

Efficiency House Plus with Electromobility

Berlin, Germany



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The Efficiency House Plus with Electromobility represents the prototype smart building developed within the framework of the new energy-efficient construction program presented by the German Federal Ministry of Transport, Building and Urban Development. The newly created program intends to test the latest construction and energy components on buildings in real-world conditions, and thus prepare recommendations for their ongoing development and to further improve their economic viability [1].

The high-tech prototype Efficiency House Plus with Electromobility is a compact and glazed two-storey house based on the newest energy standards, which generates its own energy for user consumption and vehicle charging. Based on “smart” housing principles by using the latest and efficient energy and material features, the Efficiency House Plus with Electromobility demonstrates the feasibility of synergies between “smart” housing and the use of electric vehicles [1].

Country/ City Profile

 <p>Source: © OpenStreetMap contributors</p>	Country		City	
	Population (2013)	80.9 million [2]	Population (2014)	3,421,829 (Berlin NUTS 3 region, city) [3] 4,349,400 (metropolitan) [5]
	Land area (km ²)	357,170 [2]	Land area (km ²)	892 (city) n/a (metropolitan)
	GDP per capita (2014, current international \$, at purchasing power parity)	46,400 [4]	GDP per capita (2014, US \$, at purchasing power parity)	n/a (city) 36,259 (metropolitan) [5]
	Region	Central Europe	Region	Inland
City's physical geography	Location [6, 7]	<ul style="list-style-type: none"> ✓ The capital and largest city of Germany as well as one of the 16 states of the country; ✓ Located in north eastern Germany about 60km from west of the Polish border, in an area known for its low-lying marshy woodlands; ✓ Subdivided into twelve boroughs and 96 localities, which are commonly made up of several city neighbourhoods representing small residential areas. 		
	Climate [6, 7]	<ul style="list-style-type: none"> ✓ Humid continental climate with cold winters and warm and humid summers due to its inland position; ✓ An average temperature of 9°C and minimum temperature of -1°C in winter and 18°C in summer; ✓ An annual precipitation of 570 mm (22 inches) with moderate rainfall throughout the year. 		

Initiating context

The Efficiency House Plus with Electromobility project resulted from the winning proposal of the architectural planning competition launched in 2010 by the German Federal Ministry for Transport, Building and Urban Development. This competition had the mission to create a new residential prototype that sets new living and construction standards for the future, both architecturally and in regard to energy use [1, 8, 9, 10].

The architecturally sophisticated family house proposal designated Efficiency House Plus with Electromobility was the selected proposal from 16 competition entries awarded in 2010. It was developed by the Stuttgart Institute for Lightweight Structures and Conceptual Design (ILEK) in collaboration with the architect Werner Sobek, and the company WSGreenTechnologies GmbH [1, 8, 9, 10].

This architectural concept intends to demonstrate the feasibility of “smart” housing using the latest and most-efficient materials and sustainable energy sources was designed to be a model for energy efficiency and sustainable construction in the Federal Republic of Germany in the future [1, 8, 9, 10, 11].

Project description

The Efficiency House Plus with Electromobility is materially a two-storey glazed house with 136 m² living area and an external large covered area designed to accommodate the equipment for charging and parking electric vehicles [1, 8, 10, 11, 13].

Alongside the notable contemporary architecture, the design concept of the Efficiency House Plus with Electromobility is based on the adherence to the new and strict energy standards (as e.g. the Efficiency House Plus standard) and other key energy-efficient architectural principles [1, 8, 10, 13].

The Efficiency House Plus concept

Annual primary and final energy demand of the Efficiency House Plus standard are negative ($\Sigma Q_e < 0 \text{ kWh/m}^2/\text{a}$). Other requirements, such as the part of heat provided from renewable energy sources needs to comply with the requirements given in the Renewable Energies Heat Act [12].

In terms of energy-efficient architectural key principles, the Efficiency House Plus should demonstrate:

- An optimized construction with regard to the urban location;
- The highest level of compact design;
- Maximization of energy gains and minimization of thermal loss throughout the building components;
- Supply of the energy needs through renewable energy generated onsite;
- A decrease in energy demands of the household processes as much as possible.

Following this concept, the proposed design for the Efficiency House Plus with Electromobility (as illustrated in the following schemes) demonstrates a balanced junction of energy flows between the emerging fleet of electric vehicles and the built environment [1, 8, 13].



