



LIVE IN POSITIVE ENERGY

## EXCESS

flEXible user-CEntric energy poSitive houseS

The EXCESS project builds upon concepts for residential nearly-zero energy multi-storey buildings in the main four EU climatic zones transforming them towards flEXible user-CEntric energy poSitive houseS (EXCESS).

# ABOUT THE PROJECT

This project brings together 21 partners from 8 European countries to showcase how nearly-zero energy buildings (nZEBs) can be transformed into energy positive buildings. Funded by the EU Horizon 2020 Research and Innovation Programme over a 4-year period, EXCESS will spearhead four innovative demonstration projects, introducing technical solutions that enable buildings to produce more renewable energy than they consume over the course of a year.

By implementing demonstration projects that span across the Nordic, Continental, Oceanic and Mediterranean climate zones, EXCESS seeks to test, validate and share Positive Energy Building (PEB) solutions with potential replicability across Europe.

## THE MAIN GOALS OF EXCESS

- **Advancing new materials, technologies and integrated technological systems for Positive Energy residential building solutions** in 4 different climate zones.
- **Optimizing the interplay of local generation, storage, consumption at the building and district level**, enabling interactions with the grid, capitalising on new ICT opportunities and unlocking new revenue streams.
- **Promoting a user-centric approach**, involving the user's aspects in every optimization process.
- **Co-Innovation, replication and exploitation activities with a wide range of stakeholders** to maximise the project's technical, social and economic impact and to **prepare for a future market roll out of the PEB concept**.

# EXCESS DEMO SITES

- *Demo Site Hasselt, Belgium*
- *Demo Site Granada, Spain*
- *Demo Site Helsinki, Finland*
- *Demo Site Graz, Austria*



# THE EXCESS CONCEPT

EXCESS will merge technical concepts for Positive Energy Buildings (PEB) with **new regulatory opportunities** for the production of renewable energy, self-consumption and energy communities. It is going to advance technical developments for PEB materials to address specific climate-related needs in order to meet the PEB requirements. By facilitating technological integration, lifetime costs of PEBs can be effectively reduced, making them affordable for a larger portion of society.

EXCESS will promote a **user-centric approach** that ensures that new concepts preserve **high comfort and indoor environmental quality** for tenants.



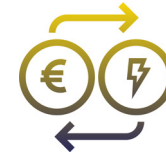
**Analysis of PEB  
concepts and  
PEB definition**



**Stakeholder  
engagement  
including  
building users**



**Testing and  
integration  
of novel  
technologies**



**Development  
of financial  
and business  
models**



**Integration of PEB  
in local, regional  
and national  
policies**

EXCESS defines a positive energy building (PEB) as an energy efficient building that produces more energy than it uses via renewable sources, with high self-consumption rate and high energy flexibility, over a time span of one year.

The project builds its PEB technical solutions on the most advantageous local renewable energy resources. **Conventional solar technologies** will be used in **Mediterranean**

**and Continental climates**, where solar irradiance is abundant, while **innovative RES solutions** (advanced PVT and Power-To-Heat flexible thermal storage) in **Oceanic** and (advanced PVT and deep borehole) in **Nordic climates** (where solar irradiance is low and higher energy performance is needed) will be implemented.

EXCESS will use the opportunities of the new EU Electricity Market Directive, that will upon adoption by the Member states enable local

energy trading, advanced interaction with the grid as well as with consumers that can actively participate in energy markets. Poor economics and missing business models are the main barrier for the roll-out of PEBs.

EXCESS therefore will **identify cost-optimal levels as a combination of current and innovative technologies**, estimating figures also as service life costs. Based on this, project partners will develop business models that also include possible market revenues and flexibilities

# THE CLIMATE ZONES

- **Nordic**- humid, cold winters and mild, humid summers
- **Continental**- cold long lasting winters and pre-dominantly hot summers
- **Oceanic**- mild, wet winters and cool, humid summers
- **Mediterranean** - hot dry summers and mild winters with hardly any frost

