# Heat Load Profiles – A Key for Unlocking Renewable Heating Systems Potential

*In the context of IEA SHC Task 64: Solar Process Heat, researchers developed a method to estimate the heat load profiles of companies in industry and commerce to facilitate preliminary designs, feasibility assessments and potential studies on renewable heating systems.*

When planning a conventional heating system, the knowledge of the expected peak load alone is sufficient in many cases. However, since the availability of renewable energy varies during a year, the need for detailed information on the shifting heat demand in line with the targeted share of renewable heat is essential for preliminary design, feasibility assessment or potential studies on renewable heating systems. While there are several methods available to estimate the expected load profiles of residential buildings, little is known about the load profiles in the industrial and commercial sectors, especially when they have a higher share of industrial process heat to overall heat demand. To fill this knowledge gap, German utilities provided almost 1,000 profiles in hourly resolution of natural gas consumption from industrial and large commercial, residential and public consumers (> 1.5 GWh/a). Using this database, the overall goal is to develop a method to predict the load profile, depending on the ambient temperature, for large companies from industry and commerce, as well as large public facilities like schools, gyms and swimming pools.

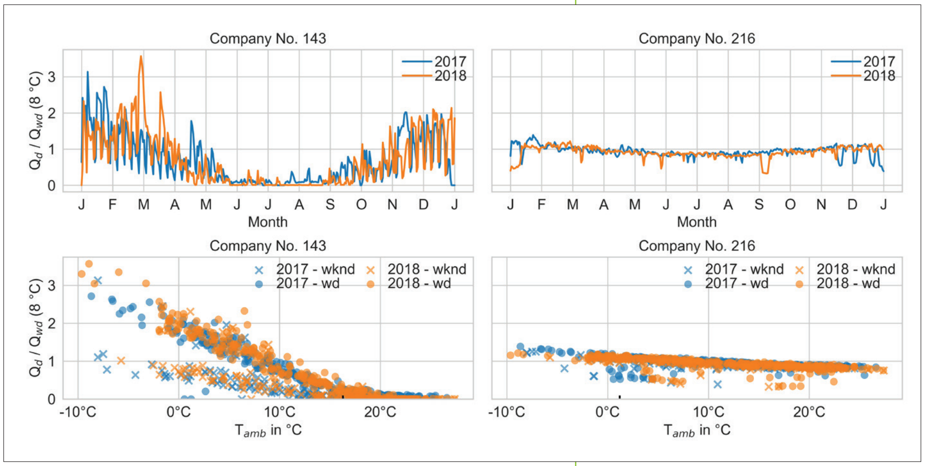



**Figure 1. Yearly profiles of daily gas consumption and daily gas consumption depending on ambient temperature for two consumers. Heat demand is normalized to mean heat demand on days with an average ambient temperature of 8 °C. (wknd: weekend or official holiday; wd: working day).**

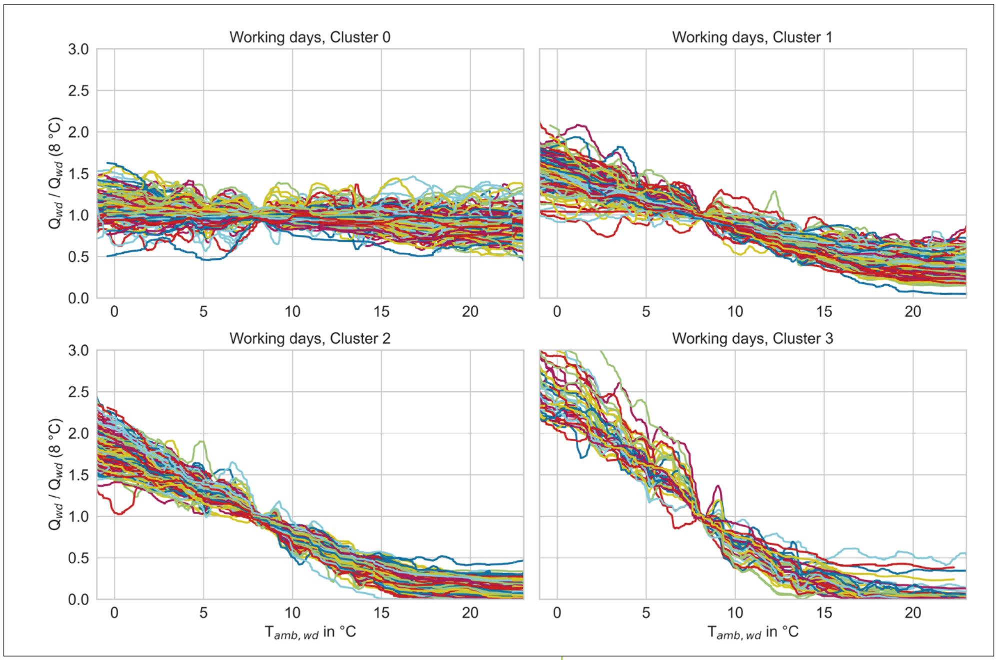
Ambient temperature has a major influence on space heating demand, and the heat demand of many industrial processes is dependent on the ambient temperature. For instance, drying processes or surface treatment processes often use heated ambient air. Several other parameters like holidays, degree of capacity utilization and type and operation of heat generators also influence the heat demand, but predicting them is difficult. Nevertheless, for most of the gathered profiles, the influence of parameters, besides the ambient temperature, seems minor, especially when the daily heat demand is considered separately for working days, weekends and holidays.

