

## **Long-Term Economic-Ecological Assessment of Optimal Local Heat-Generating Technologies for the German Unrefurbished Residential Building Stock on the Quarter Level**

**Authors :** M. A. Spielmann, L. Schebek

**Abstract :** In order to reach the long-term national climate goals of the German government for the building sector, substantial energetic measures have to be executed. Historically, those measures were primarily energetic efficiency measures at the buildings' shells. Advanced technologies for the on-site generation of heat (or other types of energy) often are not feasible at this small spatial scale of a single building. Therefore, the present approach uses the spatially larger dimension of a quarter. The main focus of the present paper is the long-term economic-ecological assessment of available decentralized heat-generating (CHP power plants and electrical heat pumps) technologies at the quarter level for the German unrefurbished residential buildings. Three distinct terms have to be described methodologically: i) Quarter approach, ii) Economic assessment, iii) Ecological assessment. The quarter approach is used to enable synergies and scaling effects over a single-building. For the present study, generic quarters that are differentiated according to significant parameters concerning their heat demand are used. The core differentiation of those quarters is made by the construction time period of the buildings. The economic assessment as the second crucial parameter is executed with the following structure: Full costs are quantized for each technology combination and quarter. The investment costs are analyzed on an annual basis and are modeled with the acquisition of debt. Annuity loans are assumed. Consequently, for each generic quarter, an optimal technology combination for decentralized heat generation is provided in each year of the temporal boundaries (2016-2050). The ecological assessment elaborates for each technology combination and each quarter a Life Cycle assessment. The measured impact category hereby is GWP 100. The technology combinations for heat production can be therefore compared against each other concerning their long-term climatic impacts. Core results of the approach can be differentiated to an economic and ecological dimension. With an annual resolution, the investment and running costs of different energetic technology combinations are quantified. For each quarter an optimal technology combination for local heat supply and/or energetic refurbishment of the buildings within the quarter is provided. Coherently to the economic assessment, the climatic impacts of the technology combinations are quantized and compared against each other.

**Keywords :** building sector, economic-ecological assessment, heat, LCA, quarter level

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