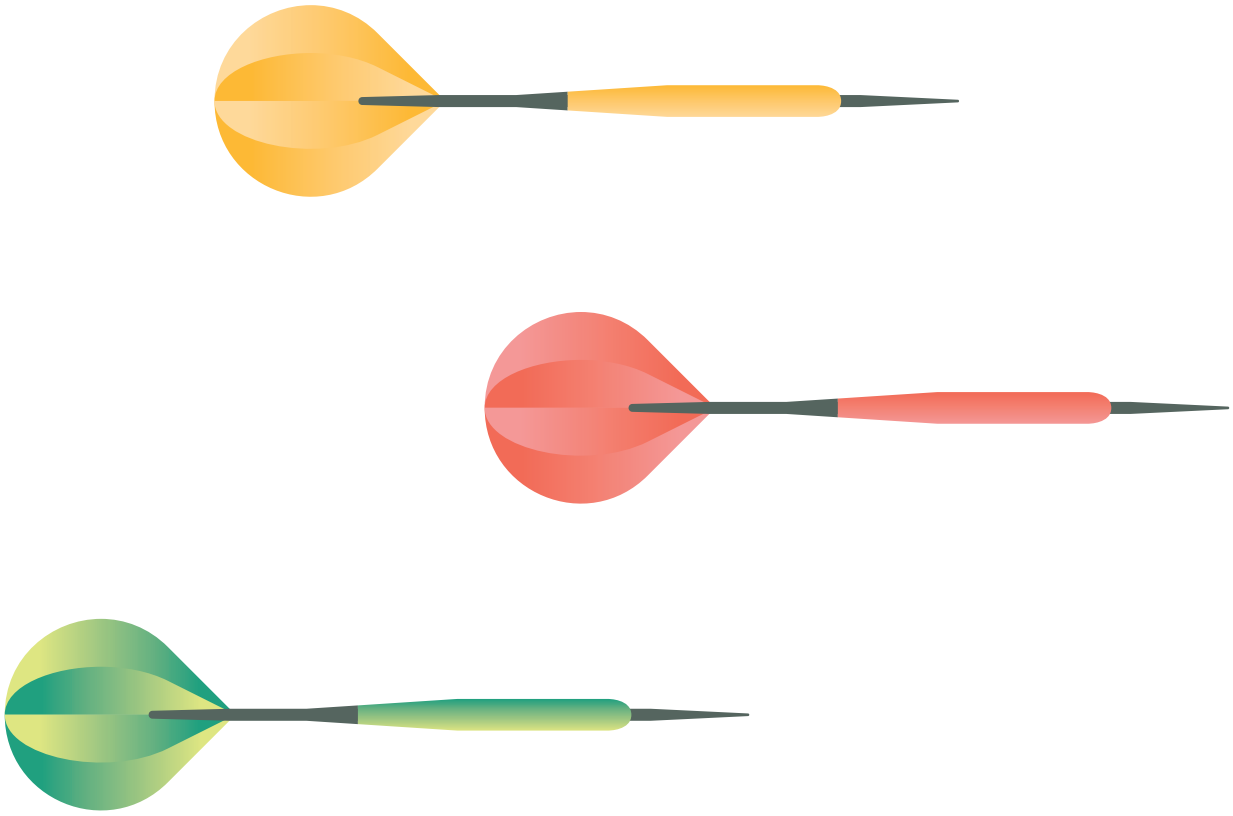
Rödl & Partner

Die Wärmezielscheibe

The Heat Target

„Limiting the risks from global warming of 1.5°C in the context of sustainable development and poverty eradication implies system transitions that can be enabled by an increase of adaptation and mitigation investments, policy instruments, the acceleration of technological innovation and behaviour changes (high confidence).“

Intergovernmental Panel on Climate Change (IPCC), 2018



Executive Summary

This concept paper deals with the status quo of the heating sector, possible developments and technologies in this sector in 2050 and presents the corresponding key findings and recommendations for the decision-makers from politics and the utility industry. It analyzes today's heating sector and discusses the most important future technologies. The investigations focus on today's heating sector, the heating sector in 2050 and the transformation that has to be implemented between now and then. Building on this, we conceptualize the heat target ("Wärmezielscheibe"), on the basis of which comprehensive strategies for the heat transition can be developed. On this basis, we can finally draw the most important findings and offer advice to the utilities. The key conclusions and statements of the four core chapters of this paper are set out below in the form of 20 theses:

Heating sector

1. The heating market is the sector marked by the highest final energy consumption rate and slowest progress in decarbonization. The reduction in end heating demand on the one hand combined with increased departure from predominantly fossil-based sources of energy on the other hand have immense potential for reducing CO_2-emissions. Additionally, it is possible to reduce the dependency on imported fossil fuels and sustainably enhance local value chains.

