SOLACE HOUSE - the First Prefabricated Plus Energy House

SOLACE House is an invention of the Polish start-up with the same name and aims to challenge prevailing paradigms in the housing market. Offering an alternative, this future-oriented home is affordable, durable, modern looking, carbon-neutral and energy-positive.

Designed to reduce energy consumption, with solar panels fixed on its tilted roof, it produces more energy than it needs and sells surplus energy to the grid, thus keeping the living and maintenance costs to a minimum. The house is made up of 16 prefabricated parts that are delivered to the customer in only one container and can be easily assembled in less than 72 hours. It is claimed to be “the first prefabricated plus-energy house”.

The first SOLACE House was erected in Warsaw. The realization of the other houses, commissioned by customers across Poland, is on the way.

SOLACE House author: Piotr Pokorski

Case study authors: Joanneum Research, Graz

Background image on case study title page:
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Introducing the Positive Energy Building

This PEB is a prefabricated house, suitably named - SOLACE. Initially conceived as an affordable housing solution for lower income families, the younger generation and the elderly.[1] SOLACE House development began in 2017 and its prototype was presented in 2018 in Warsaw, where exhibitory house was erected and is now being tested. The SOLACE House strives to provide a cheap, high-quality, carbon-neutral and energy-positive home.[2] The house is about 45 square meters, consisting of a kitchen (4 m^2), living room (20 m^2), hallway (3 m^2) and bathroom (3 m^2) in the ground floor, bedroom (7 m^2) and wardrobe (4 m^2) in the attic.[3]

Energy independence is possible due to its small surface area, cubic capacity, innovative thermal insulation and energy-efficient technical infrastructure, with PV panels on the roof[1]. Before purchasing the house, the user/client has an opportunity to co-design the house, by selecting between certain building features, including building shape options and add-ons (e.g. merging 2 houses, adding an entrance windscreen, sun protection and gardening frame), and more importantly, by choosing its desired energy performance levels, technologies and devices to be installed.[3]

Project development began in 2017, and the first, exhibitory house was erected in 2018 in Warsaw. The house development process was completely independent of any local context as it is imagined to be placed almost anywhere where a connection to a local grid is possible, e.g. connecting solar panels to the utility company's meter or connecting to the water supply and sewer system.[2]

Given that the guiding principle was to make home ownership more affordable and sustainable, it was logical that, in addition to reducing the costs of purchase, efforts also had to be made to reduce buildings' operating costs, which was made possible with installation of PV panel[1] with 6KW capacity that not only provide energy self-sufficiency (on annual basis, in majority of the EU's climate zones, including Poland for which the house was first designed), but even generate income through selling energy back to the grid.

Image 1

Completed Demo SOLACE HOUSE
[Source: SOLACE]

Image 2

Installing the mounts for the PV-system of the PEB
[Source: SOLACE]

"Initially conceived as an affordable housing solution for lower income families, the younger generation and the elderly."

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The Building's Special Features

The key technologies used in the SOLACE house are 24 PV panels with a capacity of 6 kW installed on a tilted roof, accompanied by energy-saving technologies such as heating and ventilation systems that recover heat. In addition, a smart energy system offers residents greater control over their energy consumption. To encourage homeowners to produce solar energy, the Polish net metering system offers 0.8 kWh of energy back for every 1 kWh put into the grid. The grid energy can be used when needed during the night or in the winter months.[1]

The design of the house maximizes energy collection, which was a design decision that deliberately emphasizes the performance of the building rather than the ideal aesthetic (from a designer's point of view). To get the most exposure to the sun, the roof tilts at a 32 degrees angle and has to face south. The building envelope is designed to prevent heat loss, including avoiding window frames that often act as a thermal bridge. The house is made of MFP Living Boards, a type of waterproof chipboard and non-toxic polyurethane foam. The two walls and the roof of the building are covered with modular steel, and the remaining walls are made of Siberian larch, which was collected by the Polish company, in a sustainable way.[2] As an option, a garden area can be added to the shading elements, thus encouraging self-production of food. During construction stage, less energy is used during transportation of building elements and its assembling compared to constructing a conventional building. Additionally, 80% of construction materials can be recycled once the building is out of its operation stage.[2]