Figure 1: Schematic energy flows in the Efficiency House Plus with Electromobility [1]

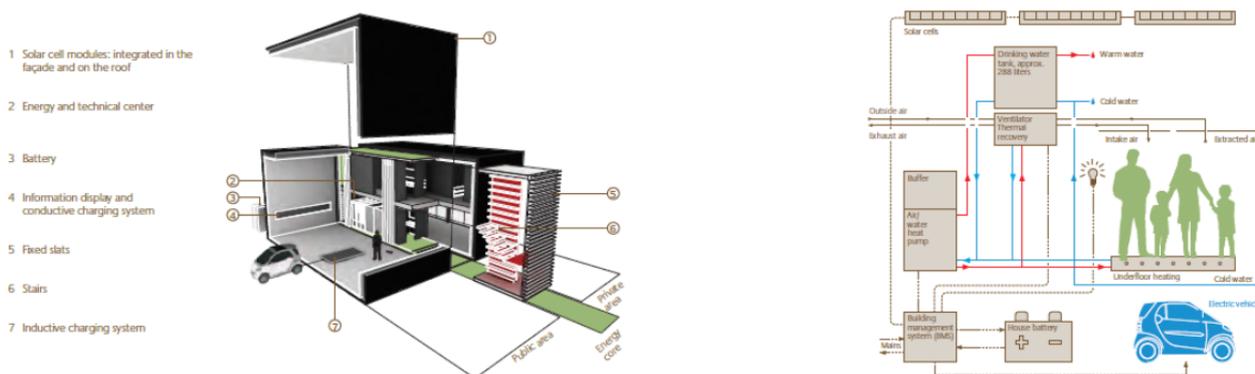


Figure 2: Schematic key components design of the Efficiency House Plus with Electromobility [1]

The entire interior space was fully thought to maximize the energy-efficient structures and components, under a flexible utilization concept [1, 8, 10].

In terms of energy generation, the building combines two technologies: an air-water-heat pump that recovers the necessary heat from the external ambient air in winter, and the solar cells on the roof and exterior glazed façade that generate electric energy (available immediately for domestic use or stored to charge the electric vehicles) [1, 8, 10, 11, 13].

In essence, the Efficiency House Plus with Electromobility pilot project intends to demonstrate the feasibility of the synergies between the living subjects and mobility under the slogan “My home, my filling station” by incorporating a charging station for electric vehicles inside an energy generator house [1, 8].

Implementation process

The construction of the prototype was concluded in December 2011. The brief construction period demonstrates that it is already possible to construct an exemplary energy-efficient building in a short period of time, thanks to the use of innovative techniques and materials [1, 8, 10].

The building was formally inaugurated in December 2011 by Chancellor Angel Merkel. This was an important milestone of this pilot building project which was realized by the financial support of the German Federal Ministry of Transport, Building and Urban Development (BMVBS), and the scientific support of the Fraunhofer Institute for Building Physics (IBP) and the Berlin Institute for Social Research (BIS) [8, 13].

After the construction period and its formal inauguration, the Efficiency House Plus with Electromobility started to be monitored frequently and used on daily basis in a period divided in two phases:

- From February 2012 the house was occupied by a four-person family who lived there for 15 months. After that, the Efficiency House Plus with Electromobility was opened to the public as part of a programme of guided tours, presentations and exhibitions [1, 8, 10].
- In May 2014, a new family occupied the house for a second period of one year [1, 8, 10].

The Network

This prototype was also the first building of the “Network of Efficiency Houses Plus Research Programme” led by Fraunhofer Institute for Building Physics (IBP) and funded by the Federal Government [1, 8].

The Network of Efficiency Houses Plus (that now includes 37 buildings) aims to establish a test-bed network of different construction solutions, materials and technologies used in buildings, by gathering several partners from the construction and building services industry [1, 8].

In accordance with the government’s research funding programme, the Fraunhofer Institute for Building Physics (IBP) developed an intensive monitoring program on the buildings network to gather and analyse key performance data such as heat energy consumption, electricity consumption, electricity generation, the percentage of renewable energy generated used in the buildings, and primary energy consumption [1, 8].

In addition to its pioneer role in the referred network, the Efficiency House Plus with Electromobility located in Berlin is now also the stage of numerous public exhibitions. Since September 2015, the Centre for Energy, Construction, Architecture and the Environment - ZEBAU GmbH - incorporates the Information Centre of Efficiency House Plus by order of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. The Information Centre acts as well as a consulting service on Efficiency House Plus Standard, architectural models and financing options [1, 8, 10].

Projects implementation details

Process/ Leadership

The program was an initiative of the Government. It was initiated by the Federal Ministry of Transport, Building and Urban Development (BMVBS) in 2011, and currently, the programme leadership is under the responsibility of Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) which will continue to run the research programme until its end [1, 8, 10].

