CASE STUDY

LIVE IN POSITIVE ENERGY

SOLARHAUS BUILDING:
Reaching New Heights with a Planned Residential PEB in Spain

SOLARHAUS, which is to be built in Pamplona, Spain, and is scheduled to be completed in 2021, will be one of the first residential Positive Energy Buildings (PEB) in the country. The unique high-end design is the result of a successful collaboration between architectural practice, science and a forward-looking client.

The building design successfully balances architectural aesthetics, functionality and energy performance, thereby proving that PEBs in Spain are both technically possible as well as commercially viable. The building will feature a powerful rooftop photovoltaics installation, four air-water heat pumps, a highly insulated building envelope, radiant flooring for heating and heat recovery ventilation system.

In light of a recent Spanish decree on energy self-consumption, which greatly facilitates the installation of renewable energy generation technology, projects such as SOLARHAUS have significant potential for replication in the country. Moreover, the project could be readily reproduced in many other countries with similar regional policies, private initiatives and market´s inclination to solar projects.

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The Positive Energy Building in its Local Context

Commissioned by the real estate development firm Domeño Construcciones, a new residential PEB is to be built in Ripagaina (Pamplona), in the north of Spain. The development consists of 2 blocks with a combined surface area of 6444 m^2 with 38 socially protected dwelling units and 38 "free housing" units. SOLARHAUS will pioneer "high rise" positive energy buildings in Spain.

Pamplona is a vibrant modern city in the region of Navarra with a population of nearly 200,000 inhabitants. The region is well known for its environmental proactivity, fostering sustainable communities that embrace social participation and cohesion. Surrounded by mountains, Pamplona´s summers are comparatively mild, hence there is no need for mechanically cooling buildings.

The buildings will span 10 floors over ground and 2 floors underground for parking. SOLARHAUS will incorporate a powerful PV installation (187 PV panels will produce an annual estimate of 106.094 kWh) covering most of the roof, which powers the main heat pumps to produce domestic hot water (DHW) and provide heating.

The design phase lasted 12 months and the construction will be ongoing for 18 more months. Construction work is planned to be finished by the end of 2021.

Image 1

Rendering of the building from a street-level perspective. [Source: © Domeño Construcciones]

The Building's Special Features

In addition to the aforementioned 187 solar panels, which provide energy for private as well as common spaces, 4 air-water heat pumps with capacities of about 45 kWh each will supply hot water needs. A gas powered backup heating device will cover the overall system if needed during the winter season.

The building's design has been carefully considered to optimize energy performance: the building envelope is highly insulated and special attention was placed on avoiding "thermal bridges". Triple glazed windows as well as ventilation systems with individual heat recovering devices have been specified to effectively reduce heating needs by up to 40%.

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Further, the design emphasizes natural ventilation and has been optimized to suit local solar radiation conditions. Achieving an aesthetically pleasing balance between solids and voids, whilst maintaining high energy-efficiency was a key challenge in the design process.

Heat pump components that are traditionally installed on the roofs of buildings have been relocated to the underground parking area, efficiently capturing heat needed for ventilating the parking area before releasing it to the exterior.

The building will not only be environmentally sustainable, but will also provide a comfortable and healthy indoor environment for residents by reducing CO_2 in interior spaces via ventilation and minimizing the infiltration of external pollutants using specific F7 type filters (capable of filtering 100% of pollen, 100% of spores, 75% of viruses and 90% of bacteria).

Selected Performance Indicators

Energy Demand

Annual thermal
energy demand: 35.7 kWh/m^{2}y

Annual electrical
energy demand: 18.3 kWh/m^{2}y

Breakdown of Energy Generation

Photovoltaic: 19.96 kWh/m^{2}y

Building Envelope Performance
External walls: 0.25 W/m^{2}K
Low floor: 0.31 W/m^{2}K
Roof & joinery: 0.2 & 0.85 W/m^{2}K

Air Tightness Value: < 1.2 m^3/hr/m^2

To what Percentage is the PEB Energy Positive? 108%

Key Technologies Installed

- PV panels with an approximate power output 100 kWp are to be installed on the building's flat roof (264 panels with 72 cells that can produce 380 Wp each) to cover communal energy consumption (heating, DHW, lifts, lighting).
- Four 45 kWh air-water heat pumps which are powered by the PV panels to cover the building's heating and DHW needs. The pumps are installed in the garage in order to improve their performance.
- A gas condensing boiler has been specified in the design to cover peak loads. Pleasant temperatures in the summer are ensured by groundwater cooling without the aid of the heat pumps.
- A 5000 liter thermal energy storage tank will be installed to store thermal energy extracted via the heat pumps for later use. This storage tank helps to store thermal energy when surplus electricity is generated by the roof-top PV installation.