Selected Performance Indicators

Energy Demand

Annual energy demand: 6000 kWh / 33 kWh/m^{2}y

Renewable Energy Generation

Photovoltaic: 6500 kWh

Degree of PEB being energy positive in % based on RES [Renewable Energy Sources]:

108%

Energy Ratings / Certifications:

Energy rating (Karta Energetyczna): 15 kWh/m^{2y}

Building lifespan certificate – 50 – 100 years

LCA – 43.5 of tCO_2 eq

Key Technologies Installed

- The wall is designed by SOLACE with regard to material optimization, reduction of required wood and finally high thermal insulation standards, also with lack of framing which reduces thermal bridging. It is filled with polyurethane foam allowing the wall to be thinner and lighter, both in construction and production. The foam itself is based on an ecological frother. The chipboard is Pfleiderer Living Board P5, which passed one of the most rigorous sustainability norms – The Blue Angel.
- The 24 PV panels installed on the roof power heating / cooling, the ventilation system as well as devices connected to electricity plugs.
- The heating / cooling system from the manufacturer Innova provides space heating and cooling as well as hot water.

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- The ventilation system of the company Ekozefir includes a heat recovery module for additional energy efficiency.

- The house has a smart energy system installed, with multiple sensors that give inhabitants greater control of their energy consumption. Although not included in the basic package, the components of the HVAC system can also be enabled with smart controls.

Non-Exhaustive List of Involved Stakeholders

SOLACE House is being developed by the company SOLACE Sp. z o.o., with a broad range of affiliated suppliers providing materials and technologies. The project is supported at international, national and city-level.

Architect & Co-Founder Piotr Pokorski http://solace.house/	**Finance Specialist & Co-Founder** Bartłomiej Głowacki http://solace.house/	**Architect** Damian Krasnodębski http://solace.house/	**Automation & Robotization of industrial processes** S-MACHINES https://s-machines.pl/en/

Suppliers:

Blachprofil 2 - Steel Sheeting (Façade)

Bricoman Polska - Further Building Materials

DLH - Formwork (Structure)

EKOZEFIR & Tempcold - HVAC System

ES-System - Energy Efficient Lighting

IKEA - Photovoltaics & Interior

Lallafom USA - Polyurethane Foam (Insulation)

MediaMarkt - Electronic Devices

Pfleiderer - MFP Board (Structure)

Orange Polska - Smart Home Solution

Supporters:

SOLACE HOUSE received support via the EU's Horizon 2020 SME Instrument & the EIT Climate-KIC European Innovation Initiative

The City of Warsaw is a patron of the SOLACE HOUSE project
https://www.um.warszawa.pl/en

The Center for Innovation & Technology Transfer at the Warsaw University of Technology provided organisational and logistical support
https://www.cziitt.pw.edu.pl/the-centre/?lang=en

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Catalysts, Challenges & Results

The determination and perseverance of the founders of SOLACE House, as well as the very uniqueness of their concept, were certainly one of the leading factors that enabled them to attract interest, and consequently the support of all stakeholders needed to develop a house prototype - from clients and financiers, specialists and suppliers to the city of Warsaw.

To realize their vision of a home for the future, they founded a start-up company and spent the first year of their collaboration testing the market to see if those design ideas would sell. After receiving more than 1000 inquiries in one month, which exceeded their expectations, they were encouraged to take further steps.[2]

Soon, they formed a team and affiliated with companies that immensely helped them to achieve their vision - such as Pfleiderer, IKEA, DLH and many others.

At the same time, while examining the technical requirements and regulations for the construction of such an energy-efficient building, they coordinated all partners and deals, as they were coming on board. The City of Warsaw, more specifically the Mayor's Office, delighted by their product, did their best to provide them with a plot for the exhibitory house, as well as assistance with all legal procedures and permits that were accepted at all levels. Warsaw University of Technology has provided them with organizational support, as the SOLACE HOUSE office is located within their premises.

