battery rack

TIME

Installation time: 1 month

Startup time: 1 hour

Operational since 4th quarter 2021

SAFETY

No dendrite formation

No risk of spontaneous fire and explosion

Modules designed for 1500V, UN3480, UL2054

SUSTAINABILITY

Reefer container can be reused.

Electrodes can be recycled

Batteries get second life by Ateps

KEY REQUIREMENTS

The battery requires a closed location where the container can be placed.

ENVISAGED DEMONSTRATION IN POCITYF

LOCATION

Outside Sportcomplex de Meent (PEB1 _B1).

TIMELINE

- Preparation of tender: Q4 2020
- Award of tender: April 2021
- Realization: Summer 2021
- Implementation: September 2021
- Operationalisation started, finetuning by Firan
- Monitoring has started in 2023

DETAILS

The complete battery system contains a 1x 10-foot container with air conditioning and 8x 19" cabinets each equipped with 1x 30kW converter, 13 battery modules, 1x Battery Management System

The system is controlled and checked via the Storage Control System (SCS) that can be controlled with different protocols by an external aggregator. The SCS enables remote monitoring of the various functions of the system. Such as output or charged power, State of Charge (SoC) of the batteries etc. It is also possible to display the production of existing PV panels via the same interface and therefore also to display the ratio between purchased, PV and battery energy. It is a containerised system.

The energy storage system is installed in a fully enclosed reefer container that integrates an industrial grade HVAC system. The container is equipped to cool, heat and de-humidify the installation.

TARGETED OUTPUT

The application of a battery has multiple advantages:

- The required amount of power from the electricity grid decreases.
- The energy consumption is more balanced. Because of that the peak load diminishes, which leads to reducing grid congestion.
- It adds flexibility to the electricity grid; the battery can respond to signals from either the market or the grid operator to charge or discharge the battery.

IMPACT ON COMMUNITY

The battery has a small impact on the community. The battery fades away in its surroundings. On the other hand, the impact in a more metaphorical sense, is high. The installation of a battery with a BEMS reduced net congestion. Through that there is more room on the grid for other initiatives.

CULTURAL HERITAGE BUILDINGS COMPLIANT

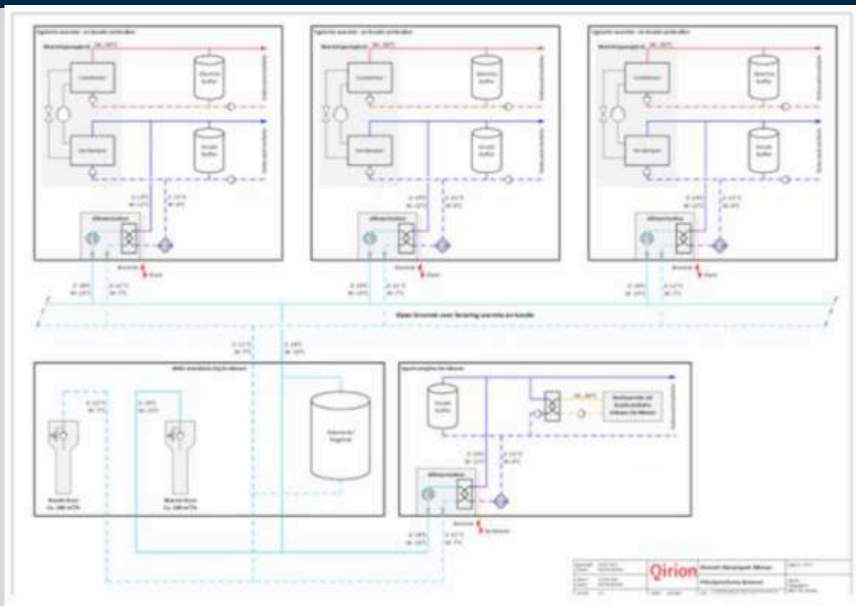
The battery requires space. When space is present in a cultural heritage building, the installation of a battery could be a suitable solution to make the building more sustainable.

OTHER COMMENTS – OPEN CONSIDERATIONS

This IE is connected to the virtual power plant and Reflex IE.

This solution has also been installed at several other demonstration locations.

Low temperature heat grid



DESCRIPTION

The Meent consists of 2 parts: The old part of the sportcomplex, the Meent 1.0 and the new part of the sportcomplex, the Meent 2.0.The heat produced by the two ice machines, situated at De Meent 1.0 were “wasted” via cooling towers. Simultaneously, the new Sport Complex De Meent 2.0 required a lot of heat for space heating and showering purposes. Fossil fuels (natural gas) were used to heat up de Meent 2.0. This lead to CO_2 emissions.

With the installation of a low temperature heat grid, which is being fed by residual heat from the ice machines, there is no need for heating De Meent 2.0 up with fossil fuels.
Besides the realisation of a heat grid, a cold grid is being implemented.

Furthermore, the opportunity is seen to transport the excessive volume of residual heat via a heat grid to the direct surroundings via the realisation of a low temperature heat grid.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

In case of availability of residual heat or cold, the installation of a low temperature heat grid could be interesting, while fossils fuels are (almost) not longer needed.

Already demonstrated in Lighthouse cities **N**

Cultural heritage compliance **Context dependent**

PERFORMANCE

Heating capacity: 2.200 kW

Cooling capacity:1.006 kW

COST

N/A

DIMENSION

The low temperature heat (smart) grid consists out of: • aquifer thermal energy storage (ATES) • Cooling batteries • Fancoils • Heatpumps • Changeover cooling exchanger • Residual heat exchangers • Cold grid • Heatbuffer

TIME

Installation finished in March 2023

Monitoring phase: April 2023

SAFETY

Safety inspection/maintenance for the grid is once a year.

SUSTAINABILITY

Reducing gas consumption by 95%

KEY REQUIREMENTS

To instal a low temperature heat grid, quite much space is needed. Besides that a low temperature heat grid required a source like an ATES.

ENVISAGED DEMONSTRATION IN POCITYF

LOCATION

The low temperature waste grid is located in PEB1, Westrand district of Alkmaar.

TIMELINE

o Preparation phase (research, design): detailed design was finished in September 2022

o Installation phase: q4 2022, q1 2023

DETAILS

In order to realize a low temperature heat grid, various cooling batteries and fan coils were installed. The heating installation of the Meent 2.0 had to be equipped with a change-over system.