## Main EXCESS technologies



PVT  
heat pump  
deep borehole



PV façade  
heat pump  
storage

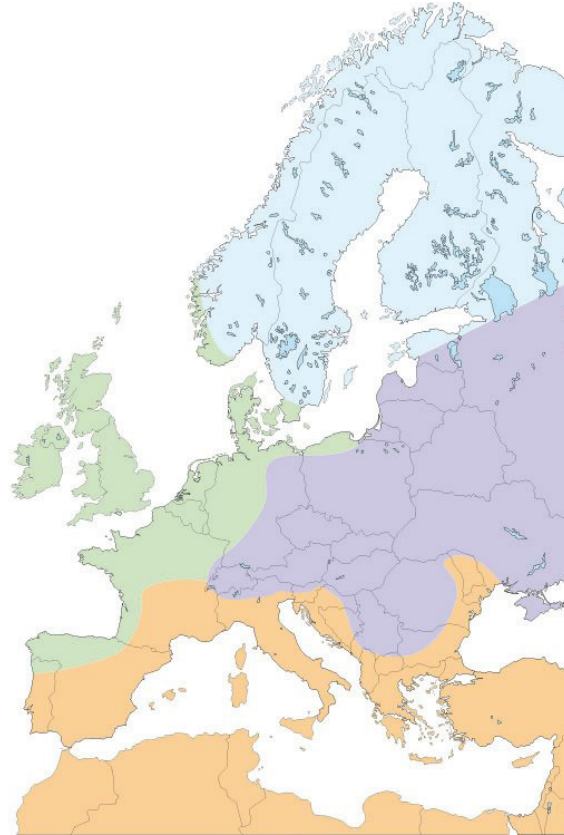


heat pump  
PVT  
wind



storage  
heat pump  
PVT

Four main climatic zones of Europe  
(<https://www.barenbrug.biz/forage/climate-map>)



# OCEANIC CLIMATE: DEMO SITE HASSELT, BELGIUM

The Belgian demo case is located in Hasselt and consists of 4 apartment buildings that were constructed in 2018 by Cordium, a Flemish social housing company. The buildings were designed with special attention to user comfort, while considering energy efficiency to guarantee optimal living conditions for the tenants. An innovative district heating system, powered by geothermal heat pumps, provides heat to a total of 70 dwellings on this site. These 4 energy efficient buildings will be converted to PEBs in the context of EXCESS. This will be achieved by integrating photovoltaics, thermal hybrid solar collectors (PVT), wind energy, thermal and electrical storage and by implementing smart control on component, building and network level. The tenants will play a central role as they can offer additional flexibility to the energy system. Activation of this thermal and electrical flexibility allows to maximize local consumption of renewable energy production onsite and to increase overall energy efficiency.

## Planned Technologies

- Geothermal and air-source heat pumps provide the base load heat for the network (142 kWth)
- Gas-fired boilers used as a peak and back-up heating system (170 kWth)



## EXCESS PEB technology upgrade

- **35 kW<sub>e</sub> DualSun PVT panels** for multisource heat pump system
- **Seasonal borehole storage:** PVT heat surplus will be used to charge the ground.
- **Two wind turbines** (5 kW<sub>e</sub>) on the roof of the apartment buildings
- **Power-To-Heat flexible thermal storages** integrated in the heat interface units inside the apartments
- **Expansion of the flexibilization portfolio** with batteries and EV charging facilities



# MEDITERRANEAN CLIMATE: DEMO SITE VALLADOLID, SPAIN

The Spanish demo case is a Renaissance palace from the 16th century located in the historical centre of Valladolid. The historical heritage of the building will be protected in the refurbishment of the palace towards positive energy standards by keeping the façade unchanged. Historic buildings currently represent more than 30% of the European building stock, accounting for more than one third of the total energy consumption of the European residential sector. The EXCESS PEB will therefore set an important example and blueprint for deep renovation of – as well as renewable energy generation and storage integration in – protected historic buildings.

The project foresees the entire renovation and subdivision into 9 separate apartment units, 5 of them as duplex apartments. To minimise the energy demand while keeping the historical façade, highly energy efficient appliances and other technologies will be installed. The internal design of the building will be shaped as to maximise renewable energy self-consumption, making it one of the very first positive energy buildings in Spain.

## Planned Technologies

- Aerothermal heat pump instead of geothermal HP
- PV
- PVT
- eV charging stations



## EXCESS PEB technology upgrade

- Integrating PV, aerothermal heat pump with energy storage (battery) and electric vehicle charging system as one controllable system
- Installation of lithium batteries for advanced energy flexibility service functionalities and electricity quality supply
- Integrated controller for easing the integration and the management of the energy generated on site
- HMI system (human-machine interface) for intelligent management of energy, management and control of the installation
- Energy sharing and trading. BEMS will decide on the best strategy to reduce the overall energy consumption. Excess energy will be shared



# NORDIC CLIMATE: DEMO SITE HELSINKI, FINLAND

Basso’s residential nZEB house will be located in the City of Helsinki at the Kalasatama Area, Finland. Given the harsh climatic conditions in Finland, energy technologies have to be further improved to reach high enough performance to reach PEB level using on-site solutions. The energy system of this demo represents a first of a kind solution. A seasonal ground storage by semi-deep energy boreholes will be used. Direct PVT or active heat pump recharge procedures will be demonstrated. Innovative hybrid energy systems combining semi-deep geothermal, geothermal collector, high COP heat pumps, balcony integrated PVT collectors and a smart control will be tested.