The development of the SOLACE HOUSE was largely funded by its co-founders and European Commission grants - € 50,000 from Horizon 2020 (SMEs) Phase 1 for the concept development and feasibility assessment; € 20,000 from the EIT Climate-KIC European Innovation Initiative; and € 50,000 from various smaller grants and tenders. Several vendors also donated materials or equipment to build the prototype.[2]

After an unsuccessful search for a manufacturer that could take over the production of new SOLACE Houses, exactly as they had envisioned them to be, the company decided to take a further step - to secure funding for its own manufacturing process.[2] In the meantime, their company has received additional grant

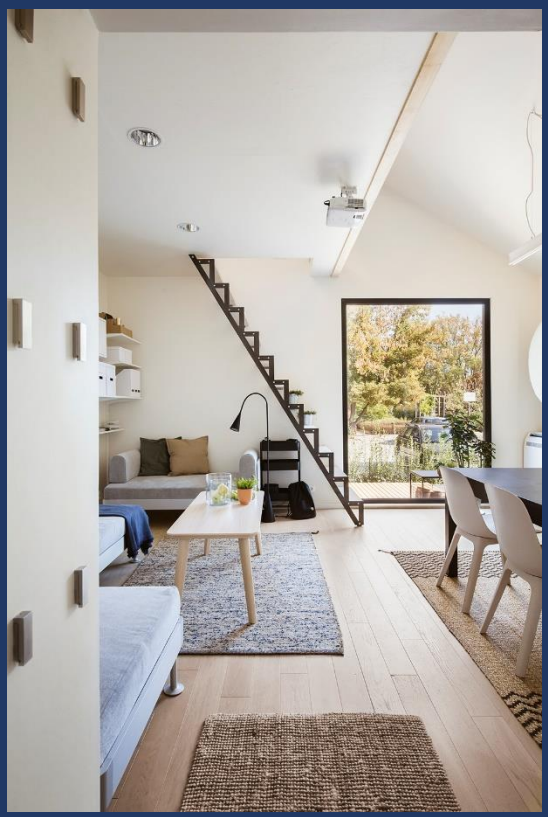

Image 4

View of SOLACE HOUSEs interior
[Source: SOLACE]

"The house delivered to its customers in only one container, and can be assembled in less than 72 hours"