Next to a heat grid, a cold grid is needed. The main infrastructure of the heat & cold network is prepared for future expansion of the grid to its surrounding, the import of residual heat from the ice machine and the supply of low and high temperature heat from the heat pumps.

Future expansion of the grid to its direct surroundings, Olympiapark, is under investigation.

TARGETED OUTPUT

Heat demand 2.949 MWh/yr

Cold demand: 3.71 MWh/yr

IMPACT ON COMMUNITY

The transfer from gas consuming installations to electricity driven installations has an impact on the technical engineers from Alkmaar Sport. Their whole way of working has changed. It will take a while before they are used to the new system. For the tenants and users of Alkmaar Sport, the impact was manageable.

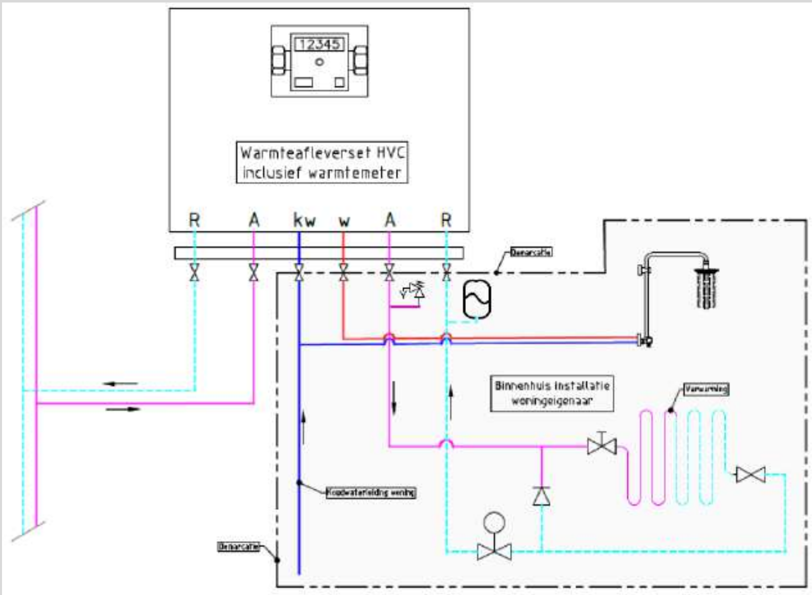
CULTURAL HERITAGE BUILDINGS COMPLIANT

Installation of a low temperature heating system in the cultural buildings requires quite an amount of extra space, in order to give room to technical spaces, tubes etc.

OTHER COMMENTS – OPEN CONSIDERATIONS

- Due to higher prices of materials and complexity of the work, much more funding was needed to implement this IE.
- Due to the complexity of the work, the decision time took much longer than expected.
- When integrating a new system into an existing system, engineering is very complex. Complexity is enhanced by the requirement of sports complex to be opened year round.

Indirect delivery set



DESCRIPTION

The innovative element of a indirect delivery sets creates an extra separation between the water from the local HVC heat network and the water from the indoor installation in the home. The indirect delivery sets creates a separation between the temperature and pressure of both installations.

Standard delivery systems are direct sets, in which the water from the local heat district is also fed into the indoor installation of the house that is connected to the heat grid. This system is only able to deliver at a certain temperature without the possibility for variation. Additionally the indoor system has to be applicable with the heat grid. By introducing a indirect delivery set a separation is made between the indoor and outdoor system of the heat grid. Therefor allowing for separate systems and more freedom of choice to the customer.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

N.A.

Already demonstrated in Lighthouse cities N

Cultural heritage compliance Y

PERFORMANCE

80% CO_2 reduction compared to the previous situation

More freedom in choice of materials and temperature settings within the dwelling

COST

N.A.

DIMENSION

Inside unit: 550 mm x 260 mm x 570 mm

Between 20 kg and 25 kg

TIME

Preparation started January 2019

Installation finished December 2021

SAFETY

N.A.

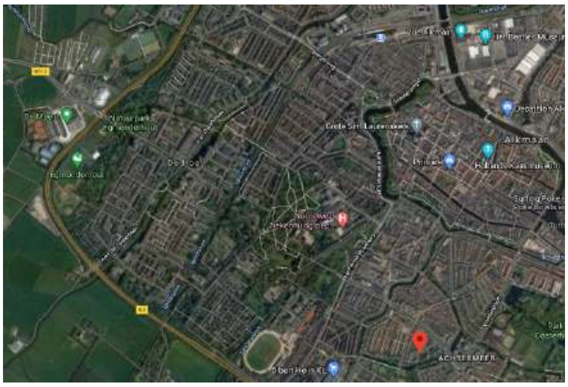
SUSTAINABILITY

Connection to local heat grid is more sustainable than individual gas-fired boilers.

KEY REQUIREMENTS

The innovative solution is an element for connecting dwellings to an existing heat grid. Thereby taking the characteristics of the dwelling and local heat grid into account.

ENVISAGED DEMONSTRATION IN POCITYF



LOCATION

2 apartment buildings at the Dillenburgstraat, Alkmaar which is south of the city center, close to the existing district heating.

Both apartment buildings have been built in 1997.

The first building, Dillenburgstraat 130-150, contains 21 apartments, with an average size of 70 square meter.

The second building, Dillenburgstraat 151-182 contains 32 apartments with an average size of 60 square meters.

TIMELINE

- January 2019 - Start of the engineering and preparation
- September 2020 - Materials were ordered
- March 2021 - Realization started
- December 2021 - All delivery sets were installed

DETAILS

- Differential pressure is adjustable and dynamic valves can be used at the radiators (cheaper and easier to adjust). In addition, a pipeline calculation is no longer necessary.

- Radiators no longer need to be replaced if they are made of aluminum.

- The operating pressure in the installation is lower and corresponds to the current situation.

TARGETED OUTPUT

An indirect delivery set in each of the 53 apartment buildings.

The application of the indirect delivery set in itself does not yield energy savings. However, the CO2 reduction achieved with a connection to the local heat grid is significant: compared to the use of gas-fired boilers, the CO2 savings amount is about 80%.

