Summary report

Title
„Nearly zero energy building – development of a standard and a calculation method for the energy performance of buildings”

Motive / Starting point
In 2010 the European Union passed the guideline “2010/31/EU“. According to this guideline, the member states have to define a national nearly zero energy building standard and apply this standard to new public buildings from 01.01.2019 and to all other new buildings from 01.01.2021.
In the framework of this research project, a possible nearly zero energy standard for Germany was derived, using representative model buildings.

Research project
Nearly zero energy buildings should exhibit a very high overall energy efficiency and a very low energy demand (nearly zero) which is to be covered by energy from renewable energy sources. According to the European guidelines the national nearly zero energy standard is to be defined using cost-optimal calculations and model buildings.
In the framework of this project a total of five model buildings (single-family house, semi-detached house, apartment building, office and hotel) were chosen, which are considered to be representative in terms of the expected future new buildings in Germany. For the model buildings the reference building standard according to EnEV 2014 was used as a basis and the quality of the thermal insulation as well as the building services were varied. In total up to 26 variations per building were investigated. For these variations the total cost as well as the annual primary energy demand were determined, during an investigation period of 30 years for residential buildings and 20 years for non-residential buildings, respectively.
The boundary conditions investigation period, calculatory interest rate, inflation rate, energy prices, energy price development, primary energy factors, investment costs, maintenance costs and life span of building components were defined.
To calculate the energy demand of the variations the series of standards DIN V 18599 was used, as they can be applied both to residential and non-residential buildings, which facilitates comparisons between model buildings. For electricity in particular the corresponding primary energy factor is expected to drop due to the increase in electricity from renewable energy sources. Hence, resulting lower primary energy demands for unchanged energetic building quality are expected in the next years. Therefore, the average yearly primary energy demand for the investigated variations during the examination period of 20 resp. 30 years was calculated and subsequently used in the deduction of the national nearly zero energy building standard.
The total cost of the calculated variations were derived on the basis of EU specifications, from a microeconomic perspective (private sector). The following cost categories were taken into account: initial investment, maintenance and replacement costs for the thermal insulation of the exterior building components and the building services, residual values for the thermal insulation of the exterior building components and the building services and energy costs. All included costs accumulated during the investigation period were calculated back to the beginning of the investigation period using calculatory interest rates. Residual values for building components at the end of the investigation period were deduced using straight-line depreciation of the initial investment and replacement costs and were discounted to the beginning of the investigation period.
For each model building the results of the variation analysis were gathered, considering only variations fulfilling the current requirements of EnEV 2016 and EEWärmeG.
Subsequently, a sensitivity analysis was conducted to determine whether the results are robust under variation of boundary conditions. According to EU specifications the energy price development of the different energy sources, the inflation rate and the calculatory interest rate were varied.

For each model building the variations within the cost-optimal spectrum were identified. These variations are available for the definition of the national nearly zero energy building standard.
For residential buildings, the variations 5 (heat transmission of exterior building components lowered by 40 %), 16 (supply and return air system with 90 % heat recovery efficiency + heat transmission of exterior building components lowered by 8 %), and 18 (“Effizienzhaus 70” with condensing boiler + solar + supply and return air system with 90 % heat recovery efficiency + heat transmission of exterior building components lowered by 18 %) are within the cost-optimal spectrum for all model buildings. It is considered appropriate to use variation 16 as basis for the definition of the future residential reference building for Germany.
For non-residential buildings, only variation 26 (improved energy recovery + heat transmission of exterior building components lowered by 40 % + improved thermal bridges for the office and condensing boiler + solar (for heating and warm water) + improved energy recovery + heat transmission of exterior building components lowered by 50 % + improved thermal bridges for the hotel) is within the cost-optimal spectrum for the model buildings and is therefore the basis for the definition of the nearly zero energy building standard for non-residential buildings.

Conclusion
In the framework of this research project it was found that the nearly zero energy standard in combination with a cost-optimal level requirement pursued by the EU results in a standard close to the current energy requirements in Germany given by EnEV 2016. The investigations in this project lead to reference buildings for new buildings in Germany which denote a very moderate increase in demand of energy efficiency standards by modifying the heat transmission of the exterior building components and the building services.