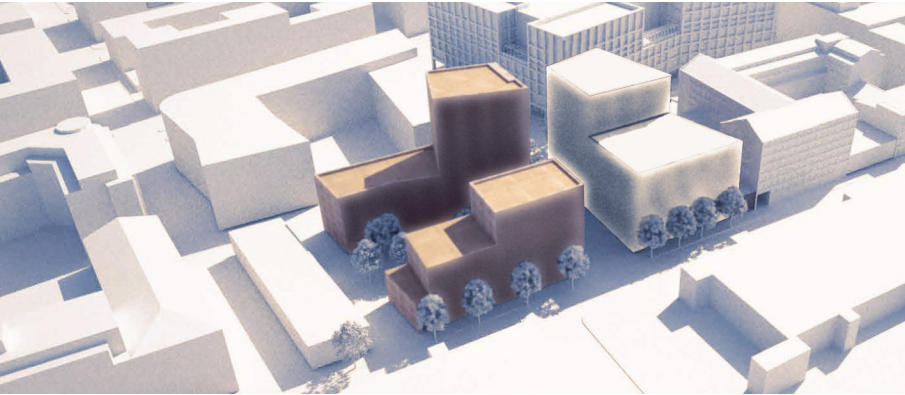
## Planned Technologies

- 5 eV controllable charging stations
- High efficiency (75%) heat recovery ventilation system



## Planned EXCESS PEB Technologies

- **Deep boreholes** 3x800m (drilling technology and heat exchangers collector)
- **70 kWel DualSun PVT panels:**
  - For multisource ground source heat pump with defrosting function supplying heat and electricity to the building and used as ground source heat pump thermal source.



- and balcony integrated to increase the useful building area where RES can be installed.
- **Seasonal borehole storage.** PVT heat surplus will be used to charge the ground during transitional months, while during summer the HP evaporator using the PVT as thermal source will charge heat to the ground
- **Multisource ground source heat pump** system for deep boreholes with high COP for domestic hot water with 2x500 litre and 2x300 litre short term tanks and remote heat pump monitoring, on-line commissioning and fault diagnostics



# CONTINENTAL CLIMATE: DEMO SITE GRAZ, AUSTRIA

The former industrial area for feed production "Tagger-Werk" is located in the southern district of Graz. Since 2012, the complex with approx. 31.000 m<sup>2</sup> gross floor area has been transformed from an economical and sustainable point of view to a completely new concept of use. The existing building structure is integrated in a new mixed-use concept and the elements of the former industrial are retained in terms of visibility. About a third of the 19 existing buildings have already been refurbished to allow energy building standard. The demonstration building in EXCESS is a former feed silo (building 10) that will become a hostel. The declared goal for the refurbishment is to achieve passive house standard. In EXCESS the existing thermal mass of the building structure, will be activated via a prefabricated multifunctional façade element, which includes heating and cooling supply of the building and façade integrated PV. The entire energy supply of the area will be done based to a large extent on locally produced renewable energy (solar energy, groundwater

heat pumps, small hydropower). By the integration of innovative elements for load shifting, storage, user integration, interaction with the local electricity grid as well as a smart, predictive control, maximum energy flexibility will be achieved.

## Planned Technologies

- Cascading GSHPs
- Community battery (225 KWh)
- Decentralized small thermal storages
- 5 eV controllable charging stations



## EXCESS PEB technology upgrade

- Multifunctional façade element
  - highly insulated prefabricated modules
  - façade integrated PV
  - active layer for heating and cooling

- Energy system
  - maximum flexibility and efficiency through cascading heat pumps for heating, water heating and cooling
  - thermal flexibility elements (thermal concrete activation & decentralized water storage) as well as electric flexibility elements (community battery and e-mobility)
  - Smart control system with weather forecast
- Smart Contracts
  - Flexible participation model for PV shares combined with automatic billing via blockchain



## EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME

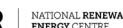
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More information available at  
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# PARTNERS & FUNDING



# EXCESS



This 4-year project brings together 21 partners from 8 European countries and is funded by the EU Horizon 2020 Research and Innovation Programme.

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