IMPACT ON COMMUNITY

One important benefit of this innovative element is that there is no need to replace the radiators if they are made of aluminium as the operating pressure in the installation is lower and corresponds to the current situation. The existing connections can be maintained in the home, choice of materials after the demarcation line is free. This yields benefits compared to a direct delivery set in case of a connection to a local heat grid, this demands more adjustment inside the homes in order to be connected.

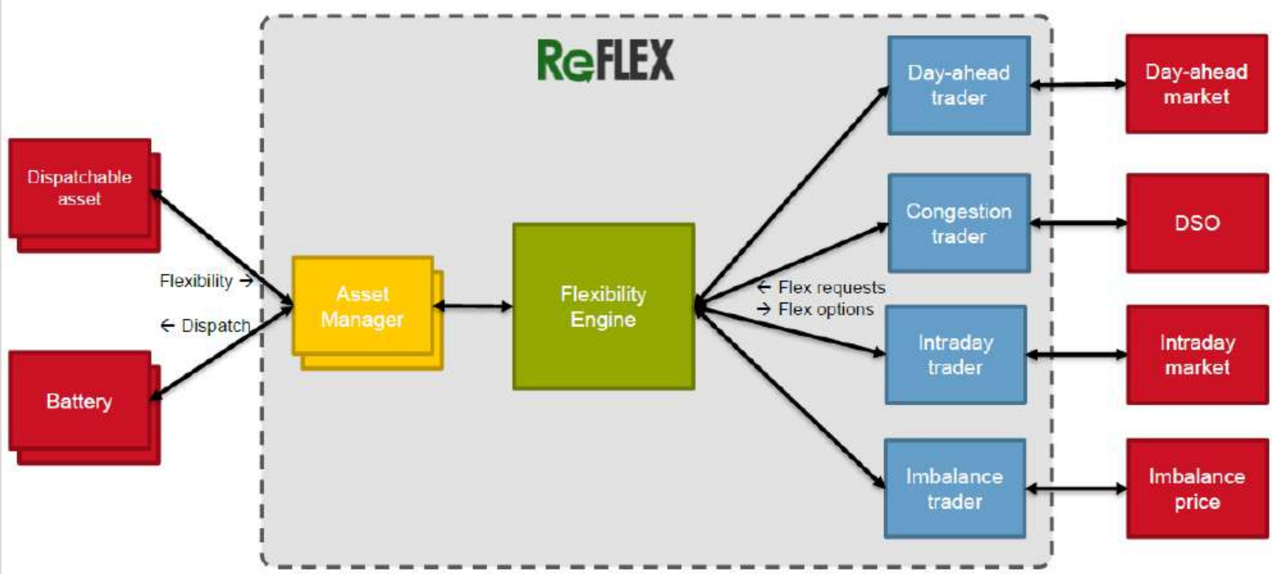
CULTURAL HERITAGE BUILDINGS COMPLIANT

Connection to a heat grid can be an interesting method for cultural heritage buildings in order to have a sustainable heating system, the indirect delivery sets can contribute to this since there is more freedom of choice for the materials used for the heating installation in the building, compared to a direct delivery set. However the capability to use a local heatnetwork for the heating of a cultural heritage buildings depends on the characteristics of the building and the heat network itself.

OTHER COMMENTS – OPEN CONSIDERATIONS

The direct delivery sets have the disadvantage that they must be linked to the existing heating system in homes. This creates limitations in the technical possibilities in terms of material to be used. The system is also susceptible to misuse by residents, causing it to no longer function. The fact that the system can only function at 1 temperature value is also a limitation. The indirect delivery set is trying to overcome these disadvantages.

Reflex



DESCRIPTION

ReFlex is a software solution to manage and optimize multiple flexible electricity assets at a location and also has the possibility to act as a virtual power plant (VPP) of that location. The goal of ReFlex is to optimize the consumption and the production of electricity at various locations within POCITYF to demonstrate the functionality.

ReFlex can be configured for different optimization goals, such as mitigating grid congestion at the power connection, improve self-consumption, optimize for energy tariffs, or offer any overproduction of power to the grid (as a VPP). All of these goals are geared towards helping PEBs or PEDs to become more sustainable. Within POCITYF ReFlex will contribute to the flexibility in and of the electricity system with more RES becoming available.

ReFlex will be demonstrated at different locations within the POCIFY project. For instance, at demonstration location De Meent several changes have been introduced, including PV panels, electrical heat pumps and a large battery. These additions create an energy system with intermittence (solar PV) and flexibility (battery) allowing for ReFlex to perform optimizations. To communicate with the battery, ReFlex uses the S2 standard (EN 50491-12-2). The S2 standard focuses primarily on the communication between smart devices and the Customer Energy Manager (CEM).