Basic data
Short title: Nearly zero energy building

Researcher / Project manager:

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Dipl.-Ing. (BA) Tim Schöndube, M. Sc. (Project manager)	Technische Universität Kaiserslautern
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Industry partner:

Dipl.-Ing. Torsten Schoch	Xella Technologie- und Forschungsgesellschaft mbH

Total cost: 253.884,54 €
Share federal grant: 153.384,54 €
Project duration: 27 months

Image files

Figure 1: Niedrigstenergiegebäude_Endabgabe_Abbildung 1.png

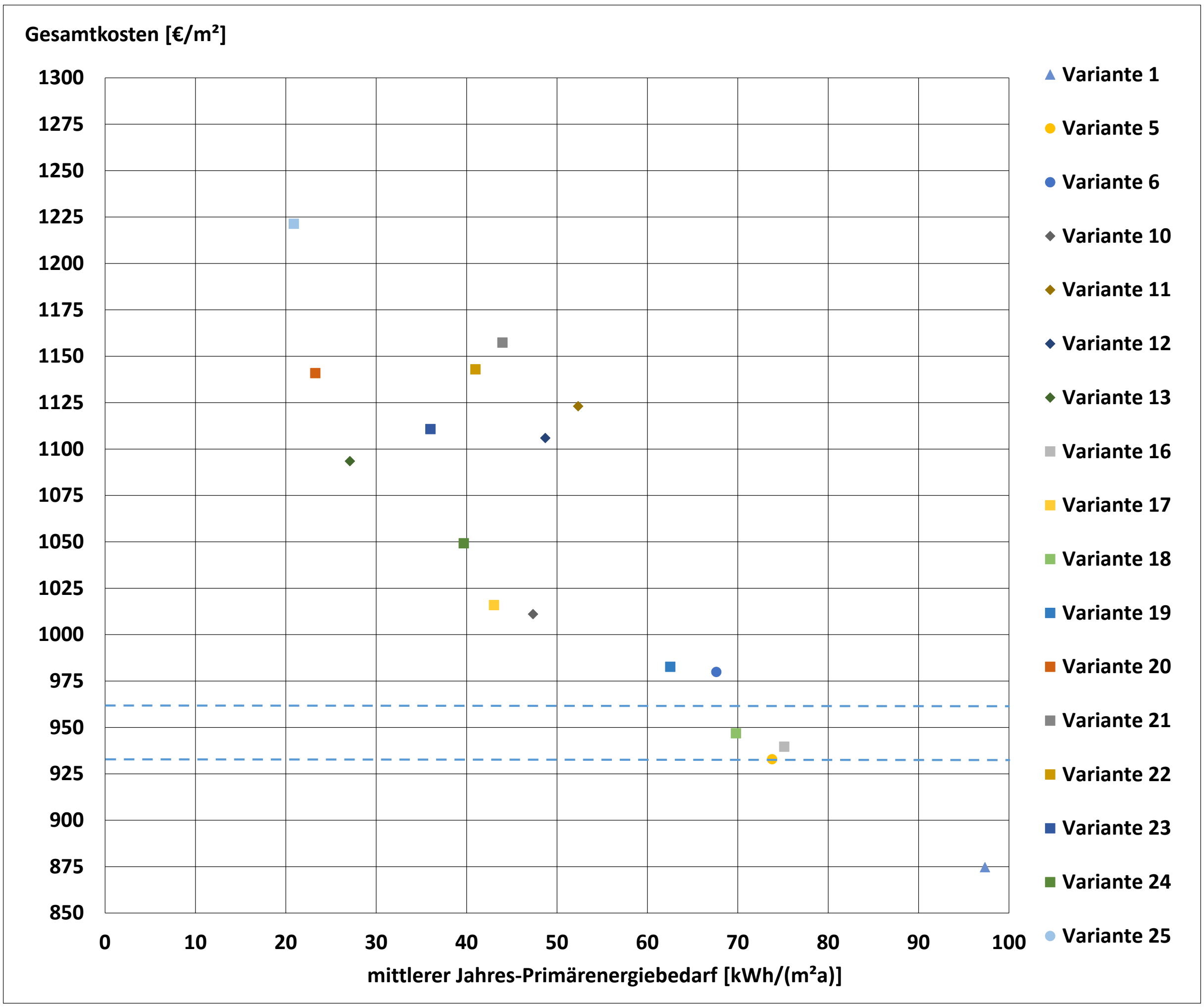

Figure 1: Cost-optimal calculation for the model building single-family house

Figure 2: Niedrigstenergiegebäude_Endabgabe_Abbildung 2.png

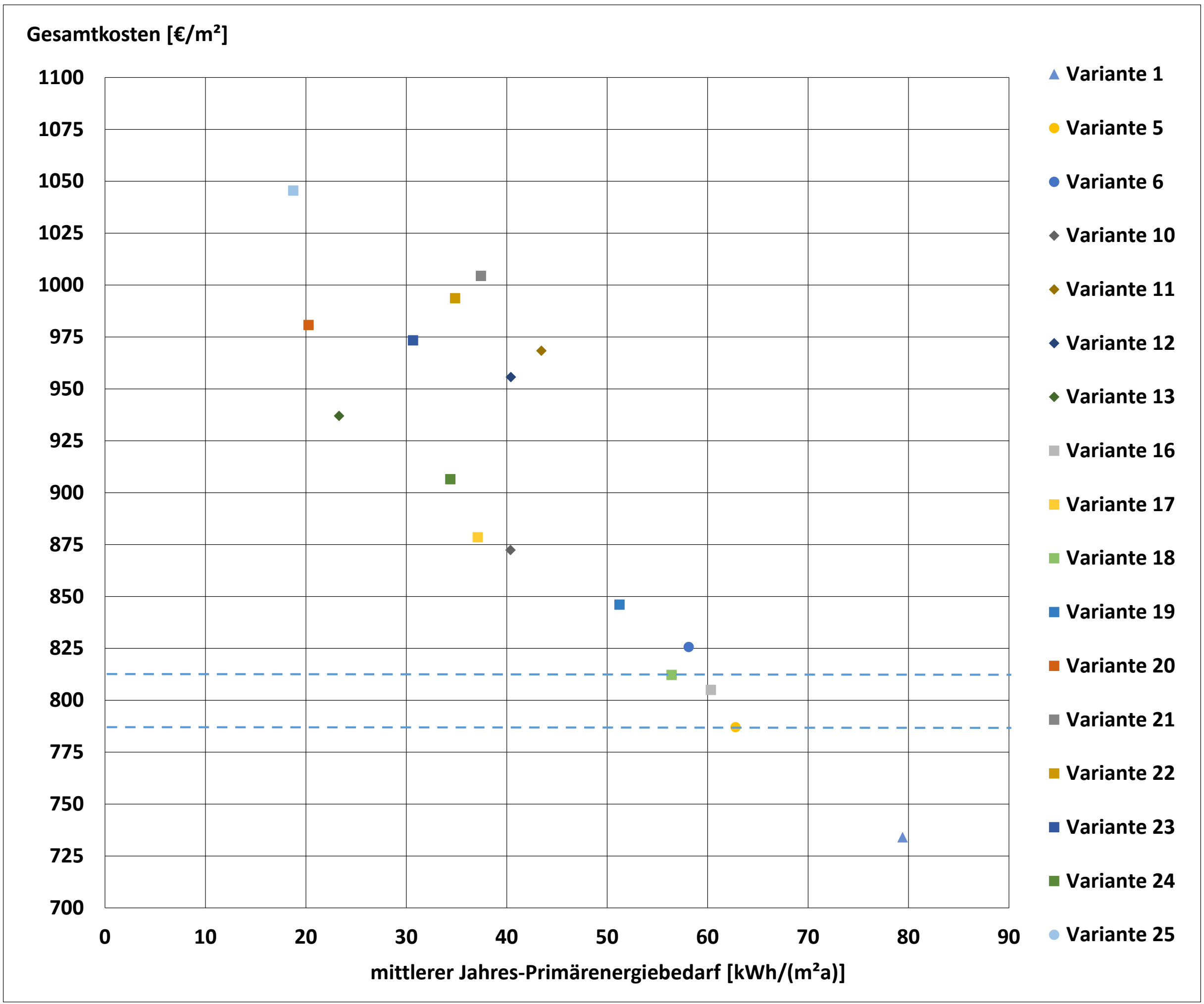

Figure 2: Cost-optimal calculation for the model building semi-detached house