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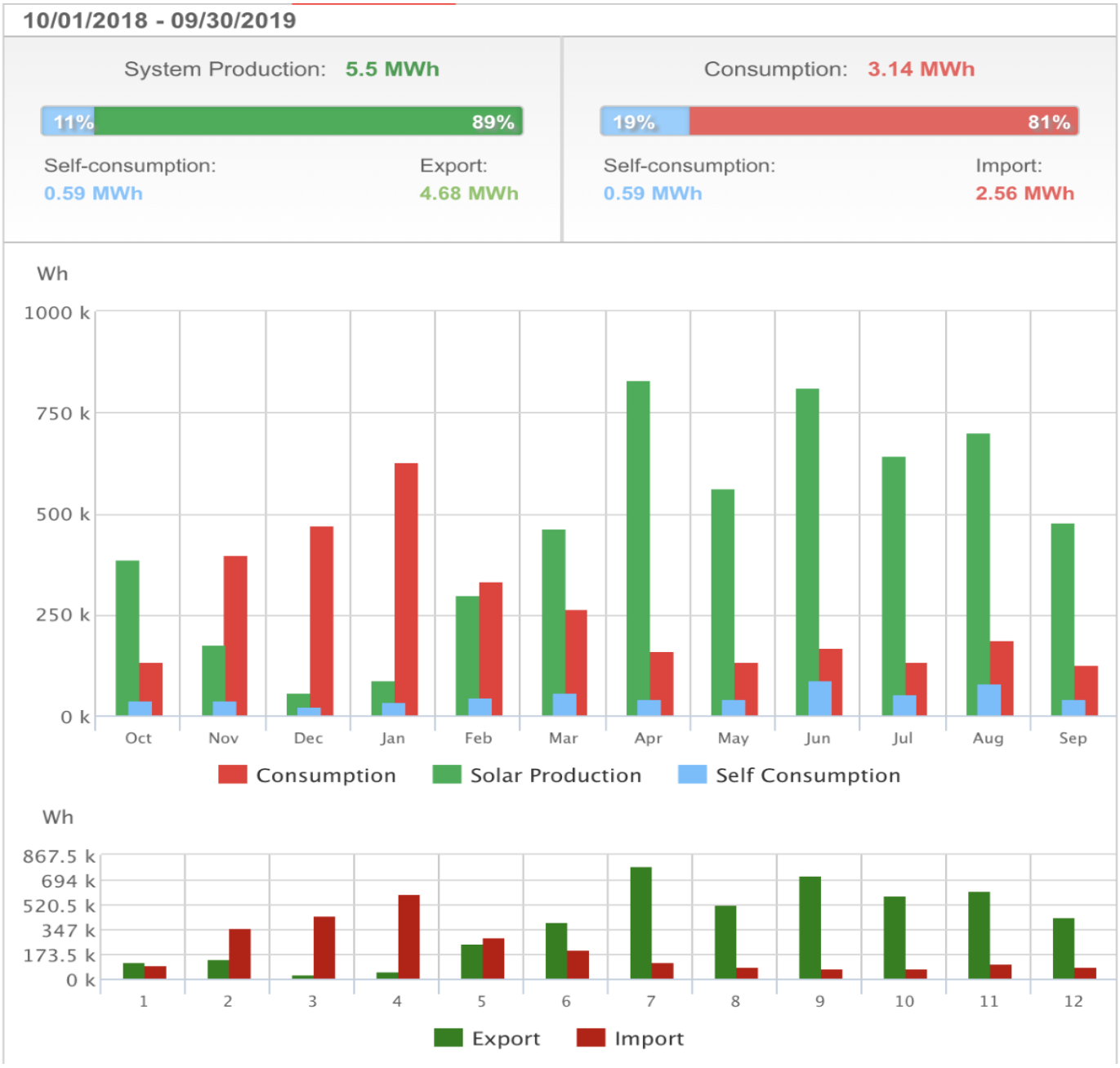
support from the European Commission, enabling them to set-up and perfect their production process - e.g. building prototype production lines for cutting wood or injecting foam. Now, together with their clients they are testing and validating some details around the House, as required by the grant. In addition to offering a model of affordable and sustainable housing that will generate income for owners, the SOLACE House has a great potential to boost local economies in poorer European Regions or even create a movement of eco-friendly lifestyle.[2] Of course, as with many ingenious ventures, there were some skeptics who questioned the credibility of the SOLACE House energy performance, but the Warsaw demonstration house proved that homeowners won't need to spend a single penny on their energy bills (based on 1 year monitoring, with internal temperature set at plus/minus 20 degrees), as shown in the graph below:



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Replication Potential

Prefabricated houses are usually planned for mass production, which also applies to the SOLACE house, where improvement of factory processes accelerates production and reduces cost of each element. For the SOLACE team, designing their own wall system was crucial, as they wanted to achieve thermally insulated walls with reduced thermal bridges, but without high costs. Now, they even managed to have it manufactured with the help of robots and its production line contains 6 workstations, which is an upgrade in comparison to current production lines of same task and complexity that have around 16 workstations.

In addition to streamlined production, the prerequisites for replication also influenced the design and installation of the house. All structural elements, facades, insulations, openings, installations, are transported to the client's plot, located anywhere, in just one single container.[1] The assembly of the elements requires 72 hours and can be done by a client alone, or with the help of his friends or construction team.

Furthermore, external factors like regulatory framework that favors small-scale energy producers to export their electricity surplus to the grid, such as the Poland's net-metering system does, can significantly impact client’s decision when considering buying a home like this and thus contribute to their wide-spreading.

Conclusions & Lessons Learned

Solace House has already gained the attention of a wide audience, with many customer inquiries coming from Poland, as well as from across Europe and the World. Currently, Solace team is oriented on delivering homes commissioned in the Polish market, and focused on optimising their work, by improving their production lines and organizational process. Of course, expansion to other countries is on their minds but in order to stay true to their vision and high standards, they deem that their House could be slightly modified to meet the needs of foreign markets, and to be in line with technical requirements of each of the countries, which might result in generation of several new versions of Solace House.