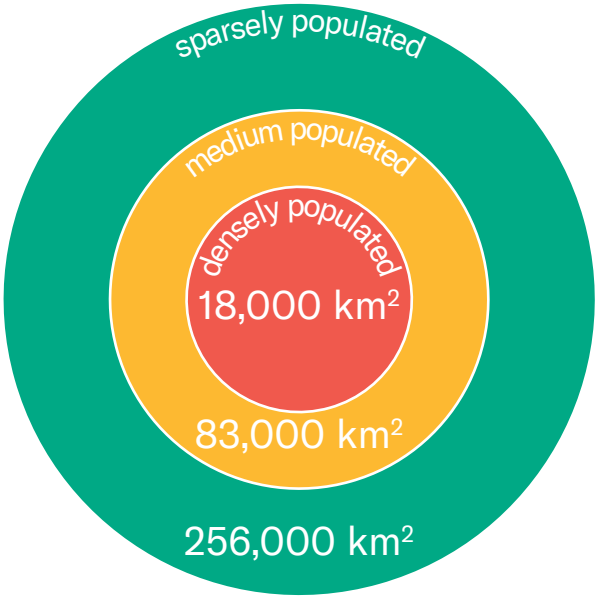
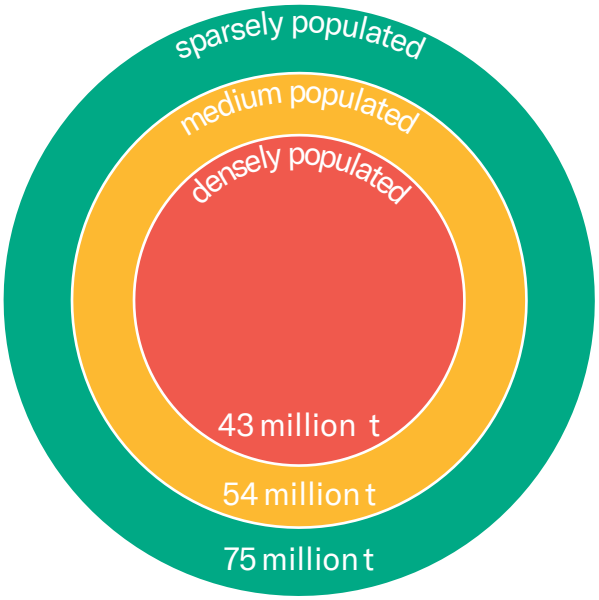
2. The supply of heat in Germany today is largely decentralized (approximately 90 percent), but district heating will play a significant role in the heating sector of tomorrow.

3. So far, no substantial progress either in efficiency or in the usage of renewable energies has been made. The share has been around 11 percent for years and should be increased in the long term through extensive investments. Generally it is assumed that a decrease in energy demand is possible, yet estimates widely vary. If the current trend continues until 2050, a decrease in heat demand of only 25 percent will be reachable. For the pursued target of reducing CO_2-emissions by 80 percent, the savings should be a minimum of 38 percent.

4. Using the heat-specific degrees of urbanity ("Urbanitätsgrad"), which correlates with heat density – heat demand per square meter – and the settlement types, the heat, cooling and hot water demand can be divided into three different segments. The three identified segments consist of densely, medium and sparsely populated areas. Densely populated areas are characterized by a high degree of heat density and can be found in conurbations. Sparsely populated areas are rural communities or peripheral regions of larger cities. In Between there are medium populated areas. The distinction between the three is fluid.

5. When analyzing the three areas, it appears that 30 percent of heat demand arises on just 5 percent of the area, the densely populated area. In the future, due to effects such as rural exodus and suburbanization, the densely and medium populated areas will increase in importance. In 2050, 70 percent of energy consumption will be in these two areas. The (gross) revenue-based market volume in densely populated areas is EUR 20 billion per year, in medium populated areas EUR 16 billion.