Figure 3: Niedrigstenergiegebäude_Endabgabe_Abbildung 3.png

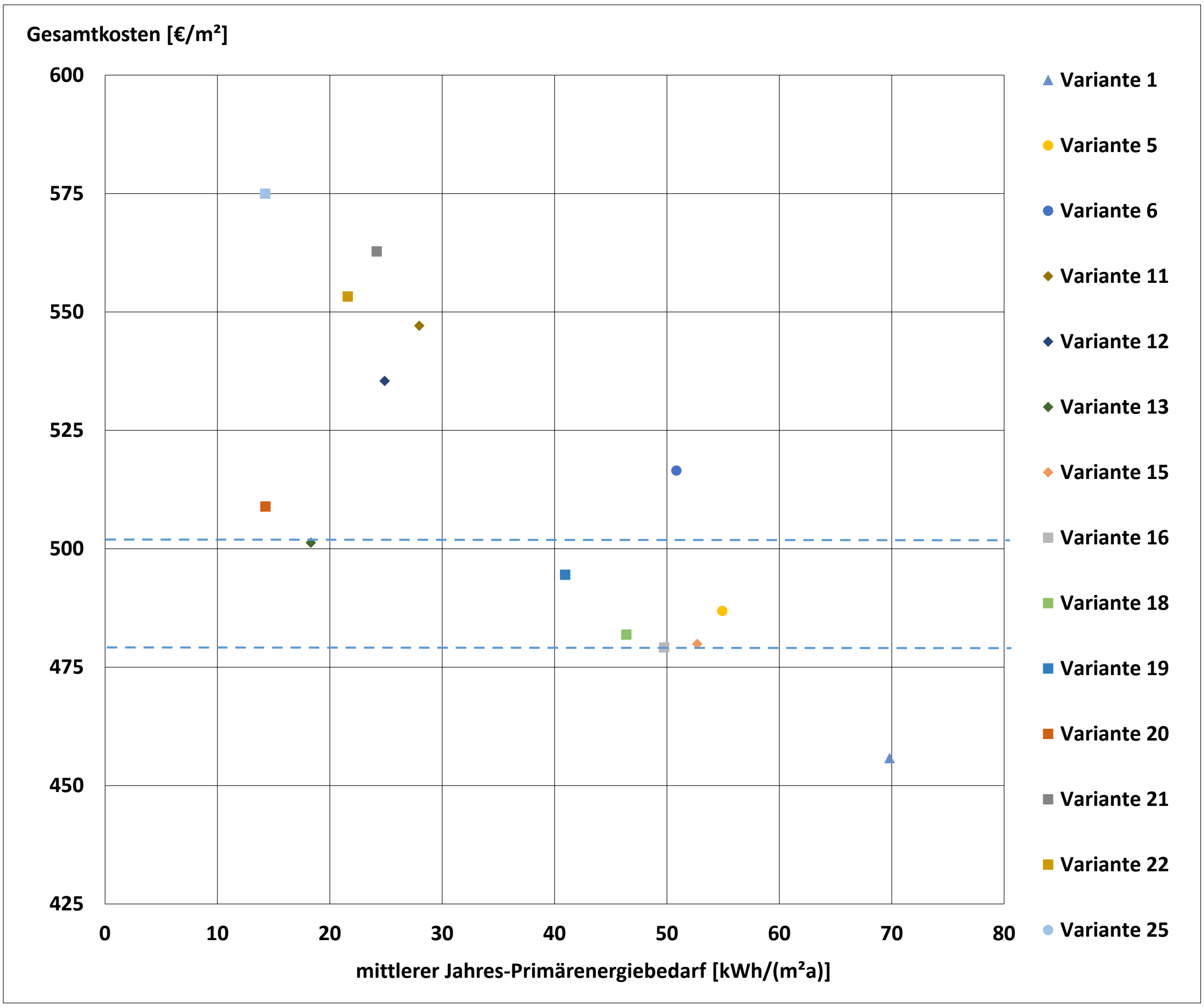

Figure 3: Cost-optimal calculation for the model building apartment building

Figure 4: Niedrigstenergiegebäude_Endabgabe_Abbildung 4.png