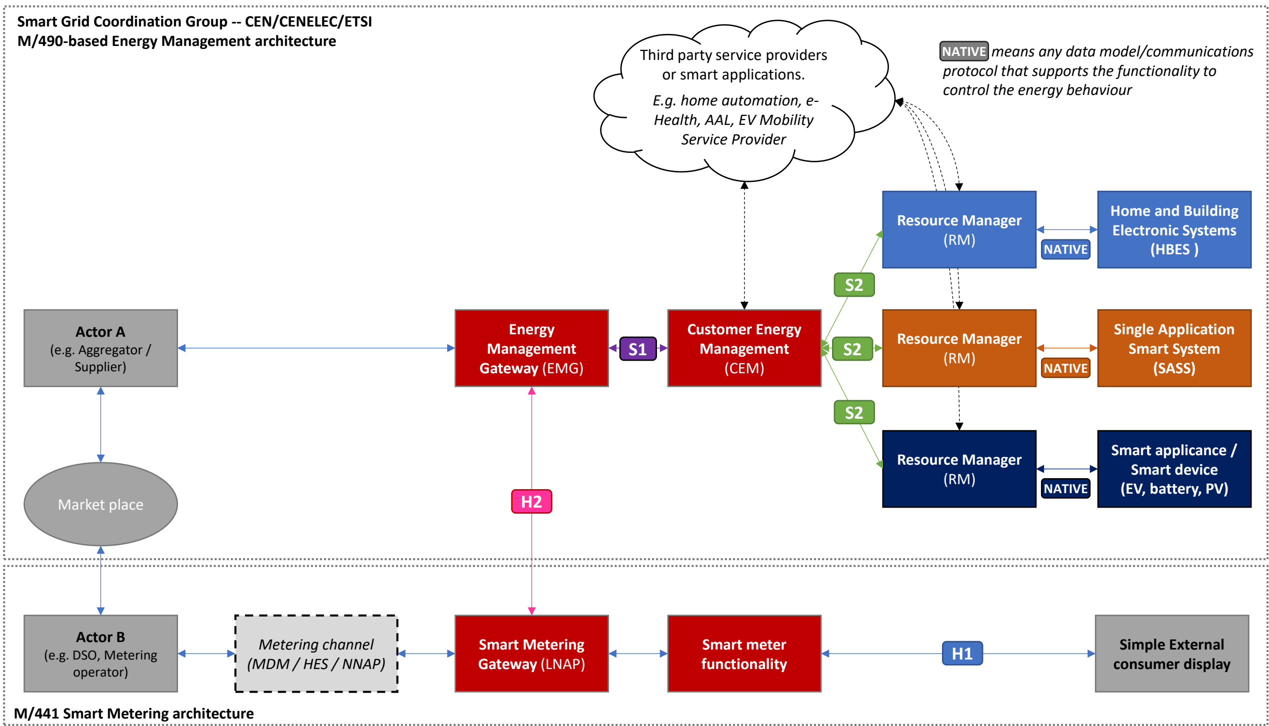


Figure 1: European Smart Grid Architecture, with S2 interface in green showing the communication between the smart/flexible device and the Customer Energy Manager (CEM) (Source: EN 50491-12-2).

By making use of S2 a lot of the implementation details of the devices are hidden for CEM, which therefore can focus on its core business; managing energy flexibility, allowing to connect to a wide variety of devices and promoting interoperability.

The demonstration area Bloemwijk in Alkmaar is an area of social housing which will be entirely rebuilt. The first buildings are completed in Q1 2023, which includes 55 buildings equipped with PV panels as well as 10 houses which will also be equipped with a heat pump. Five of the built houses will also be equipped with a batter for storage next to the PV panels and the heat pumps. The five houses with the batteries will be used for demonstrating ReFlex since they will provide the most energy flexibility.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

Context and requirements dependent

Already demonstrated in Lighthouse cities **N**

Cultural heritage compliance **Y**

PERFORMANCE

Increase Energy Flexibility

Reduce Grid Congestion

COST

Context dependent

DIMENSION

Aggregator level

TIME

N/A

SAFETY

Data security and GDPR compliancy

SUSTAINABILITY

Increase energy efficiency

Promote local renewable energy generation and usage

KEY REQUIREMENTS

Regarding key requirements for ReFlex there are different angles to consider. For one, it is necessary to have available RES, the respective data as well as energy storage devices (e.g. battery). Secondly, it is a software solution that empowers aggregators to create a powerful Virtual Power Plant (VPP), which can utilize the flexibility of large quantities of devices effectively for multiple purposes.

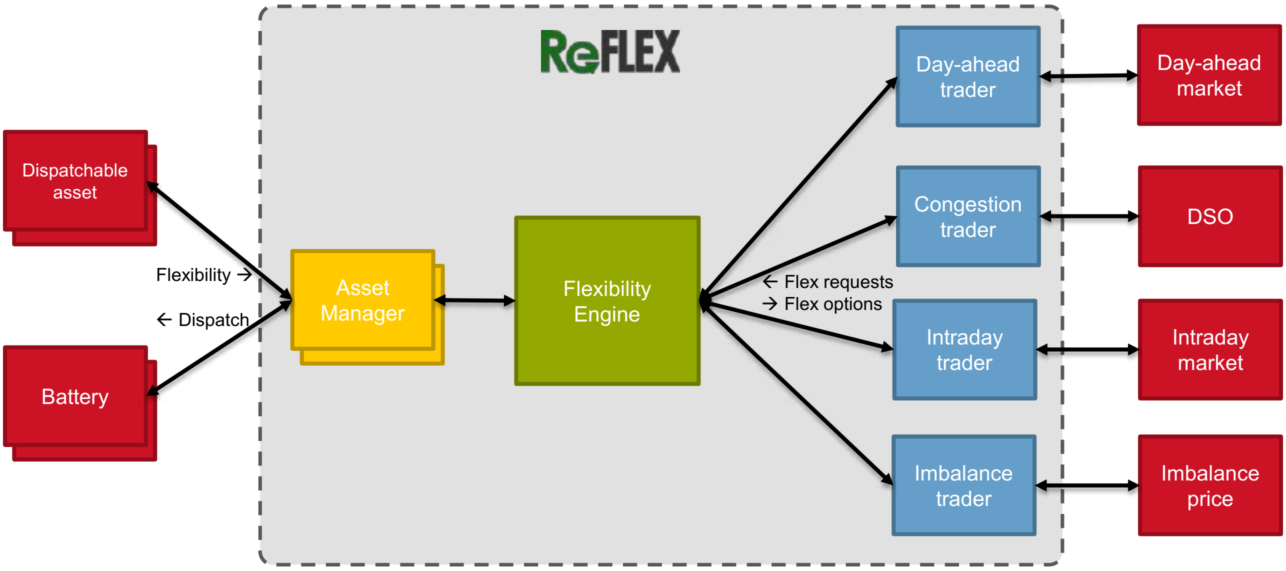
Enabling the flexibility of DER assets, such as: electric cars, batteries and solar panels, to be utilized in both energy markets and ancillary service markets. In this way the value of flexibility can be stacked, and the profits of utilizing flexibility increased.

In order to optimize the utilization of flexibility, it needs to be known what the flexibility of a cluster of assets is. Since there are typically too many devices of different types, it is not possible to consider each device individually. Instead, the aggregated flexibility of the cluster needs to be considered. ReFlex works with a moving planning window. Typically, ReFlex plans the energy production and consumption for every device for the coming 48 hours with a precision of 15 minute intervals.

In order to plan the energy consumption and production of each device, ReFlex needs to have knowledge about the future behavior of the devices. This typically requires forecasts of the behavior of the devices to be made.

ReFlex always has a target for the sum of the energy consumption and production of all the devices in the cluster for each interval. The flexibility of the devices can be utilized by changing the target. When the target changes, ReFlex will try to adjust the behavior of devices in cluster in such a way, that the sum of energy comes as close as possible to the target.