Needless to say, governments at all levels could support similar projects by reinforcing their climate and energy commitments, or alternatively by rethinking how to tackle the problems of emergency or social housing provision. This could be followed by building incentives, if not for the final user, then for the actors in the production chain. who at least in the Solace House case, seemed willing to innovate and to embrace the positive energy homes / sustainable living movement.

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Acknowledgements

The EXCESS project team would like to thank the following companies, institutions and individuals for their contributions to this case study:

- The team at SOLACE for providing further information and granting permission for using photographs and renderings.

Selected References

[1] Article on Innovate CEE web portal:
http://www.innovatecee.com/business/a-house-which-can-allow/

[2] Article on Redshift by Autodesk web portal:
https://www.autodesk.com/redshift/positive-energy-building/

[3] SOLACE House official website:
http://solace.house/

[4] Article on Energy-Forum web portal
http://energy-forum.eu/en/the-polish-startup-has-presented-a-prototype-of-its-first-solace-prefabricated-prefabricated-house/

Local Context Details

Address of exhibitory house: ul. Rektorska 4, 00-614 Warsaw, Poland

Geographic Coordinates [Google | EPSG:4326 – WGS 84]: 52° 13' 8.436'' N, 21° 0' 37.044'' E

Local government in which exhibitory house is built / erected: City of Warsaw

Population: 1,790,658 [2019]

Total Area Administered: 517.24 km²

Municipal Budget: 3,900,000,000 EUR [2020]

Total annual GHG emissions: 10,121,489 tCO2eq

Climatic Zone [Köppen]: Dfb - humid continental climate - cold and temperate - significant rainfall

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Further Images & Plans of the PEB

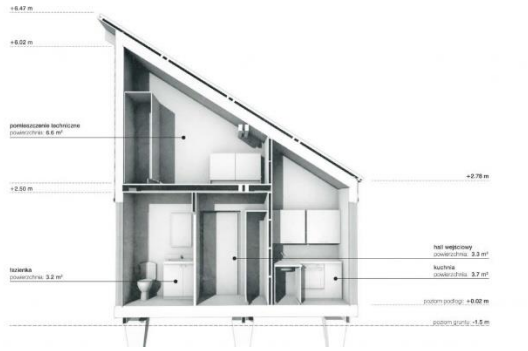
Image 4

Rendering of SOLACE HOUSE, showing the add-on gardening frame
[Source: SOLACE]

Image 5

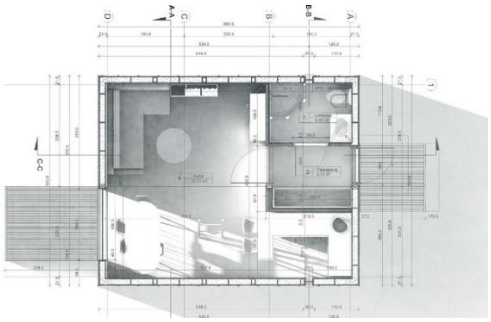
Interior view of the building's living space
[Source: SOLACE]

Image 6



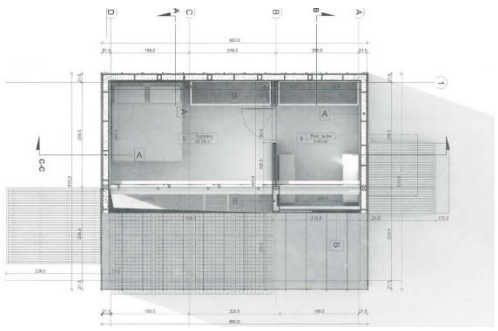
Annotated cross-section of the SOLACE HOUSE
[Source: SOLACE]

Image 7



Top-down view of the ground-floor
[Source: SOLACE]

Image 8



Top-down view of the first floor
[Source: SOLACE]

Image 9

Artist's impression of the SOLACE HOUSE with gardening frame
[Source: SOLACE]

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