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PICTURES: SPARCS, Siemens and Citycon

POSITIVE ENERGY DISTRICT: A NEW PUZZLE PIECE FOR CITIES' ENERGY TRANSFORMATION

Positive energy districts are one of today's trending research topic for decarbonizing cities' energy systems. Mitigating climate crisis requires a huge transformation process to decarbonise the energy system. Both energy efficiency and the integration of renewable energy need to be increased, which also increases the need for energy flexibility, ICT solutions and holistic approach to developing districts and cities. Positive energy blocks and districts are currently demonstrated in many EU funded Smart City lighthouse projects around Europe. In Finland, adapting of the concept of PEDs into practise are demonstrated among others in the lighthouse cities of Espoo (in SPARCS project), Oulu (MAKING-CITY project) and Turku (RESPONSE).

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IN the research field of energy in buildings, the trend has also been from nearly zero energy buildings towards net zero and energy positive buildings. However, when integrating decentralised renewable energy into urban environment, the district scale brings benefits as compared to single buildings. In Positive energy districts (PEDs), renewable energy can be unevenly distributed throughout the district, which allows renewable energy systems to be installed in a more strategical manner. It is possible to install renewable energy plants and energy storage in a slightly larger scale, improving the cost-efficiency.

THE PED CONCEPT

The European Strategic Energy Technology Plan (SET Plan) considers PEDs as a building block for reducing carbon emissions in cities. JPI Urban Europe and SET-Plan have defined: "Positive Energy Dis-

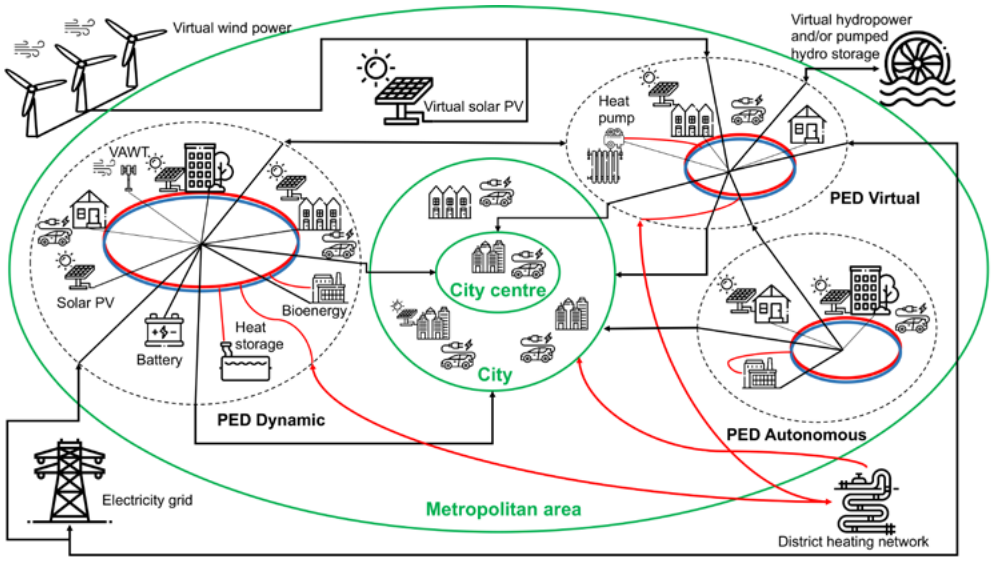


Figure 1. Different PED concepts as a part in local energy system.[2]

tricts are energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy. They require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and ICT systems, while securing the energy supply and a good life for all in line with social, economic and environmental sustainability."[1]

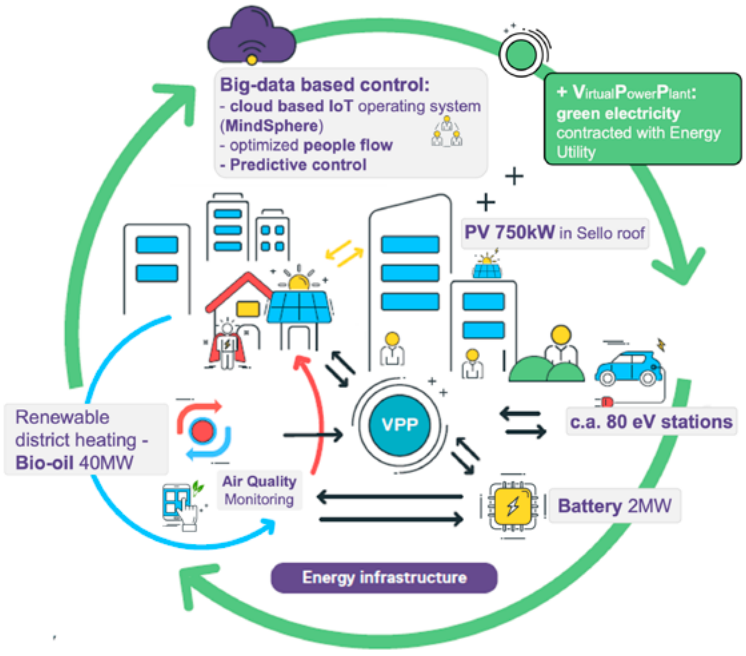
The key in PEDs is that have greater annual renewable energy production than the demand. The European Energy Research Alliance (EERA) has classified three different PED categories (Figure 1):

- PED autonomous is a completely self-sufficient district energy system with clear geographical boundaries, no import of electricity, heating, or gas; can export excess renewable energy.
- PED dynamic is a district energy system with clear geographical boundaries, exports more energy than it imports on a yearly basis.
- PED virtual operates within virtual boundaries, which means that the energy system can operate outside the geographical boundaries of the district, and consequently utilize renewable energy sources or energy storage systems to greater extents. However, the part of the energy system that operates outside the district borders must be an asset of the district in order to be classified as a PED virtual.

