EXCESS

H2020 proposal / *Topic:* New developments in plus energy houses (IA)

Energy fleXible user-CEntric poSitive houseS

EXCESS project build up on nearly-Zero Energy multi-storey Building (consumption below primary energy threshold) residential concepts of the main 4 EU climatic zone towards Energy fleXible user-CEntric poSitive houseS (**EXCESS**). A positive house produces more energy than they use over a time span of one year.

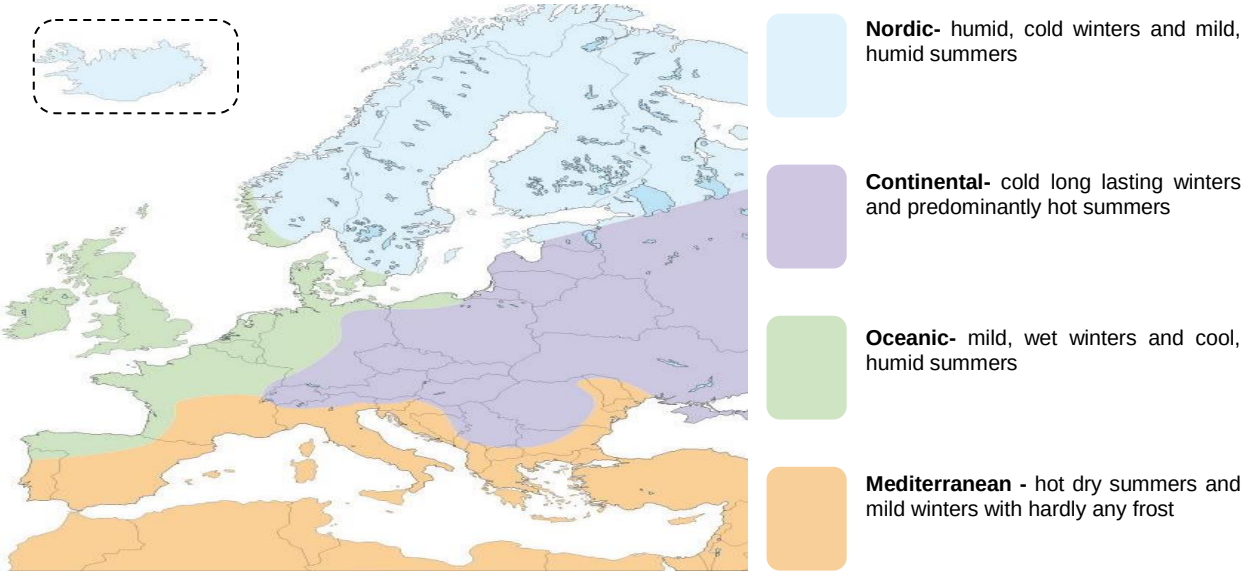


Figure1. Four main climatic zones of Europe (https://www.barenbrug.biz/forage/climate-map)

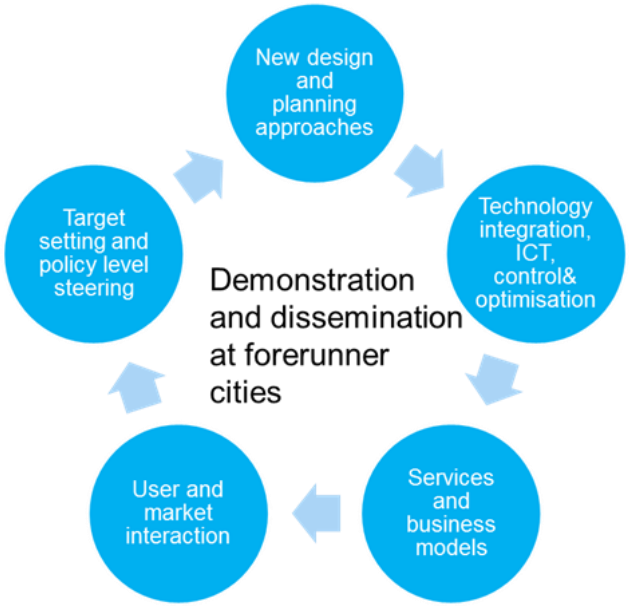
In most of the cases (also depending on the climate zone), nZEBs do not have enough on-site energy generation and storage (flexibility) and focus mainly on the reduction of energy demand through energy efficient technologies. Thus besides reducing the building energy demand, large on-site **carbon free** generation systems (wind, solar, PV/T, etc.) and energy storages (battery + thermal) are needed to achieve a positive energy building. Depending on the climate and on the period of the year residential buildings with integrated RES will produce more energy than needed (transitional months and summer). Once charged their energy storage, there will be a surplus of energy available. In order to make an efficient use of such energy

surplus, exchanging of energy with nearby buildings is a promising option. Therefore, connection with the local network becomes a priority. This option can bring additional benefits to the local and national grid, especially if energy feeding mechanism of Positive Energy Buildings (PEBs) and energy consumption of nearby buildings can be governed. Orchestrating the PEBs energy surplus delivery and the energy consumption of nearby buildings can shave energy consumption peaks and easing the burden of the local grid when high amount of renewable energy is produced and not consumed locally (dispatching energy from LV to MV network). EXCESS acknowledges that there may be the need for different definitions of PEB in different climate zones.

RES and smart technologies exists, but complete packages for different climates not. Indeed, single technologies can be purchased on the market, while fully integrated packages of RES generation technologies, energy storages, DSM-feedback/monitoring infrastructures and associated smart building/ smart control components do not still exist. Thus, integration is needed for upgrading single technologies to be part of a large orchestra, enabling also smart energy contract between utility and customers (selling flexibility). Also, the design of the PEB need to take into account option to integrate innovative technologies

What is needed?