It is also possible to put in energy constraints for intervals for a subset of the cluster. This way, it is possible to take (local) grid congestion constraints into consideration. By placing a constraint on a subset of devices, ReFlex will do anything in its power to respect those constraints.



ReFlex high-level architecture

The high-level architecture of ReFlex shows on the right side different trader modules (blue) focussing on different markets (red) that can ask the Flexibility Engine (in green) for flexibility in the cluster. ReFlex provides these trader modules with flexibility options from which the trader can decide which options matches its market best. The Flexibility Engine is able to calculate these options through aggregating and planning the flexibility provided by the assets (such as batteries, on the left side of the figure).

The flexibility of all the assets is provided by utilizing the S2 (EN 50491-12-2) standard. That standard defines five distinctive ways to model energy flexibility for a myriad of assets, and is part of the European Smart Grid architecture. This means that, according to the S2 architecture, each device is accompanied by a Resource Manager that is able to translate low-level data (such as power or temperature measurements and setpoints) to flexibility information in S2. Therefore, ReFlex utilizes a standard and generic way to manage any flexible asset as long as it supports S2, without any additional effort. This allows the system to scale easily.

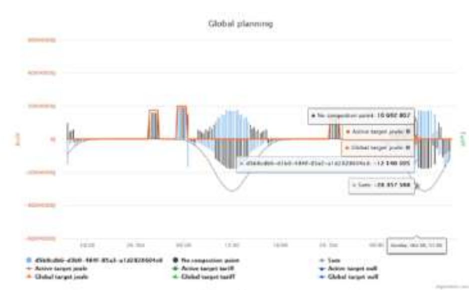
ENVISAGED DEMONSTRATION IN POCITYF

LOCATION

Image of the PEB 1.3 – Bloemwijk demonstration area in POCITYF. One of the locations where ReFlex technology will be demonstrated and optimize the energy production and usage of installed devices. Other locations where ReFlex will be demonstrated: PEB 1.1 – De Meent Sports Complex.

DETAILS

Image of the De Meent ice rink which has PV panels installed on the roof and a large battery installed.



TARGETED OUTPUT

Example of ReFlex Dashboard showing the forecast of the upcoming 48hours of energy consumption and production (negative values).

IMPACT ON COMMUNITY

Implementation of ReFlex instead of investments in grid reinforcement: awareness of DSO that avoiding grid reinforcements is in their interests and that ReFlex is valuable in network operation. ReFlex provides highly accurate insights into how much flexibility is available and thus provides the technological basis for the smart services of the future energy supplier.
Involvement/willingness of residents is crucial in relation with user acceptance. Need for support for homeowners and knowledge and information on energy flexibility and on practical consequences as well as the potential benefits.

CULTURAL HERITAGE BUILDINGS COMPLIANT

There are a few conditions that are a requirement or a benefit for deploying ReFlex. Firstly, it is a requirement to have multiple assets (small and big) available that can be combined for flexibility. Consideration of the objective and alternatives (what is the problem? Some are depending on objectives (Reflex has an optimization objective), is there an energy market?).
Secondly, the impact on the energy grid needs to be considered. Assets need to be connected to the grid, and capacity can be an issue for the aggregator. On an individual level considerations regarding each flexibility source in relation to network limitations needs to be taken into account.
Third, regulation in favour of future smart electricity systems that allows to use flexibility opportunities or congestion management systems. Implementation of a variable /tariff system (NL) in which energy taxes are coupled to the energy price and network tariff.

OTHER COMMENTS – OPEN CONSIDERATIONS

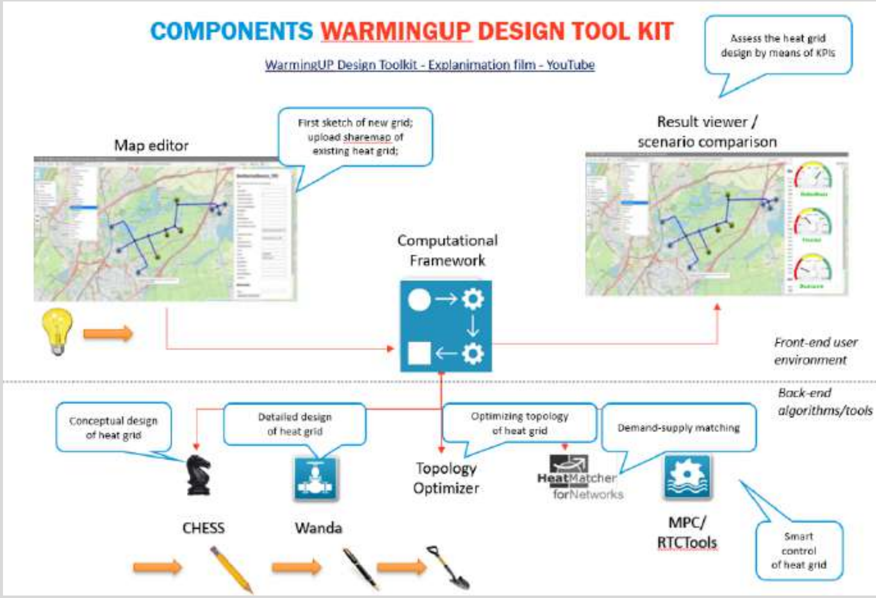
Other considerations:	
SOFTWARE	
Privacy	Include privacy & security from the start, or "by design". This way it is not an obstacle for implementation and the implementation will meet the required Dutch standards.
User Interfaces	Using future-proof standards (even with low maturity) to implement new use cases and future business models
ORGWARE	
Business models	The profit needs to be (able to be) connected to assets, and exploiting the available flexibility. Allowing aggregators to combine several smaller profits for a big trade amount that can be regarded as 1 (virtual) power plant. Energy market is not accessible for smaller parties (citizens are not able to entry). Accessibility on the trade market is increased by bundling multiple smaller devices. Reflex optimizes flexibility, the profit is related to cost reduction and exploiting flexibility. Costs: connecting two or more energy appliances to optimize.

