IDENTIFICATION OF TYPICAL ENERGY GRID STRUCTURES BY CROSS-SECTORAL CLUSTERING

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Content

In order to further develop distribution grid infrastructure in a future-proof manner, urban grids in particular are facing the challenge of increased electrification of the transport and heating sectors and thus an infrastructural change in the energy grids. Due to the future coupling of the different energy sectors, it is important to ensure corresponding sustainability through cross-sectoral analyses and grid planning. Therefore, a joint consideration of electricity and gas distribution grids in particular is indispensable in the future. Publications such as [1-5] already describe exemplary data sets, but only in the area of electricity grids. Thus, this contribution analyses cross-sectoral distribution grid structures for electricity and gas grids of an urban distribution system operator. The contribution extends the analyses and results from [6], in which urban electricity distribution grids were identified on the basis of extensive data sets, and contrasts them with the gas grid for one grid area. The cross-sectoral clustering superimposed on the cross-voltage level clustering carried out in [6] then serves, among other things, to estimate the effects of progressive electrification on gas grids and cross-sectoral grid planning, taking into account commercial market and geodata according to [7].

Methodology

Methodologically, the clustering for low- and medium-voltage grids (LV and MV grids) from [6] is used. Since this contribution deals with the same grid area as well as a uniform clustering method is to be ensured, the methodology described in [6] is also used for gas clustering and applied to low- and medium-pressure gas grids. The parameters “connection density” as building connections per kilometre and “load density” as metering points per building connection are therefore deduced for the gas clustering, which are composed of the pipe lengths, building connections and metering points per assumed supply area of the gas pressure regulating and metering stations in the gas grid. The assumed supply areas are determined by means of an area analysis with Voronoi cells in order to approximately assign a gas grid to a gas pressure regulating and metering stations. Finally, a regionalisation of heat pump (HP) scenarios for the grid area is carried out and effects on the electricity and gas grids are analysed.

Results

As a result of the clustering, Figure 1 shows how the respective LV grids, differentiated by the colour according to their clusters, (points) are distributed in the gas grids which are also differentiated by the colours according to their clusters (polygons). It is clear that LV clusters 6 and 10 are mainly located in gas clusters 1, 6 and 7. In addition, the regionalisation of HPs for the year 2050 in the progressive scenario [8] shows in Figure 2 that most HPs are expected in gas clusters 1, 6 and 7.

In principle, this shows that in addition to the correlation between the MV and LV level according to [6], the gas grids also have a similar structure to the electricity grids. Furthermore, the regionalisation of HPs in certain electricity and gas clusters has an increased share with perspective effects on the respective energy grids, so that the substitution of gas heating by electric HPs reduces the energy sales in the gas grid.

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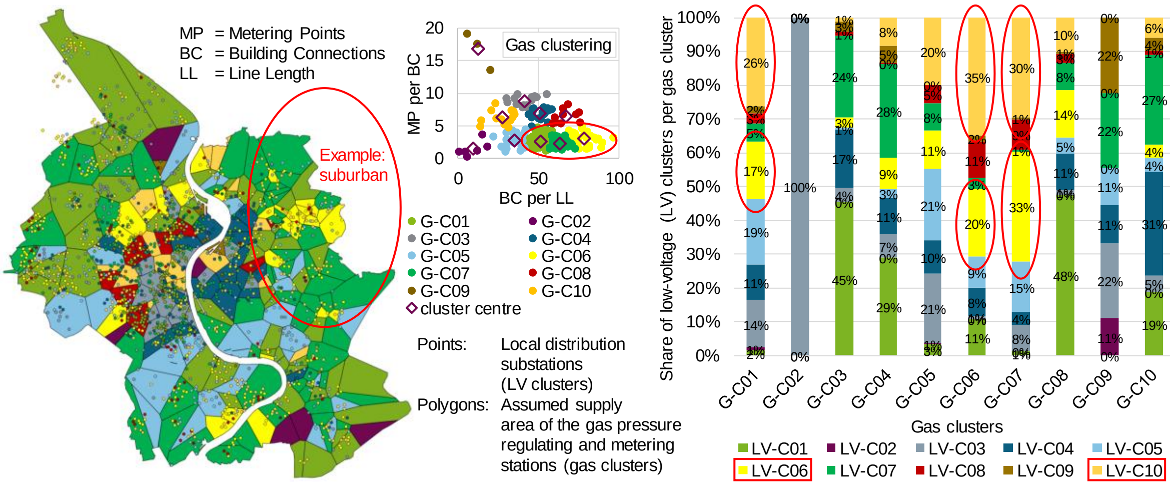

Figure 1: Representation of the low-voltage clusters per gas cluster

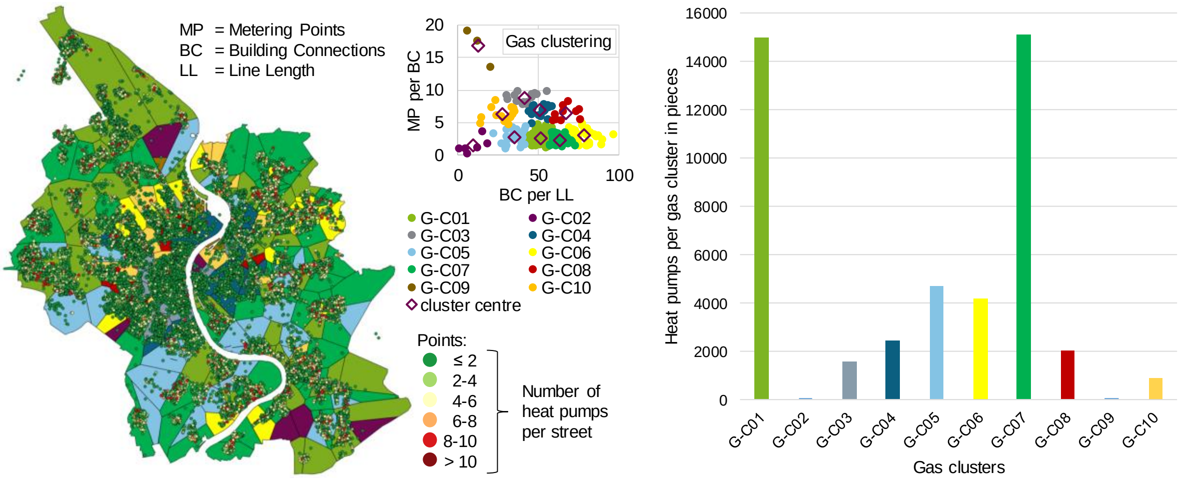

Figure 2: Representation of the number of heat pumps in the respective gas cluster

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