# Aktiv-Stadthaus

**„Development criteria for urban multi-family homes meeting net-plus construction standard. In reference to EU 2020 and in preparation of a projected prototype building in Frankfurt/Main“**

## Executive Summary

## The first Urban Net-Plus Energy Multi-Family-Building

TU Darmstadt, Unit for Design & Energy-Efficient Building (FGee) | Steinbeis Transfer Zentrum, EGS Stuttgart | HHS Planer + Architekten | Bauherr: ABG Frankfurt Holding | Projektpartner: HAGER

TECHNISCHE UNIVERSITÄT DARMSTADT

Bundesministerium
für Verkehr, Bau
und Stadtentwicklung

FORSCHUNGSINITIATIVE
ZukunftBAU

Bundesinstitut
für Bau-, Stadt- und
Raumforschung
im Bundesamt für Bauwesen
und Raumordnung

**Research Initiative ZukunftBau – Future Building**

*Within the framework of the research initiative ZukunftBau of the German Federal Ministry of Traffic, Housing and Urban Development's (BMVBS) and the German Federal Institute Building, Urban Affairs and Spatial Research (BBSR)*

**Executive Summary**

*This project on which this report is based was funded by the German Federal Institute Building, Urban Affairs and Spatial Research (BBSR), funding code SF-10.08.18.7-11.31. The responsibility for the content lies with the author.*

TECHNISCHE UNIVERSITÄT DARMSTADT
HHS HEGGER-HEGGER-SCHLEIFF ARCHITEKTEN
stw Steinbeis Transferzentrum Energie-, Gebäude- und Solart
ABG FRANKFURT HOLDING Wir machen Räume wahr.
:hager

Figure 1 Aktiv-Stadthaus, Rendering, South-West Perspective; Source: HHS Planer + Architekten AG

## Initial Position

Within this research project, experiences and methods from recent developments of net-plus energy single family homes shall be transferred for the first time to large-scale urban multi-story buildings and the feasibility of implementation be examined through a demonstration project, the Aktiv-Stadthaus ("active-city house"). The Aktiv-Stadthaus is a multi-family building to be developed by AGB Frankfurt Holding in FFM. Eight floors with a total of 74 units are currently projected.

## Research Topic

Target is a preparatory feasibility study for development and design of multi-family buildings meeting the net-plus-energy standard. Its focus is laid on four core subjects:

- Energy concept
- Electro mobility within the house community
- Energy management for the occupants
- Life cycle analysis

**Energy Concept**
The energy balance is based on the definition of the „Effizienzhaus-Plus" standard by the German Federal Ministry of Traffic, Housing and Urban Development (BMVBS) and was compared with balances in reference to passive house project package (PHPP). Significant differences and recommendations are being noted and resented.

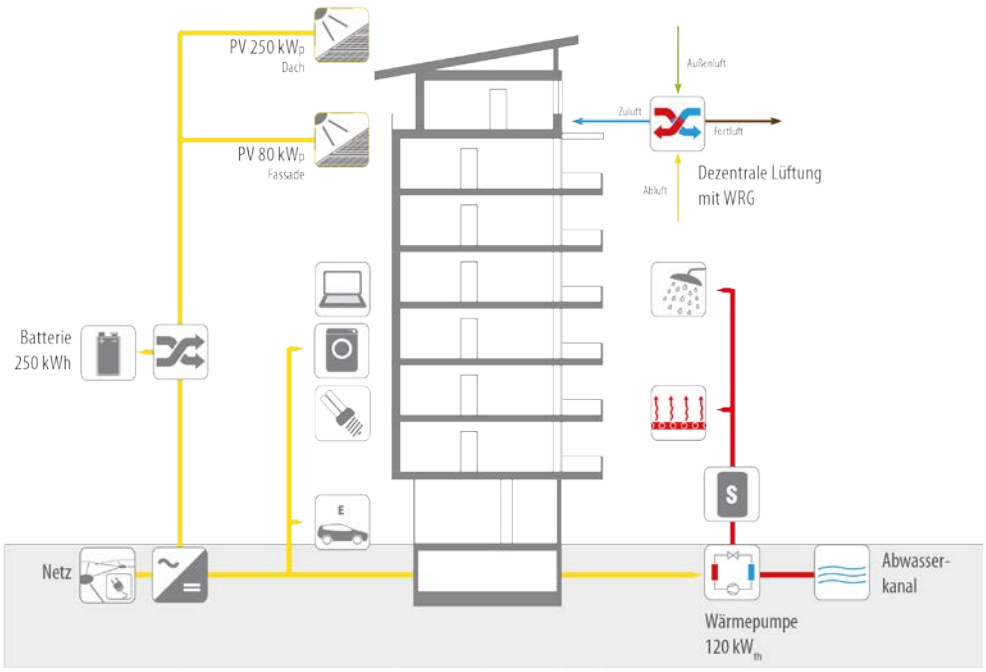


Figure 2: Energy Flow Schematic, Aktiv-Stadthaus; Source: Steinbeis Transfer Zentrum