Impact level 2 Embedded outcomes of smart solutions	
HARDWARE	
Communicating infrastructure	Reflex is on internet/digital network, and devices are as well. Reflex needs real time communication between assets, network and energy market and thus requires continuously connection. ReFlex utilizes the EN 50491-12-2 (S2) standard to exchange energy flexibility.
Robustness of the systems	Software, computer and communication infrastructure need to be robust (for profits and for functionality). Redundancy is needed e.g. fast response to disconnection, back up facility. Risk management on robustness is crucial for the business model: system could overload if ReFlex is unavailable or system is down. What goes wrong if ReFlex is unavailable? Depending on how bad that is countermeasures should be taken. Is it only 1 day and some data is missed or are problems bigger and is more effort needed to solve/avoid system overload?
SOFTWARE	
Interoperability	Translation of protocol of assets to EN 50491-12-2 (S2) to enable communication. ReFlex needs to be adjusted to the market, so you need a plug-in that fits with the market. Need to understand each other, plug-ins that allow two-way translation. Reliance on standards instead of proprietary protocols to allow interoperability.
Dashboards	Management and administration dashboards, ReFlex has the dashboard in itself
ORGWARE	
Smart Governance	Regulation in favor of future smart electricity systems that allow to use flexibility opportunities or congestion management systems. Implementation of a variable /tariff system (NL) in which energy taxes are coupled to the energy price and network tariff.
Windows of opportunity	Implementation of ReFlex instead of investments in grid reinforcement: awareness of DSO that avoiding grid reinforcements is in their interests and that ReFlex is valuable in network operation. ReFlex provides highly accurate insights into how much flexibility is available and thus provides the technological basis for the smart services of the future energy supplier.
Stakeholder management	Involvement/willingness of residents is crucial in relation with user acceptance. Need for support for homeowners, they lack knowledge and information on energy flexibility and on practical consequences, potential benefits.

Ownership	Multiple aggregators in order to guarantee free choice for citizens (selling energy flexibility) and the DSO (congestion management)
Business models ad split incentives	Analysis of market liquidity and pricing mechanisms. Wide spread implementation of S2 interface: for widespread adoption, standardization is needed.

ETT2 - Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions

Thermal Network



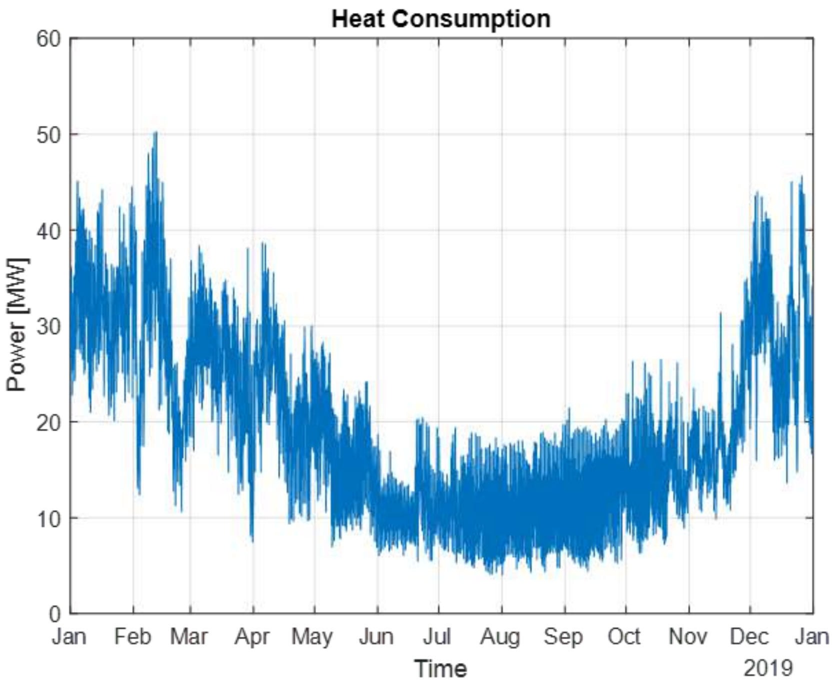
DESCRIPTION

The WarmingUp design toolkit is a software package that supports designers of heat networks in their design of future-proof heat networks. The Design Toolkit connects different innovative tools for planning, design, hydraulic engineering and control of heat networks in one software package. It is made by experts in a Dutch consortium of 38 participants relevant for the heat part of the energy transition. Within POCITYF we have the opportunity to leverage on the full WarmingUP design toolkit, including CHESS simulations and HeatMatcher demand-supply matching, to add flexibility to the grid and contribute to the decision making process of the city of Alkmaar while finding solutions to connect historical buildings at its city centre.

TNO is using the WarmingUp Design Toolkit to assist in the development of innovative, future-proof heating and cooling grids. Several innovative tools of TNO are part of this toolkit, including the MapEditor, CHESS and HeatMatcher for Networks.