DEMONSTRATING PED SOLUTIONS IN ESPOO, FINLAND

International research and demonstration project SPARCS (Sustainable energy Positive & zero cARbon CommunitieS), funded by European Commis-

Figure. 2. Shopping center Sello. Source: Siemens



Leppävaara+ Center multi-use LEED district (Sello shopping-block & hotel)

sion[3], aims to demonstrate and validate the technical and socio-economic viability and impacts of scalable, innovative solutions for the planning, deploying, and rolling out smart and integrated energy systems. The possibilities of PED solutions are studied as an efficient mean for the climate neutral urban energy transition. The city of Espoo is one of the two lighthouse cities, where the project coordinator VTT and Finnish partners Siemens, Citycon, Adven, Kone, PlugIt Finland and RIL demonstrate various PED solutions at the centres of Leppävaara and Espoonlahti.

SPARCS explores the virtual power plant concept to facilitate the integration and the active participation of buildings to energy markets by offering additional services, such as energy flexibility and the quality of supply. SPARCs Virtual Positive Energy communities utilise green energy transactions with the GoO (Guarantees of Origin) instrument.

ENERGY FLEXIBILITY SOLUTIONS IN SELLO

At the centre of Leppävaara lies the shopping centre Sello, which is the second largest in Finland with 23 million visitors yearly. Sello received the LEED environmental rating system's platinum classification in 2015.

Heating demand (space heating and DHW) is covered by renewable district heat from Fortum. 750 kW of photovoltaic panels cover a part of the renewable electricity needed in Sello.

The Sello block is developed into a micro-grid, with the largest integrated electricity storage facility in Northern Europe. The battery storage has a power capacity of 2.1 MW, and a storage capacity of 2.1 MWh. The microgrid controls in total 1.6 MW flexible loads, mostly from HVAC and lighting, and electrical vehicles charging stations. Sello is the first significant Finnish property complex participating to the Fingrid's electricity reserve market for frequency controlled reserves (FCR-N and FCR-D). Siemens and VTT are developing' solutions that could support the management of Sello's energy performance in real time with VTT's virtual twin simulations.

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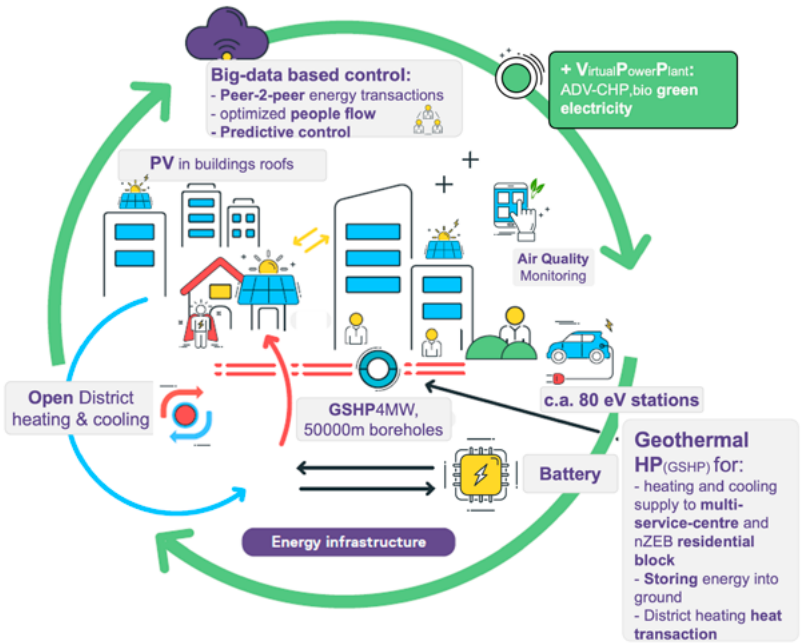
Figure. 3. The Lippulaiva block. Source: Citycon



Espoonlahti+ District New multi-use nZEB district (Lippulaiva multi-service-centre & residential block)

GROUND SOURCE HEAT FOR LIPPULAIVA BLOCK

Citycon is currently constructing an extensive re-development of the Lippulaiva block at the centre of Espoonlahti. The new urban centre with shopping center and residential buildings will open on next year, serving as state-of-the-art cross point for eight million visitors annually.

Adven and Citycon demonstrate various PED solutions in Lippulaiva: geothermal heat and excess heat utilisation, photovoltaic panels, studying of energy trade strategies, e-mobility charging infrastructure, and citizen engagement actions. The Lippulaiva block has one of the biggest ground source heat pump units in commercial buildings in Europe (4 MW, 171 bore holes, each over 300m deep). Also, the integration of battery energy storage will be installed.

SUMMARY

The impacts of SPARCS demonstrations will be monitored for 2 years, with the real time performance visualisations. Pioneering business models are developed for peer-to peer energy transaction and awareness solutions, and services for PED solutions. With these R&D activities, SPARCS partners lead the way toward climate neutral urban energy solutions as a part of the European network of smart city lighthouse cities. ril

FOOTNOTES 1 JPI Urban Europe / SET Plan Action 3.2 (2020). White Paper on PED Reference Framework for Positive Energy Districts and Neighbourhoods. https://jpi-urbaneurope.eu/ped/

2 Lindholm, O.; Rehman, H. ur; Reda, F. Positioning Positive Energy Districts in European Cities. Buildings 2021, 11, 19, doi:10.3390/buildings11010019.

3 Grant number 864242, https://www.sparcs.info/