Executive Summary

In order to reach the climate targets set by the EU as well as the Austrian government, a drastic reduction in greenhouse gas emissions is necessary. Heat pump-based heating systems make considerable emission savings possible by using environmental energy sources. However, this technology requires a sufficiently large capacity of the heat source used. The exploitation of sufficiently large heat source capacities, particularly in urban areas, poses a major challenge. The aim of this study is to develop as well as techno-economically evaluate solutions for the heat supply in existing multi-storey residential buildings in which several local heat sources are used to cover the heat demand (so-called ‘multivalent’ systems). This is demonstrated for two exemplary Test-Case buildings. From the analysis of the Test-Case buildings, the aspects that determine the transferability of the proposed solutions are deduced and generalised and practical recommendations for other existing residential multi-storey buildings are derived.

The survey of the demand to be covered and the available capacities shows in both Test-Case buildings that the heating demand could even be covered using only one available heat source (via a ‘monovalent’ system). Both monovalent and multivalent (several heat sources) system solutions are therefore considered for the proposed system variants and evaluated in terms of their costs. For the property located in Dianagasse, a combination of geothermal energy with probes on the property's own land and air source heat pumps is proposed, with the alternatives being a system consisting of air source heat pumps only or a system containing a geothermal heat pump only with probes on the property's own land as well as in the road (the road being a public good). Hot water is generated either via fresh water stations, small heat pumps or electric storage tanks. It emerges that the investment costs of the monovalent air source heat pump systems are lower and those of the monovalent geothermal heat pump system are higher than those of the multivalent system variants. In terms of the annual costs for energy, maintenance and repair, the variants that work with a higher share of geothermal energy, operate at lower system temperatures or produce hot water decentrally using small heat pumps are cheaper. For the property located in Gerlgasse, a solution with a combined system of air and geothermal heat pumps with probes on private land, a solution with air heat pumps only and a solution with a geothermal heat pump only with probes on private land and the road (again, a public good) are proposed. Regarding investment costs, the monovalent air source system is again cheaper and the monovalent geothermal source solution again more expensive than the multivalent solution. A look at the annual energy, maintenance and repair costs of the different variants shows that system solutions with an electric storage tank for hot water production are more expensive than those with a fresh water station or a small heat pump. The annual energy, maintenance and repair costs of the various variants in this Test-Case depend strongly on the type of hot water production system. In total, the monovalent solutions presented for the Test-Cases perform better in terms on annual total costs than their multivalent counterparts.

Drawing on the results of the current study, readers are advised to first and foremost exploit the potential for the improvement of the thermal properties of the building envelope, which makes it possible to operate the heating system at lower flow temperatures and thus makes the use of heat

pumps possible and efficient. Furthermore, a smaller heating demand allows for lower heat source capacities and reduces the space required to tap local heat sources. Dynamic building simulation can be used to determine the necessary heating system capacity and heating demand, providing a more realistic estimate and usually resulting in lower values for heating power and heating demand. With the consent of the building owners, the heating load design can also be optimised by designing the heating system for higher outside temperatures than the standard outside temperature ('Norm-Außentemperatur') specified in the ÖNORM standard, or by assuming that exterior walls adjacent to neighbouring buildings are adiabatic (no heat loss to neighbouring buildings), thus avoiding unnecessary oversizing of the system. However, particular attention must be paid to the control system. Multivalent systems offer the advantage of greater flexibility in terms of how the existing heat generators are used. By analysing the heating requirements for heating and hot water production and the efficiency of the various heat generators, the available heat generators can be prioritised according to the operating mode in order to achieve the highest possible system seasonal performance factor. In addition, multivalent systems offer greater system resilience due to the availability of multiple heat generators. In practice, however, the higher cost of higher-level system control still represents an obstacle.