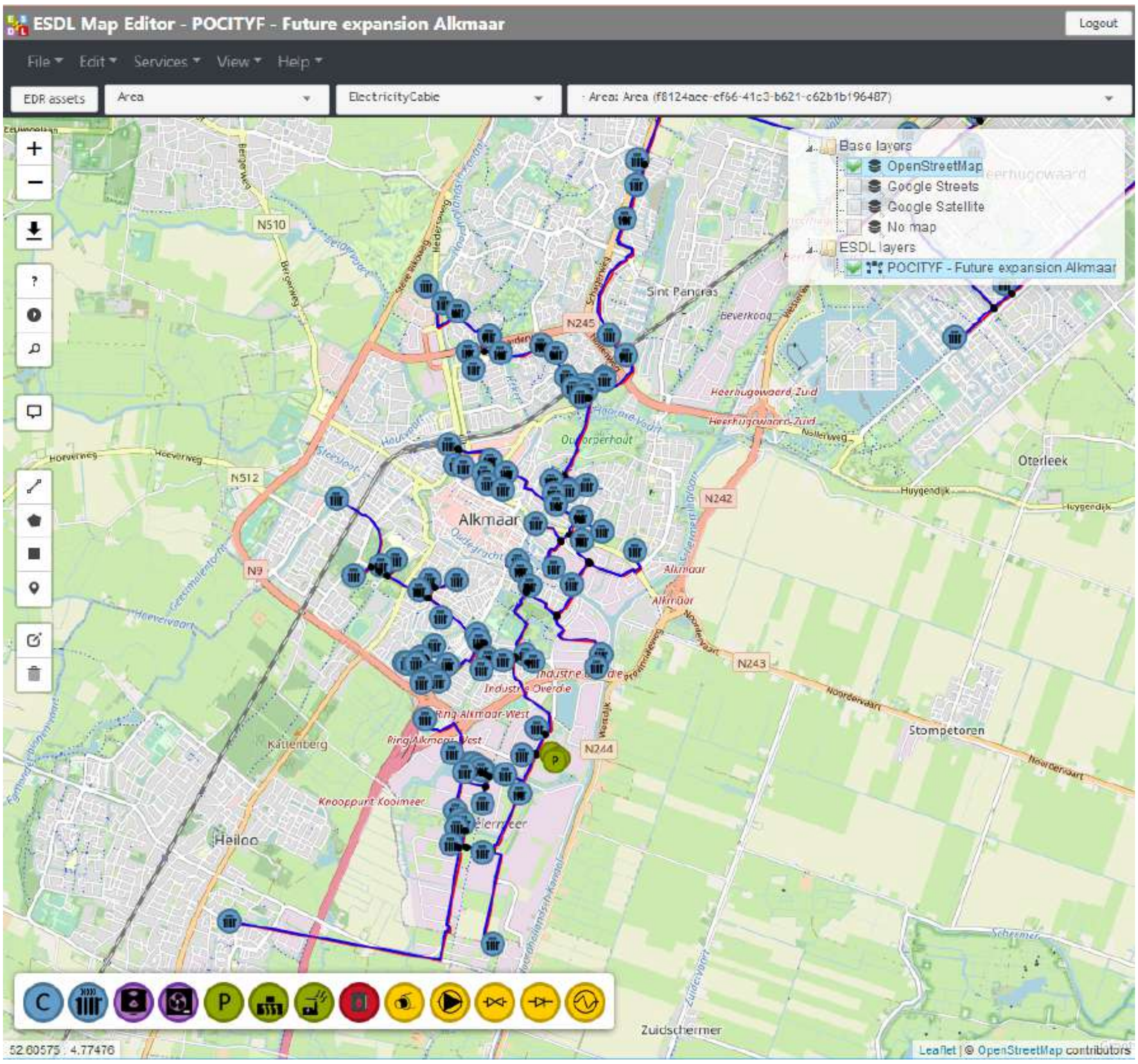
HVC is a member of the Alkmaar lighthouse ecosystem and the operator of the existing local heating network in the Alkmaar region. They are in the process of designing various potential extensions of its current heating network in Alkmaar area. The aim of the extensions are to be affordable and sustainable, including to come up with a future proof heating network, which reduces current transport limitations and creates optimal storage places. In addition, possibilities to reduce fossil heat and use more sustainable sources (geothermal) will be explored. With more Renewable Energy Sources (RES) in use, there will also be multiple sources supplying heat, which will profit from smart controls deployed. The HeatMatcher technology for example will be able to address the delivery of different heat sources based on marginal costs and ensure that a market equilibrium is achieved. Improvements deployed in one demonstration area, will also positively affect the rest of the heat network, creating a holistic solution for the city and feed into Alkmaar's Vision and Master Plan.

TNO has built the digital version of the heat network in the ESDL MapEditor to display the existing and future heat network and in which it is possible to model the current and future heat demand. During project workshops it was identified that for additional heat supply the design of the future network should focus on additional sources to match the increased demand in future scenarios and which rings will alleviate the network. This also revealed that in the current phase of network expansion, the focus of the analysis should be on production and transport flexibility in order to connect more consumers to a sustainable grid.



Above displays the heat consumption throughout a year for the current heat network. This hourly base data was also input for the CHESS simulations.

The screenshot below shows a part of possible future expansions for the heat network, as modelled in the ESDL MapEditor. This serves as input for TNO's heat network simulator CHESS



With all the input, a simulation of several scenarios can be conducted. First of all a validation of the simulation with measured data was performed and tune the simulation to output realistic numbers. This first analysis confirms that the high pressure drop in the North of the network is currently problematic for future expansion, due to the fact that most production is currently in the South of the network.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

Support in the decision making process for heat network providers in upcoming investments.

Already demonstrated in Lighthouse cities Yes as a simulation

Cultural heritage compliance **N/A**

PERFORMANCE

Optimization of the heat network

COST

Context dependent

DIMENSION

N/A

TIME

Work for this simulation was concluded in 2022. Any investment by HVC or other heat network provider is context dependent

SAFETY

Secure data transfer and confidentiality agreements to be made with partners

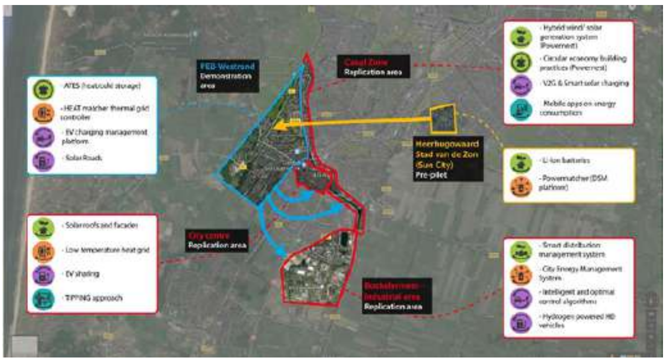
SUSTAINABILITY

Simulation of possible investment scenarios as well as future proofness of heat network to support decision making processes.

KEY REQUIREMENTS

Existing heat network including available data as well as modelling software. Furthermore, to determine what should be explored an analysis of the technical details, new infrastructure and pipeline routes as well as heat-storage and sustainable heat source locations needs to be considered for defining logical scenarios for simulation purposes.