Distribution of area and CO2-emissions in Germany (2020)

Area	CO_2-emissions
	

Technology

6. Energy generating technologies to be used in the future heat market can be divided into efficiency improvement technology, cross-sectoral technologies and renewable heat generating technologies. To evaluate the future role of the technologies in the energy market, it is necessary to analyze aspects such as space or land usage requirement, local availability, CO_2-emission, as well as economic aspects such as investment and operating costs. Besides generation, heat distribution using district heating systems and storage of thermal energy play an integral role.

7. Cogeneration from thermal waste treatment and industrial waste heat is classified as efficiency improvement technology. It is particularly suitable for areas characterized by high heat density – i.e. densely and medium populated areas. For those technologies the following observations can be made:

   - Cogeneration based on fossil fuels plays a key role in today's supply of electricity and heat. However, if one is not able to successfully supply clean synthetic gas on a large industrial scale, cogeneration represents a bridging technology. The maximization of the replacement of conventional fuels with clean synthetic gas is pivotal and essential for the future energy mix.
   - The thermal waste treatment in Germany should be restructured to cover residential waste treatment and the use of thermal energy for the supply of heat, and cooling energy should be given priority.
   - The prioritization of the usage of emitted waste heat in industrial processes is of great importance for the future energy system. Estimations of the potential use differ in a great variety. Nonetheless, even under conservative assumptions, they are enormous.

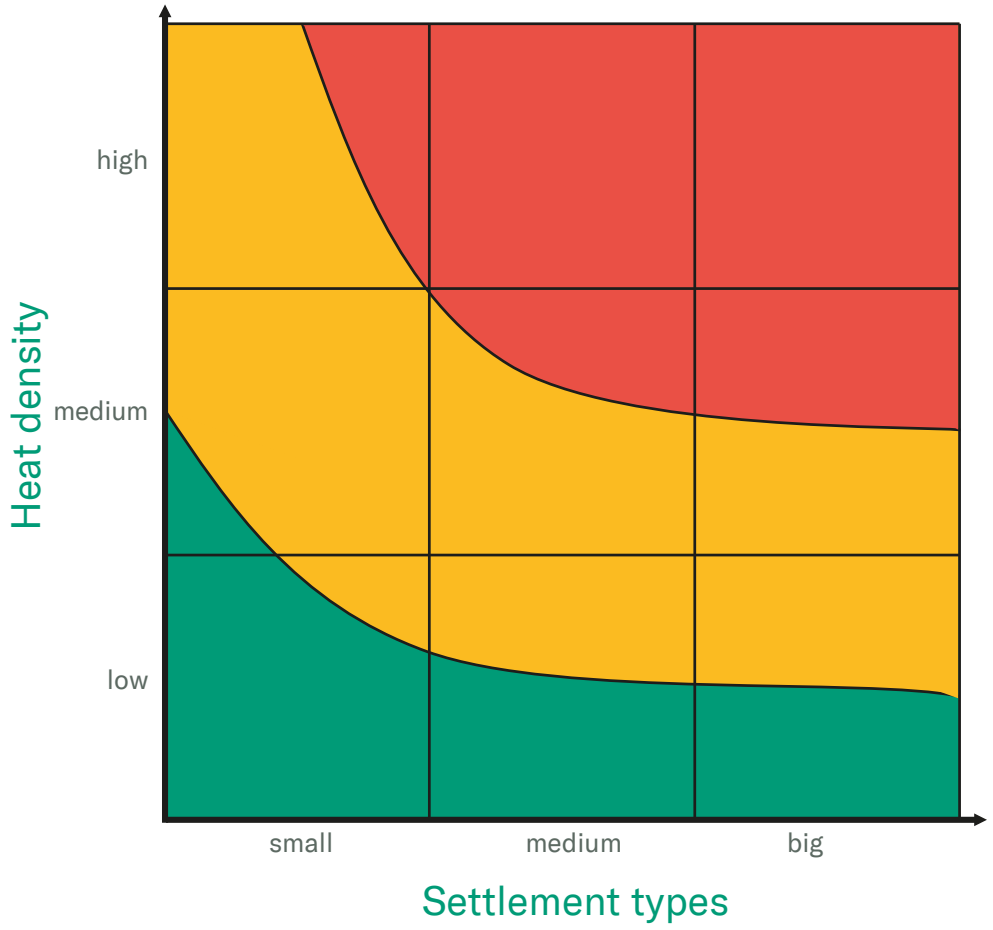
8. With an increasing share of renewable energies used in electricity generation, sustainably generated electricity can potentially be an important contribution to the supply of heat in Germany. For the interconnection of the sectors, there are different technologies available, such as Power-to-Heat, heat pumps and Power-to-Gas. To increase the market readiness of Power-to-X, it is essential to adjust the legal framework. All cross-sectoral technologies require a massive increase in sustainable electricity generation and therefore distribution grids should be modernized.