The load profiles are clustered by their dependency on ambient temperature using a machine learning algorithm (K-Means). With four clusters, the analysis shows a good compromise between accuracy and a manageable small number of clusters. From cluster 0 to cluster 3, the dependency on ambient temperature continuously increases. For consumers in cluster 0, gas consumption is roughly the same on every working day of the year, making this cluster especially appropriate for a high share of solar thermal heat supply. In the case of the ambient temperature dependent clusters, the summer load decreases from cluster 1 to 3. While for cluster 1, a significant amount of heat could still be supplied by a solar thermal system with a storage capacity ranging from hours to a maximum of one day, solar heat generation without seasonal storage can only have a minor impact in clusters 2 and 3.

*continued on page 13*

## Heat Load Profiles *from page 12*

The share of the different clusters found within a specific industry sector shows that some subsectors like the production of food products or beverages are dominated by a process heat demand that is not dependent on the ambient temperature. For consumers within some other subsectors like the manufacturing of computer, electronic and optical products or the manufacturing of electrical equipment, almost all consumers show a dependency on the ambient temperature.

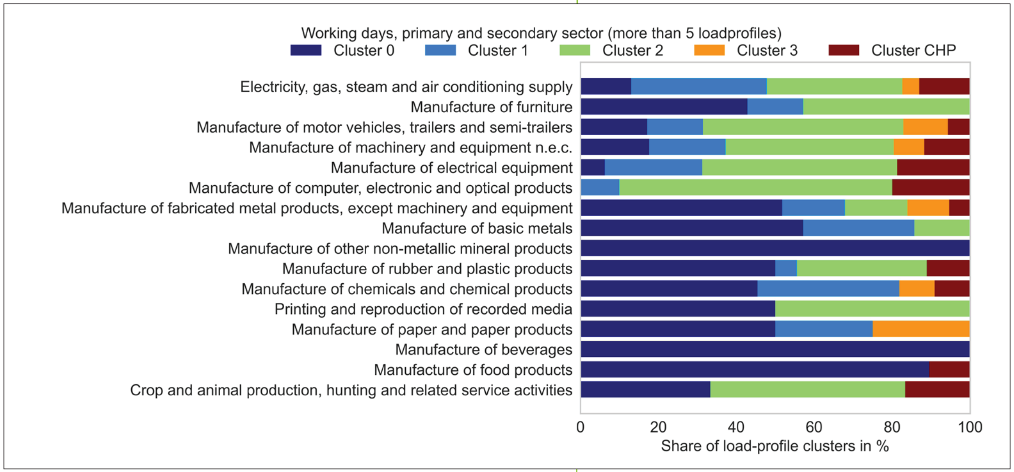



▲ **Figure 2. All load profiles in the four working-day clusters. To keep the figure clean, only the moving average (and not the daily heat demand as a scatter plot) for each consumer is illustrated.**

The correlation between ambient temperature and heat demand will be captured in a regression analysis. Finally, the hypothesis that the dependency on ambient temperature is similar for consumers within a particular subsector located all over the world will be tested using international heat demand profiles provided by IEA SHC Task 64 participants. In subsectors where this hypothesis can be verified, a transferability of the regressions to locations across the globe will be given.

Within IEA SHC Task 64, the load profile regressions in conjunction with defined temperature levels will be used to define reference applications for integrated energy systems at various international locations. In a simulation study, the influence of the location on, for example, the system design or the economically achievable renewable energy share will be investigated for each of the defined reference applications at the beginning of 2021. Eventually, this will mark an important step towards facilitating global comparability and transferability of integrated energy systems.

▼ **Figure 3. Share of the four clusters within the primary and secondary sector for different subsectors (only subsectors with at least 5 consumers are illustrated). Some load profiles could be assigned to a CHP and were excluded from the cluster analysis.**




*This article was contributed by Mateo Jesper and Felix Pag of the University of Kassel, Germany. Felix Pag leads Subtask A of SHC Task 64: Integrated Energy Systems. For more information, visit the Task 64 webpage, https://task64.iea-shc.org, or contact pag@uni-kassel.de*