EXCESS

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Non-Exhaustive List of Involved Stakeholders

The following list includes some of the key actors involved in achieving the PEB. The companies previously worked together on the design and construction of highly energy efficient residential buildings under the NZEB standard. Construcciones Domeño is the main developer of SOLARHAUS while Tabuenca & Saralegui is the architectural firm in charge of the building design, Naven Engineers are the designers of the building's facilities and CENER leads the PEB energy concept development and integration.

Domeno Construcciones S.L / Promotors
www.construcciones domeno.com

CENER (Spanish National Centre for Renewable Energies)
www.cener.com

NAVEN engineers
www.naveningenieros.com

Tabuenca y Saralegui / architects
www.tabuenca-saralegui.com

Catalysts, Challenges & Results

With the success of ZERO 2020, a residential nearly zero-energy building (NZEB) project, Domeño Construcciones proved that the local community was ready to embrace buildings with high energy efficiency. ZERO 2020 received an overwhelmingly positive feedback from building's occupants after one year of monitoring, especially on comfort and energy performance. This commercial success led the company to launch SOLARHAUS, and thorough collaboration with CENER, NAVEN Engineers and Tabuenca y Saralegui embark on a new development that pushed the boundaries of energy efficient buildings in Spain even further.

With years of experience, the challenges faced in the project were less related to specifying and integrating technologies, but more related to achieving a perfect balance between the roof surface area for the powerful PV installation and the calculated power requirements of 76 housing units. The need to maximize roof space required creative solutions and the team ultimately found a way forward: relocating building services technologies, such as heat pumps, that are usually installed on the roof. By moving technology components underground, the heat produced by ventilation equipment in the parking area could be partially tapped into – thus improving the energy performance of the entire system even further.

The case of the SOLARHAUS demonstrates that PEBs in Spain are technically feasible and economically viable. Whilst data for projected building costs is not in the public domain, it should be noted that the development will be fully financed by Domeño Construcciones without receiving any local government subsidies. At the moment, 30% construction of SOLARHAUS is complete, however the majority of residential units in the building have already been sold.

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Replication Potential

The case study demonstrates that residential PEBs such as SOLARHAUS have significant replication potential across Europe under regular market conditions. A limiting factor for replication is often the willingness of the client / developer to cover the high initial investment cost of the technologies involved. Furthermore, the general public may not yet be broadly aware of the long-term merits of owning energy efficient housing units and consequently be reluctant to pay an up-front premium, even if savings on monthly domestic expenses are significant.

In Spain there is still a lack of general technological knowledge amongst professionals regarding the design and construction of PEBs, but this situation is improving fast.

Important steps have recently been taken in Spain that will enhance the replication potential of PEBs, with the recently approved energy self-consumption regulation promising to be a key catalyst for greater investment in building-connected renewable energy generation.

Against this backdrop and drawing inspiration from international examples, especially in France, SOLARHAUS is a pioneering building project that is likely to be replicated across the country and beyond in years to come.

Image 2

Rendering showing the generously proportioned balconies [Source: © Domeño Construcciones]

Image 3

Rendering of the SOLARHAUS façade [Source: © Domeño Construcciones]

Conclusions & Lessons Learned

SOLARHAUS showcases that PEBs are market-ready and have a high replication potential. In light of the recent national government action to better support consumers, households and businesses to install renewable energy generation systems, the trajectory for PEB-development looks very promising.

The case study of SOLARHAUS has revealed that the integration of PEB technologies requires careful planning and collaboration. Barriers to the greater roll-out of PEBs include clients' reluctance to accept higher upfront costs associated with PEB technology as well as lacking knowledge / capacities for energy efficiency and renewable energy generation in the construction industry.

"… a pioneering building project that is likely to be replicated across the country."

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Acknowledgements

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- CENER (Fran Serna Lumbreras) Engineering team in charge of Energy Strategy of the PEB

References

- On line Publication (5/02/2020) CONSTRUIBLE:30 housing units Positive Energy Building with Self Consumption in Ripagaina, Pamplona
- Construcciones Domeño website. www.construcciones domeno.com
- Other online press publications

Local Context Details

Address: C/Dublín. Ripagaina, Navarra, Pamplona, 31016, Spain

Geographic Coordinates [Google | EPSG:4326 – WGS 84]: 42.817413, -1.608318

Local Government: City of Pamplona

Population: 199.100 (2018)

Total Area Administered: 25.098 km²

Municipal Budget: 196.508.440€

Total annual GHG emissions: 47819,3 tCO2

Climatic Zone [Köppen]: Cfb - Temperate oceanic climate | Temperate | Without dry season | Warm summer

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Plans of the PEB

Image 4

Floor plan of an apartment unit with a private garden
[Source: © Domeño Construcciones]

Image 5

Floor plan of an apartment unit with two outdoor spaces
[Source: © Domeño Construcciones]

Image 6

Floor plan of 3-bedroom apartment with large balcony
[Source: © Domeño Construcciones]

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