   - Power-to-Heat plants can be used on an industrial scale to supply heat to district heating grids. The efficiency is well above the 90th percentile.
   - Power-to-Gas plants can, depending on system combination, produce hydrogen or methane, which can be distributed partly (hydrogen up to 10 percent) or completely (methane) via the existing gas grids. However, the losses along the process chain are substantial. Power-to-Gas is reasonable where the use of fluctuating electricity does not show higher potential.
   - Heat pumps enjoy a strong market position especially in the construction of new buildings. They could enable covering the future heat supply in sparsely populated areas. For densely populated areas, the efficiency of this resource is relatively low.

9. For the renewable heat generation, the use of deep geothermal energy, solar thermal energy and biomass technologies is very promising.

   - Theoretically, the potential of deep geothermal energy is inexhaustible. At first, the favorable geological areas, where the use of hydro-geothermal technologies is possible, should be extended. In the medium to long term, geothermal energy has the potential to ensure the supply of heat in densely populated areas.
   - Availability of and demand for solar thermal energy differ daily as well as seasonally. This is why for an optimal utilization of solar thermal, suitable heat storage is essential. The area-specific energy output is comparatively low, for industrial-scale plants, open space is needed. In densely populated areas, space is limited or cost-intensive due to residential construction. Solar thermal energy in combination with storage solutions is an option for medium and sparsely populated areas.
   - Different types and sources of biomass can be distinguished. The future heat supply should not be based on biogenic solid fuels or biogas produced from wood and crop plants, these should be used in fields that rely on high temperatures. In particular, the road, railway and air transport sector. On the other hand, biogenic waste should locally replace fossil fuel applications.

Heat-specific degree of urbanity subject to heat density and settlement types



densely populated

medium populated

sparsely populated

The Heat Target – conclusions

10. The Heat Target concentrates on the area where fast progress in efficient decarbonization can be achieved. The Heat Target divides the heating market into densely, medium and sparsely populated areas, resulting in a shape of three different ring-like areas. The densely populated area forms the center. In these densely populated and small spaces, it is possible to achieve fast and efficient reduction in CO2 emissions.

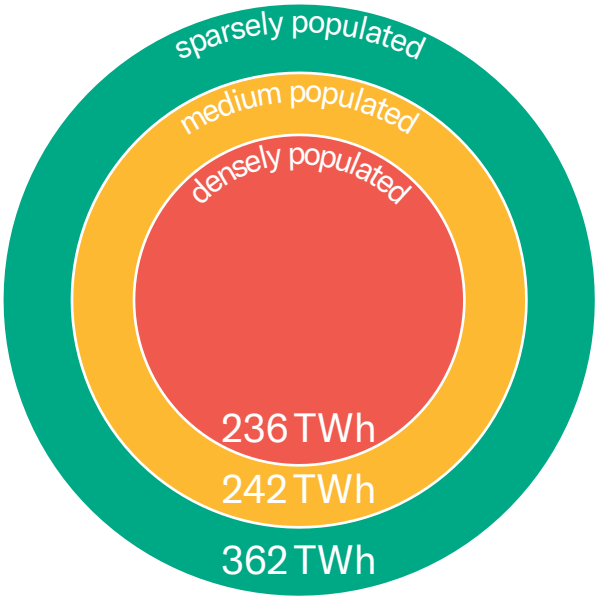
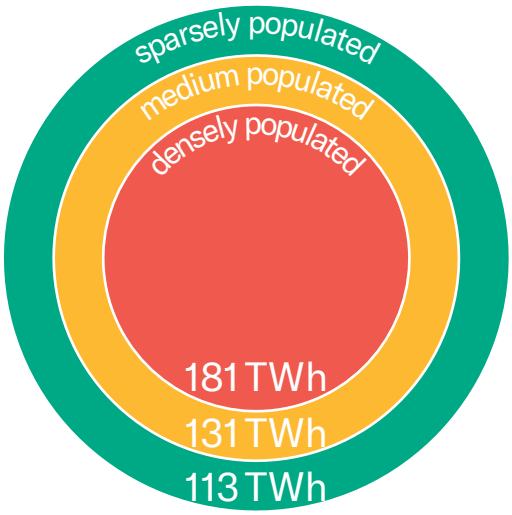
11. Based on The Heat Target two important findings can be derived: firstly, priorities for the heating market can be set. Secondly, each of the three rings requires different actions, operators, technologies and political incentives. Depending on whether an area is densely, medium and sparsely populated, the heating market requires different incentives for economic solutions and strategies to be optimal. The Heat Target serves as a means for the classification of the entire heating market, local heat utilization concepts, and the development of sustainable business models for the utility industry.

