USE OF URBAN SPACE TYPES FOR THE PLANNING OF CROSS-SECTORAL ENERGY GRID INFRASTRUCTURES

Wiebke GERTH[1]*, Eric SCHULZE BERGE[2]*, Marius GÜTHS[3], Markus Wolfgang ZDRALLEK[2]

Introduction

In order to solve the current problems of the German energy transition and achieve the greenhouse gas reduction targets by the year 2045, the transformation of the electricity, gas and heating sectors is an important starting point. To this end, the quarter approach is repeatedly taken up in various studies [1-3] and is taken into account in particular by political initiatives such as municipal heat planning or in the amendment of the German “Gebäudeenergiegesetz”. However, most studies only differentiate between building types such as multi-family houses or single-family houses. In addition, only the cases "holistically centralized" or "holistically decentralized" are considered for the construction of the energy supply infrastructure of the entire quarter or no specific procedure is provided on how to design a corresponding analysis for a given quarter. This article therefore presents a method that groups buildings in a quarter on the basis of urban space types (UST) and assigns a centralized or decentralized heat supply concept to these USTs based on the associated linear heat density.

Methodology

Definition of urban space types

UST is the term used in this contribution for units similar to urban morphology and is based on the UST presented in [4]. Using this approach, a quarter can be subdivided into different levels of consideration (several blocks, sections and parcels with buildings) in terms of urban development. Figure 1 shows schematically how the individual levels of consideration are defined.

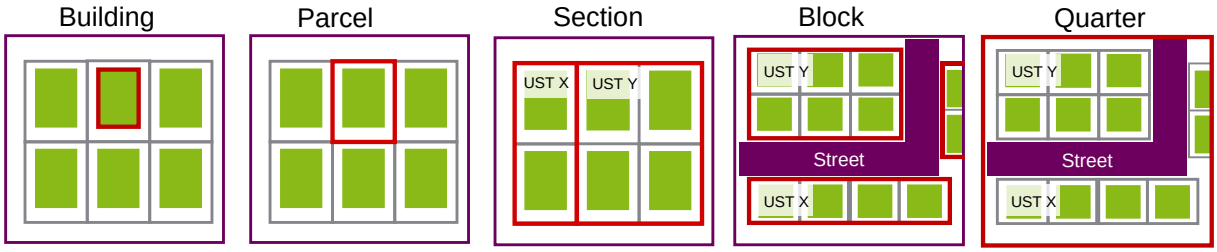

Figure 1: Schematic representation of the different levels of consideration.

Programming implementation

Various data on the buildings and parcels of land is required so that the quarters can be divided into different observation levels. Based on this, an analysis of the input data is carried out. Significant variables such as building type, number of full storeys and building floor area are taken into account. In order to be able to compare centralized and decentralized heat supply concepts, the determination of the area-related heat demand and the linear heat density is an important approach. The linear heat density is defined and calculated as the heat demand of all buildings in relation to the length of the corresponding street section.

[1] Institute of Power Systems Engineering, University of Wuppertal, Rainer-Gruenter-Str. 21, 42119 Wuppertal, Germany, +49 202 439 1194., +49 202 439 1977, gerth@uni-wuppertal.de, https://www.evt.uni-wuppertal.de/de/personen/detail/gerth/
[2] Institute of Power Systems Engineering, University of Wuppertal, Rainer-Gruenter-Str. 21, 42119 Wuppertal, Germany
[3] Stadtwerke Bielefeld GmbH, Schildescher Straße 16, 33611 Bielefeld, Germany
* Labeling of young authors

Results

The method was tested on five quarters, all of which have a different building typology. Figure 2 shows the results of two different quarters. On the one hand, the allocation of the UST at block level and the determined linear heat density are shown. It can be seen that quarter 2, which was assigned to UST 8, has a higher average linear heat density. In quarter 1, it can be seen that UST 1 has a lower linear heat density compared to UST 3 and is therefore more suitable for a central heat supply concept.