Projects implementation details

Financing	<p>The Efficiency House Plus with Electromobility as prototype of the program was financed by the Zukunft Bau Research Initiative, an initiative of the Federal Ministry of Transport, Building and Urban Development to promote the sustainable development of the building sector in Germany and strengthen the competitiveness of the German building industry in the European market. Since June 2006, Zukunft Bau is a component of the High-Tech Strategy for Germany, which comprises the needs for research and future construction markets [1, 8, 10].</p> <p>Zukunft Bau Research Initiative states that € 2.2 million were spent within the project on general research aspects, building materials and techniques, and laboratorial activities. The actual House Plus with Electromobility building itself cost € 1.75 million (including building materials, civil works, energy technologies and house equipment and appliances) [10, 11].</p> <p>Up to now, the result reveals that the costs of other network funded buildings are highly specific due it is huge variability in terms of construction type and needs. The Efficiency Houses that have been built to date usually have a building envelope that is a 40% improvement on the requirements of the Energy Saving Ordinance. Each individual component (energy-efficient walls and windows, highly efficient ventilation systems, heat pump systems, household appliances, PV systems, electric battery systems) requires additional investments that range from €30 to €90 per m² of useful floor space. In general, it is possible to assume that an Efficiency House Plus requires an average additional investment between €230 and €325 per m² of useful floor space [8].</p>
Involved stakeholders [1, 8, 9, 10]	<ul style="list-style-type: none">✓ Federal Ministry of Transport, Building and Urban Development (BMVBS);✓ Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB);✓ ILEK Universität Stuttgart, Werner Sobek Stuttgart, and WSGreen Technologies represent the architectural and engineer team;✓ Berlin Institute for Social Research (BIS) conducts the social-scientific monitoring process of the house and its inhabitants;✓ Fraunhofer Institute for Building Physics (IBP) conducts the scientific monitoring of the Efficiency Houses Plus from the network Efficiency House Plus;✓ ZEBAU - Centre for Energy, Construction, Architecture and Environment GmbH develops the social visits programmes and the information platform about the project.

Projections

- The Efficiency House Plus with Electromobility annual energy need is projected to be less than 10,000 kWh and the projection of annual energy generation is more than 16,000 kWh, allowing a significant energy surplus to be generated and used for charging e-vehicles [1, 8];
- The assumed annual driving distance of the electric vehicles is 29,000 km, which correspond to an annual demand of approximately 6,000 kWh. This is projected to be entirely generated by the Efficiency House Plus with Electromobility solar cell array [1, 8];
- The main programme's objective is that from 2019 all new buildings throughout Europe will be nearly climate-neutral [1, 8].

Achieved Results

- In the first year of monitoring, the photovoltaic system generated 13,306 kWh, of which 6,555 kWh were used in the house itself and 6,751 kWh were fed into the public grid [1, 8];
- 47% of the building's energy was used for space and water heating, 4% was used for lighting and the remaining 49% were used for ventilation, building automation and electrical appliances [1, 8, 10, 11];
- The Efficiency House Plus pilot project is a valuable opportunity to combine new highly energy-efficient materials with leading electromobility technology [1, 8].

Lessons learned

One of the main success factors of this energy-efficient construction program was the exhaustive monitoring program of the families, their daily domestic routines and its consequently available results for the large-scale construction market, thus showing the economic viability of such buildings and enabling further development of the concept [1, 8].

References

- [1] Efficiency House Plus with Electromobility: http://zebau.de/fileadmin/Redaktion/Dokumente/Broschueren/BBSR_EffizienzhausPlus_Elektromobil_EN_Aufl1_barrierefre.pdf
- [2] World Bank: Data Germany: <http://data.worldbank.org/country/germany>
- [3] EUROSTAT regional statistics by NUTS classification: <http://ec.europa.eu/eurostat/web/regions/data/database>
- [4] World Bank : GDP per capita, PPP: <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD>
- [5] 2014 Global Metro Monitor Map, Berlin: <http://www.brookings.edu/research/reports2/2015/01/22-global-metro-monitor>
- [6] Silk World Data Base: <http://beta-world.silk.co/page/Berlin>
- [7] Wikipedia: https://en.wikipedia.org/wiki/Geography_of_Berlin#Climate
- [8] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) leaflet "What makes an Efficiency House Plus": http://www.ibp.fraunhofer.de/content/dam/ibp/en/documents/Areas-of-Expertise/heat-technology/2014-08_Broschuere_Wege-zum-Effizienzhaus-Plus_engl.pdf
- [9] German-architects projects: http://www.german-architects.com/en/projects/45422_Efficiency_House_Plus_with_electromobility
- [10] ZEBAU GmbH: <http://zebau.de/effizienzhaus-plus/das-haus/>
- [11] Effizienzhaus Plus: <http://www.forschungsinitiative.de/en/effizienzhaus-plus/fragen-und-antworten/effizienzhaus-plus-mit-elektromobilitaet-in-berlin/>
- [12] International Energy Agency - Renewable Energies Heat Act: <http://www.iea.org/policiesandmeasures/pams/germany/name-24388-en.php>
- [13] BuildUp - *Efficiency House Plus in Berlin*: <http://www.buildup.eu/en/practices/cases/efficiency-house-plus-berlin>

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