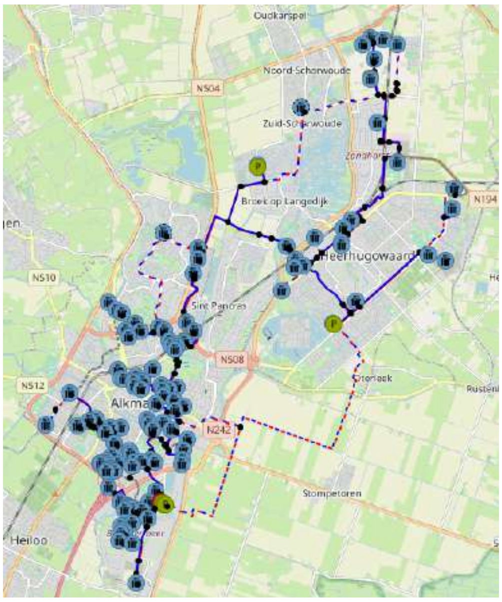
ENVISAGED DEMONSTRATION IN POCITYF



LOCATION

HVC and TNO elaborate on the “Smart Design of future proof extensions of the thermal grid Alkmaar” including the entirety of the demonstration and replication areas in the POCITYF use case. The map overlays the areas between the HVC thermal grid and its potential extensions with the demonstration and replication areas identified in the POCITYF project.

TIMELINE Completed Q4 2022



Modelling of the Heat Network

DETAILS

This demonstration supports the development of a local heating network, in which heat from different sources is transported to customers in the most optimal way. To optimize the new heating network TNO in collaboration with HVC simulated the existing heat network in CHESS (quantitative model to support the developing of new, integrated energy concepts and associated business models). The new innovative elements and control algorithms will be added in the model and based on the selected KPIs (financial, CO2 etc.) will be optimized.

TARGETED OUTPUT

The expected output of the IE is to support heat network providers in the decision making process for future sustainable investments. This is relevant for investments regarding current and future operational and potential new heat sources as and heat storage solutions.

IMPACT ON COMMUNITY

The aim of the simulation is to explore the extensions in relation to affordability and sustainability, including to come up with a future proof heating network, which reduces current transport limitations and creates optimal storage places. Furthermore, possibilities to reduce fossil heat and use more sustainable sources (geothermal) is explored. With more Renewable Energy Sources (RES) in use, there will also be multiple sources supplying heat, which will profit from smart controls deployed.

OTHER COMMENTS – OPEN CONSIDERATIONS

The challenges to be addressed are:

- Increasing the contribution of sustainable heat by taking away transport limitations
- Finding the optimal locations, strategy and methods for heat storage/buffers
- Finding the optimal location/capacity of back-up power
- Integration of low temperature heat sources in a high temperature grid
- Maintaining or improving the heat grid efficiency
- Finding the optimal planning/phasing of CAPEX investments in relation to new connections to the grid

Li-ion batteries

DESCRIPTION

Main purpose of the battery is to provide grid flexibility in the building itself, but also to the main power grid. This battery will "shave" off the power peaks provided by the panels, by locally storing the excess electricity instead of delivering it back to the grid. This will prevent an overload of the building connection and will also prevent that the solar system will be temporally shut down by the grid. Then, in the evening and during nighttime, when there is no electricity production by the solar panels, the electricity used by the building will first be provided by the battery that was charged during day-time. At the moment that the battery runs out of power, electricity will be taken from the grid. In this way the battery also "shaves" of a peak in the grid at the demand side.

INDICATORS

POTENTIAL DEGREE OF USEFULNESS

N.A.

Already demonstrated in Lighthouse cities N

Cultural heritage compliance Y

PERFORMANCE

Type: 2x I-well Power Cube 35kW (400V)

Capacity: 2x 32.5 kWh

Expandable by 30 kW up to 210 kW

COST

N.A.

DIMENSION

Size: 70 x 60 x 80 cm (per battery)

Weight: 500 kg (per battery)

TIME

Permit to be granted around July 2022

Deployment scheduled for end 2022

SAFETY

Extra fire hazard, measures need to be taken as precaution. Depending on the exact location of the battery in the building.

SUSTAINABILITY

Peak shave the solar system, increasing the own use of electricity from the buildings solar panels.

KEY REQUIREMENTS

There are severe fire-regulations for the positioning of batteries from this size. Due to the fact that the exact position inside has still to be determined, these regulations should be taken into account among some other technical and financial aspects.

ENVISAGED DEMONSTRATION IN POCITYF

LOCATION

The highrise building at the v.d. Veldelaan. The battery will physically be placed at the ground floor of the building.

TIMELINE

Batteries scheduled to be operational March 2023.

DETAILS

Woonwaard prefers a position inside the building, somewhere near the connection to the main grid and the electricity meter.

The battery will be connected to the electrical system of the building between the connection point of the main electrical grid (3x80 Amp) and the main electrical distribution box of the building itself. The solar panels that are in use for the central facilities of the building will also be connected to the main electrical distribution box. For this a new main electrical distribution box has to be installed.

TARGETED OUTPUT

Two I-Well batteries connected to the electricity network of the Highrise building. Storing excess energy produced during the day by the PV-panels on the Highrise building, and deploying the energy when there is little to none energy production from the PV-panels. Thereby increasing the amount of electricity used by the building itself and decreasing the dependency on the energy grid.

IMPACT ON COMMUNITY

There will be some disruption to the tenants of the Highrise during the installation of the batteries. However most of it will take place in the technical room of the building, keeping the disruption to a minimum.

CULTURAL HERITAGE BUILDINGS COMPLIANT

This innovative element can be placed in cultural heritage buildings. However it does requires some fysical space in the building and might require the electricity cables of the building to be replaced. The battery will be most effective if there is electricity being produced by the building itself, for example with pv-panels. The production of electricity will be most likely the main issue for cultural heritage buildings since it may disrupt the outlook of the building, making it legally challenging to place pv-panels. Despite this the battery itself is compliant to cultural heritage buildings.

OTHER COMMENTS – OPEN CONSIDERATIONS

The highrise building at the v.d. Veldelaan will be provided with a large amount of solar panels on the roof as well on the façade (approximately 910 panels in total).

The first challenge is that the total amount of power that these panels will generate on a bright day in summertime cannot be handled by the current grid connection of the building (3x80Amp) or possibly not even by the local grid itself. When the power-grid is not able to handle the power peaks it automatically will shut down local solar systems that try to put the excess power into the grid. When this happens, the solar system of the building itself will not function efficiently and a part of the sustainable electricity that could be produced by the system will not be produced, because the system is temporarily shut down.

Another challenge is the mismatch between the moment that the maximum power is produced by the solar panels (around noon) in relation to the moment that the use of electricity of the building is at its maximum (approximately between 16.30 and 22.00 p.m. next to the power peaks). Therefor the battery should be large enough to mitigate between supply and demand.