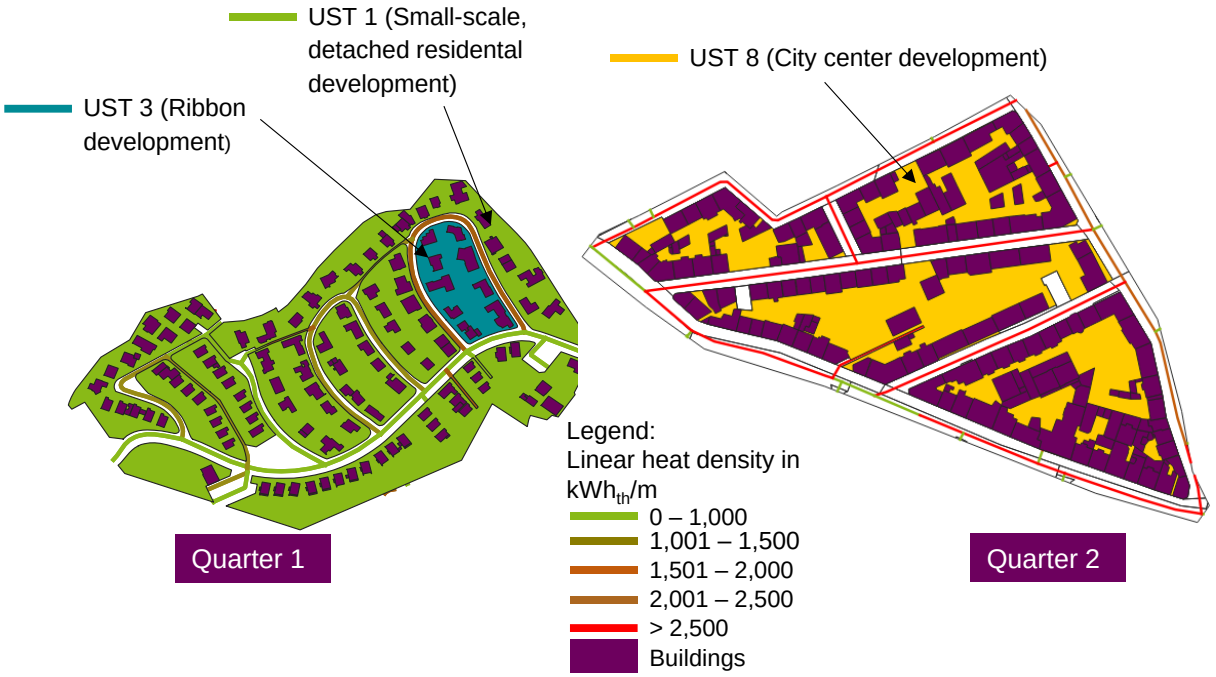

Figure 2: Representation of the block level, the linear heat density and the urban space types.

The grouping of buildings through the automated assignment of different USTs within a quarter offers the possibility to take into account the different connection and load densities as well as heat line densities per level of consideration and to compare centralized and decentralized heat supply concepts with each other. This approach allows different levels of consideration within a quarter to be evaluated separately or in conjunction with each other, either technically or economically. In addition, based on this targeted consideration of spatially connected buildings, operating resources to cover the heat supply can be determined and a cross-sectoral energy infrastructure can be planned.

Acknowledgment

The presented work in this publication is based on research activities, supported by the State of North Rhine-Westphalia. The Funds are based on the directive for granting funds from the "Programm für rationelle Energieverwendung, Regenerative Energien und Energiesparen (progres.nrw) - Programmbereich Klimaschutztechnik". The described topics are included in the research project "NeuPlan". Only the authors are responsible for the content of this paper.

References

[1] Rezaei, B. Samadzadegan, H. Rasoulian, et al., "A New Modeling Approach for Low-Carbon District Energy System Planning," Energies, vol. 14, no. 5, p. 1383, 2021.

[2] T. Riedlinger, P. Wintzek, B. B. Wierzba and M. Zdrallek, "Cross-sectoral planning of energy grids in development areas with different heating concepts," PESS 2020; IEEE Power and Energy Student Summit, Online, 2020, pp. 1-6.

[3] D. Schmidt et al. 'Development of an innovative low temperature heat supply concept for a new housing area'. In: Energy Procedia 116 (2017), pp. 39–47.

[4] J. Dettmar, C. Drebes, S. Sieber, (Hrsg.) (Fraunhofer IRB Verlag, 2020) "Energietechnische Stadtraumtypen" Strukturelle und energetische Kennwerte von Stadträumen.