12. Densely populated areas, especially metropolitan regions in major cities and partly in mid-sized towns as well, can be decarbonized with an extensive expansion of the CO2-neutral fueled district-heating grid. This will require increasing efficiency of buildings and thus a lower return flow temperature. This is a fundamental decision for an efficient and enforced use of waste heat from waste treatment, industrial processes, the services industry, deep geothermal energy, solar thermal energy and the substitution of carbon cogeneration.

13. All discussed technologies have their individual advantages and respective justifications for existence. All of them are necessary for the successful heat transition and for achieving the climate trajectories. An analysis of the local and structural circumstances is necessary so that the suitable technology solution can be selected. It is important that the technologies do not cannibalize each other, but are rather applied in cases where requirements related to the degree of urbanity are met. Therefore, each technology will have their suitable market segment with a sufficient market volume.

14. It is necessary to eliminate market barriers for central technologies – especially in the center of the Heat Target. For example, the risk involved in structuring industrial waste heat contracts between industrial companies and consumers as well as the issue of different requirements for the utility industry and the private sector has to be recognized and mitigated. Deep geothermal investors should be hedged during the first phase as it involves high risk and high investment. Lastly, the Power-to-X-Technologies should be relieved from the power levy (e.g. EEG-Umlage).

Distribution of the heat demand in 2020 compared to 2050

2020: 840 TWh	2050: 425 TWh
	

Action recommendation for suppliers

15. The majority of public utilities and energy suppliers have recognized the fact that they should make changes. However, politics do not offer concrete and economically viable guidelines for implementation. A successful transformation requires a free and unrestricted train of thought. Shareholder and managers should come together, create diversification strategies and have the courage to give up unviable businesses to leave room for innovations.

16. For local environments, a local Heat Target should be developed. The site-specific heat structure, the arrangement of industrial and commercial enterprises, the supply of space and the geological conditions define an overarching heat usage concept. This will thus make it feasible to identify sources of long-term potential. At the same time, there are lines of business that are not prepared for a decarbonized future. The long-term development of gas grids, for example, depends on the development of synthetic gases.

17. A holistic strategy in the course of the heat transition creates economic opportunities for the energy sector arising from the usage of energy sources that increase local value creation and enable money flows, eroded by the imports of fossil fuels in the past. Such energy sources could be e.g. deep geothermal and solar thermal energy. The fundamental decision about the future portfolio should give priority to sources of energy and generating technologies with a complete value chain on local level.

18. For the required investments, it is necessary to compute an adequate heating price. This is done by using long-term cash flow models. The base prices will take a higher share in the future price structure because of capital-intensive generation technologies and distribution with lower operating costs.

19. The challenges that public utilities will face and their role will change significantly. The business model will become digitized and the service offering will be relevant to the business success. This also offers opportunities for the marketing of district heat, which should be positioned as a comfortable and innovative product for customers.

20. The strategic heat approach has to be prepared now. Due to the long life expectancy of grids and generating plants, decisions today shape the result of tomorrow. Therefore, a checklist concerning the supplier strategy for the purposes of the transformation was developed.

Strategic transformation approach for utilities