Project target is to decrease the total energy consumption and to meet the leftover energy demand as efficiently as possible from regenerative sources. Upon analyzing optimization potentials of different aspects, second to the optimization of building shape and envelope, optimizing household electricity demand turned out to be the most important task. Cubature and the amount of stories turned out to be important factors in achieving the goal of energy-plus in multi-family buildings. The Aktiv-Stadthaus is to be constructed as “electricity-only” building. The technical concept includes regeneration of heat in wastewater = through a heat pump heating system. The building’s electricity demand shall be covered through façade and roof-integrated photovoltaics. Thereby, in response to the urban context, the focus is laid on energy gains from the roof surface. In reference to the BMVBS balance projection, a plus of 11% is achieved. In addition, intelligent load management and storage concepts shall help to increase in on-site use of the solar generated electricity. Under consideration of economic viability, on-site electricity storage enables a rate of approximately 50% on-site utilization. Further increase is possible through the integration of the heat pump in the load management. In order to implement the energy concept in rental apartment buildings, a new model of accounting the utility fees is necessary, which has been analyzed and is presented within this project. A monthly flat-rate for electricity and heat guaranties economic viability for the provider, and renewable and price stable energy supply to the users.

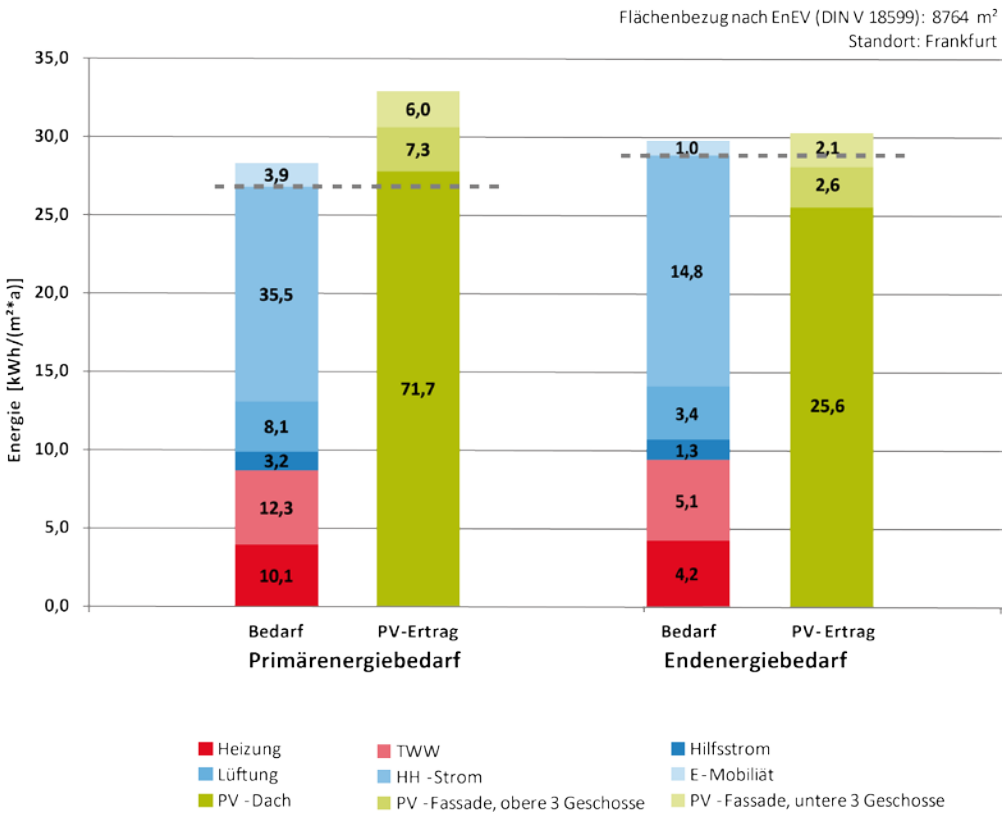


Figure 3: Final- and Primary Energy Balance, Location Frankfurt, Date: 22.10.12; Source: Steinbeis Transfer Zentrum

**E-mobility**

Holistic energy concepts for the buildings of the future consider energy flow beyond the building. Here, occupants' mobility has been identified as significant energy load. With the Aktiv-Stadthaus project a sustainable mobility concept shall be developed through the integration of electric vehicles. Projected is a car-sharing fleet of up to eight electric cars and five e-bikes, which shall be available for use to the tenants and the public. The charging infrastructure shall be provided through conductive charging columns as well as surfaces for inductive charge. Savings in parking space, shared use of cars, solar charged electric vehicles and the related relief to the environment are aim for a sustainable mobility concept.