- Technology solutions and concepts for plus energy houses
- Business cases/models to make the plus energy houses as business
- Change of planning /design practises
- User and market interactions
- City level policy steering and replication; leading by examples
- Dissemination and impact creation



The vision of EXCESS therefore is to

- Involve architects, construction companies and engineers, building management solution providers and ICT experts in the Co-design of PEBs and the needed installations (e.g. shape of the building)
- Optimize generation ->storage -> consumption at the building level towards increasing energy efficiency, as well as at the district level, enabling interactions with grid and the provision of added value services to overlay energy networks.
- Develop a methodology to exchange energy between buildings (virtual power plant between the demo sites), to enable the transition to virtually enabled positive energy buildings and positive energy building blocks.

Partners will develop a fully building and neighbourhood integrated RES system turning a conventional nZEB into a PEB. A virtual market place, based on per to peer energy transaction, will be established between PEB and nearby buildings to exchange energy surplus and shave the neighbourhood energy consumption peaks, while enabling the characterization of individual buildings as PEBs, utilizing surplus of energy exchanged with the use of block chain technologies. An advanced ICT infrastructure will be developed for enabling the virtual market place operations with the aim of putting people at the centre. This infrastructure pursues several aspects:

- enabling interaction between the integrated energy system and the building users' for accommodating specific energy need, comfort requests/wishes and selling energy flexibility (smart contracts),
- monitoring the energy status of PEB energy system and energy demand of nearby buildings,
- receiving energy exchange requests between PEB and the local grid for solving the electricity market,
- processing the data flow coming from PEB, nearby buildings and local grid (three points above) for extracting meaningful information to be used for control purposes and user awareness,
- performing predictive control (intelligent control based on weather forecasts, day ahead energy market price and prediction of energy demand and RES production) of the whole orchestra (PEB, nearby building and local grid requests),
- activate energy exchange at different level (PEB-nearby building, PEB-local grid and local grid-PEB) and
- performing remote commissioning (fine-tuning operating parameter) of PEB energy system and health check of both the energy system and indoor comfort condition for predictive maintenance

Monitoring and control:

Main aspects of this system will be:

1. Monitoring of energy generation flows from different energy sources at building and district level
2. Monitoring of energy consumption patterns at the level of the district, building, but also individual loads
3. Monitoring of indoor air quality conditions and other ambient parameters (sensing)
4. Forecasting of demand and generation at the short- and mid-term
5. Definition of optimal control strategies for PEB and PED properly balancing demand, storage and generation
6. Further instantiation of demand side management strategies into human-centric control in order to properly balance energy savings with comfort and IEQ preservation
7. Decision support for optimal "virtual" energy flow management for the establishment of PEBs within a district
8. Flexibility maximization to allow going beyond the PEB and PED concept and allow buildings to offer their flexibility to the grid in cases required (through comfort regulation, appropriate load shifting strategies with the use of storage) allowing for optimization of the cost-efficiency of the solutions through the creation of new revenue streams

Interoperability between PEB energy system and local grid infrastructure is also addressed from a semantic and operational point of views to ensure a smooth vertical interaction form the building users´ to the local grid operators.

Big data analysis techniques (Artificial intelligence and machine learning algorithms) will be used for performing predictive control demand, generation and storage optimization of PEB energy system at different levels (building, neighbourhood and national).

Furthermore, **EXCESS** team believes that it is necessary to go beyond the technical and regulatory aspects proper of PEB embracing also an urban perspective in order to successfully roll out PEB solutions as consolidate part of the urban energy infrastructure. Cities will be partners in EXCESS, as they need to consider PEB and related regulations in urban development plans.

Moreover, the purpose of creating a strong interaction between PEB and nearby buildings wants to contribute to the Net Zero Energy District (NZED) target achievement as well. Thus, where is not possible to turn single buildings into nZEB, the implementation of PEBs could turn the district into a NZED.

EXCESS includes cities/local authorities, which influence the future urban planning and are responsible for issuing construction regulation and urban energy target. They will investigate, with the help of experienced partners, regulatory obstacles and financial barriers, which prevent the deployment of the proposed user-centric solution, with the aim of introducing the developed PEB concept in the urban development plans and of incorporating PEB design principles in planning instruments. Specifically, the identified regulatory obstacles will be analysed with building developers as regard the building context and with energy utilities as regard the local grid interaction, in order to draw recommendations intended to overcome these. Partners will ensure that the demo locations will be free of regulatory obstacles zones. Replication will be facilitated by cooperating with other cities and the Covenant of Mayors.

Energy utilities, service provider-SMEs and research organizations will test innovative business models for releasing the untapped benefit of on-demand energy consumption (electricity market failure) and generation (NZED) of PEB solutions (smart energy contract) and selling of flexibility by means of energy virtual storage and user comfort choices (comfort as service). Financing organization will support local actors to set up urban-context tailored financial mechanism for deploying the developed user-centric PEB solutions. Including banks (e.g. KBC). Research organizations will produce recommendations to integrate measures for designing positive energy multi store residential building in national building codes.

EXCESS will constantly engage with stakeholders. During the project proposal phase partners will carry out workshop for co-creation of the user-centric PEB concept, elaborating technical, business model, financing, user engagement and acceptance aspects in order to build solid bases for the project implementation.

While the project is running, dynamic participatory events will be organized every year to critically assess the work done and to keep the project on the right innovation track, ensuring that all technical novelties, regulatory changes and innovative financing schemes, which will indubitably arise with the passage of time, are extensively considered.