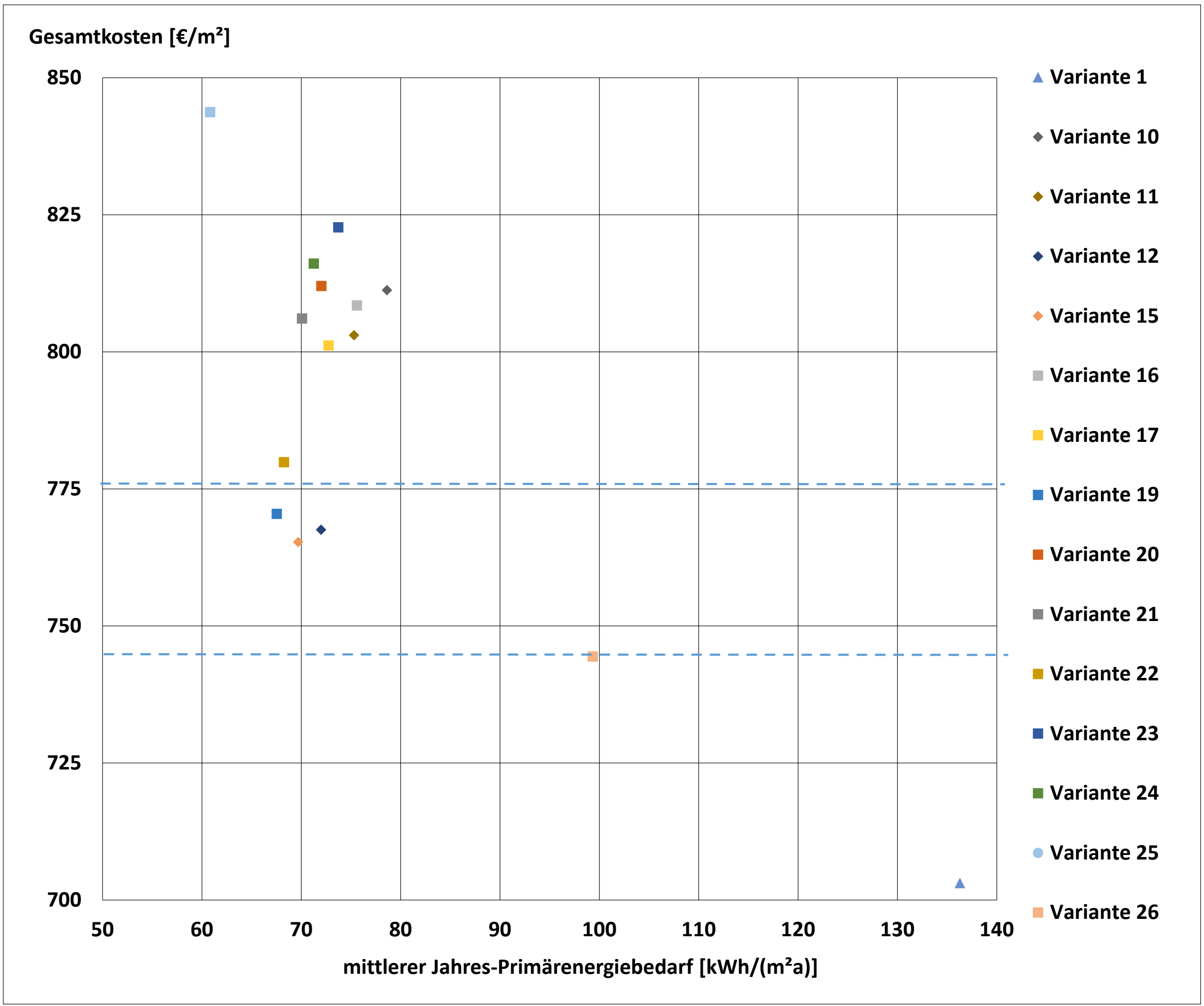

Figure 4: Cost-optimal calculation for the model building office

Figure 5: Niedrigstenergiegebäude_Endabgabe_Abbildung 5.png

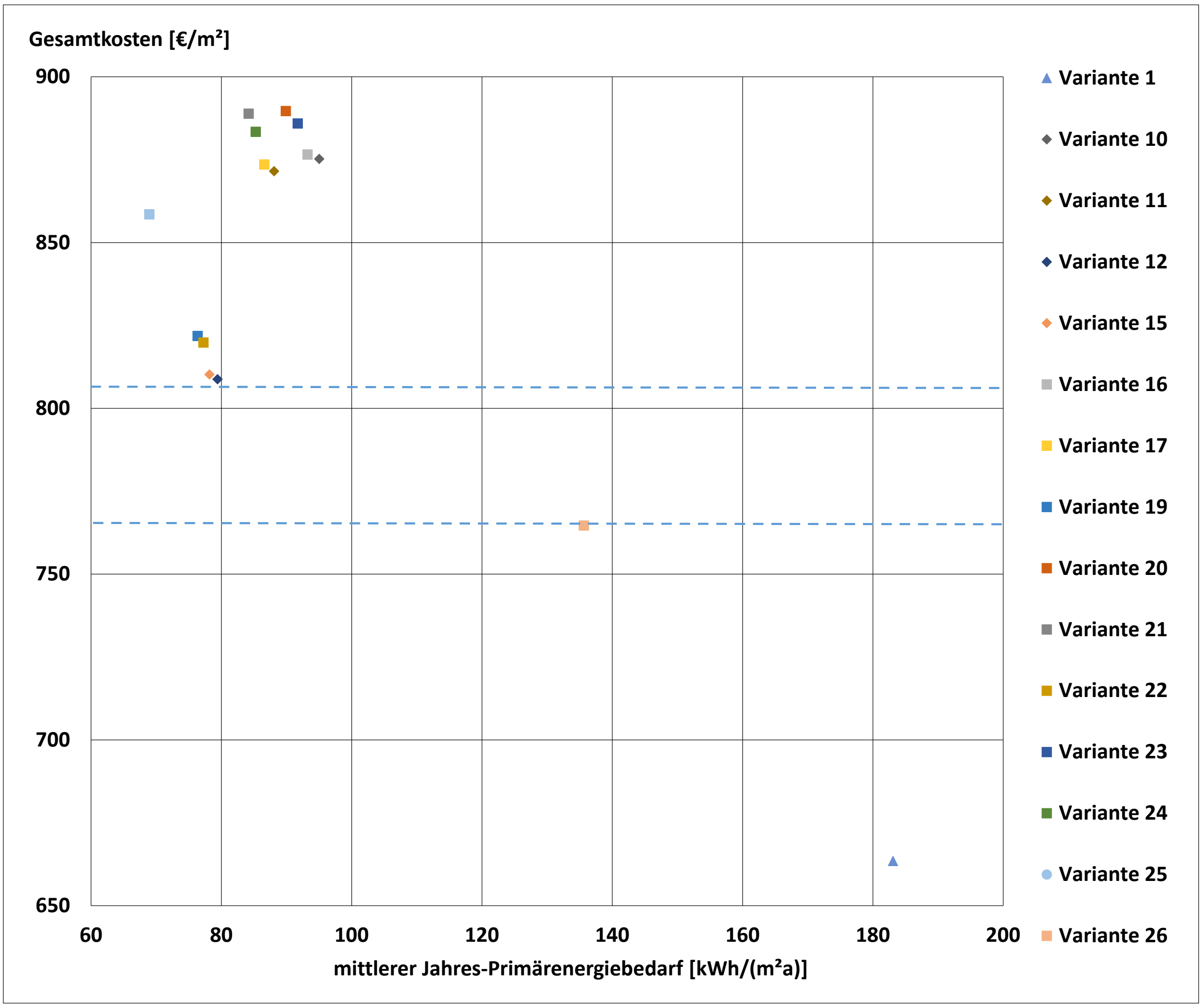

Figure 5: Cost-optimal calculation for the model building hotel