**Energy Management for the User**

Besides the implementation of innovative technology for energy generation, users shall be invited to save energy and to increase the on-site use of solar generated electricity through interactive user interfaces. Through touch panels in the units, individual energy consumption as well as energy generation of the building shall be made visible. An all utilities-included rent concept with a demand-dependent energy credit shall create incentives for saving energy. A user-interface integrating the energy credit concept was schematically developed within this research project.


Figure 4: Sample Pages User Interface: Home Page, Energy Balance, E-Mobility, Electricity Consumption (Month, Real-Time and Comparison of different Consumers within the household); Source: Unit of Design & Energy Efficient Building, TU Darmstadt

**Life-Cycle Analysis**

In light of reduced operating energy demands, energy input over the whole life cycle of a building gains more importance. Especially in aiming for net-plus energy standard, it is recommended to plan, control and optimize material use in detail, so that net-plus in operation is not bought with great expense through invisible embodied energy in materials, technologies and maintenance. Photovoltaic production leads to a significant amount of embodied energy. Because of the energy-plus in operation though, the Aktiv-Stadthaus reaches a slightly negative global warming potential overall. In comparison with passive house standard, it compensates the additional emissions from building construction within approximately 10 years.

## Conclusion

The presented study shows the feasibility of a net-plus multi-family building in urban context. The added difficulty resulting from a constricted site and eight floors still allow for a balanced plus in final energy and primary energy. This is possible through an optimized thermal envelope, highly-efficient space conditioning through a heat-pump, energy-efficient appliances in combination with façade and roof integrated photovoltaics. Meeting net-plus energy standard requires an interdisciplinary dialogue between architects, consultants and engineers already in early concept and design phases. The related additional expenses are sustainable though, in light of the results and impact on the building, the environment and the profession.

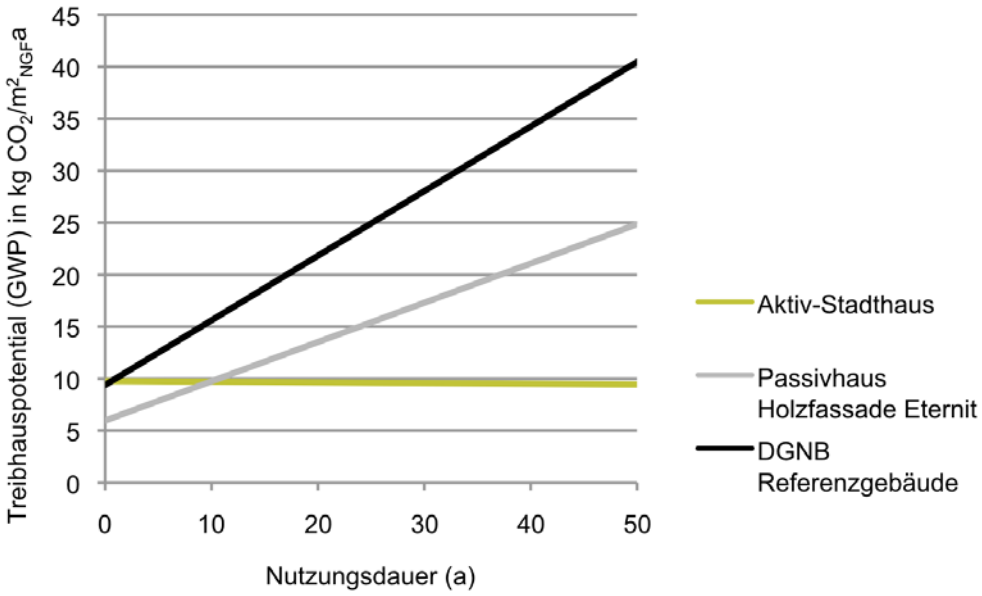


Figure 5: Global Warming Potential (GWP) from Building Construction and Building Operation over 50 years. Source: Unit of Design & Energy Efficient Building, TU Darmstadt

## Key Data

**Short Title:** Aktiv-Stadthaus

**Research/Project Management:**
- TU Darmstadt, Department of Architecture, Unit of Design & Energy Efficient Building, Prof. Manfred Hegger (Project Management)
- Steinbeis-Transferzentrum Energie-, Gebäude und Solartechnik (STZ), Prof. Dr.-Ing. Norbert Fisch
- HHS Planer + Architekten AG

**Third Party Funding:**
- ABG FRANKFURT HOLDING, Wohnungsbau- und Beteiligungsgesellschaft mbH
- Hager Vertriebsgesellschaft mbH & Co. KG

**Total Cost:** 277.597,92 €
**Partial Federal Funding**: 164.697,79 €
**Project term:** December 2012 until incl. February 2013