DECARB CITY PIPES 2050

Transition Roadmap City of Munich

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Transition Roadmap of Munich

Introduction

Space and water heating requirements account for a total of about 34 percent of the entire energy consumed in Germany. In private households, heating and water heating are even responsible for around 90 percent of total energy consumption. In addition, the demand for cooling and air conditioning is rising continuously. In Munich, heat demand from residential and non-residential buildings is even higher, covering about 48 percent of total final energy consumption.

At the same time, fossil fuels currently still dominate as energy carriers in the heat sector, both in Germany as a whole and in Munich. Not surprisingly, greenhouse gas (GHG) emissions of the heating and cooling (H/C) sector make up slightly more than a third of energy-based GHG emissions in Munich. Consequently, the success of the energy transition and the transition to climate-neutrality is decisively dependent on more energy-efficient buildings, economic use of energy and future climate-friendly GHG-free energy generation and management.

There is a long history of climate protection policies in Munich. In 2010, so-called Integrated Action Programs for Climate Protection in Munich (IHKM) have first been designed. Climate protection strategies and measures in the H/C-sector have since then always played an important role. Recently, climate change issues have even become much more prominent and visible in Munich.

Munich's municipal utility company Stadtwerke München (SWM) is a key player in the energy and heating transition. SWM supplies Munich with energy (electricity, natural gas, district heating/cooling), fresh drinking water, mobility and advanced telecommunication services. Moreover, there are city-owned housing companies which play an important part in providing affordable housing and transforming the building stock to account for the requirements of climate neutrality.

The next section describes in some more detail the current situation with respect to climate protection and the role of the H/C-sector as well as overall goals of the City of Munich and SWM. Then, a more detailed outlook of Munich’s H/C-sector for the future is provided. Based on that, key levers and strategies for the transition are explained and a selection of local instruments are mentioned. As Munich is currently revising major part of its strategy for the H/C-sector the final section provides an outlook on current discussions.

Status quo and goals for 2035 and beyond

In line with the Paris climate protection agreement of 2015, the City of Munich declared to become a climate-neutral city by 2035 and brought forward its previous goal from 2050 to 2035 (defined as 0.3t CO2e per inhabitant). The city administration and companies closely attached to the city administration have to reach the goal of climate neutrality by 2030 already. With the city council resolution of 18 December 2019[20] where these goals have been passed, Munich has also declared a climate emergency. The city administration was asked to develop an action plan that defines a path to achieve climate neutrality for the entire city by 2035 and for the city administration by 2030.

For this purpose, the Department of Climate and Environment commissioned a study that reviewed previous scenario calculations and developed proposals for such a comprehensive action plan ("Climate-neutral Munich 2035"). The department then presented two basic city council decisions (Grundsatzbeschlüsse). The first one in June 2021 outlines the importance of the neighbourhood approach (see below) and proposes some mostly institutional changes in city climate governance (e.g. establishment of a municipal climate ordinance, a climate council with various stakeholders, a separate climate budget, a climate appraisal of council resolutions). The second one in January 2022 then presented the above-mentioned action plan and the necessary financial outlay for climate protection measures highly prioritized and in need of financing from the city's climate budget (mostly for the period 2021 to 2025).

SWM makes a significant contribution to Munich’s energy transition with its own goals and by actively supporting the goals of the city of Munich. With respect to district heating and cooling, SWM is the only supplier in the designated district heating and cooling area (900-kilometer long; outside some local grids from other suppliers exist). In the year 2012, SWM announced the District Heating Vision: SWM will cover Munich’s entire district heating requirements on a CO_2-neutral basis. Tapping geothermal energy is a key component of this vision. In addition, the expansion of green district cooling is supposed to replace individual air conditioning systems. Energy consumption for cooling shall be reduced by using groundwater and city streams. Furthermore, from 2025, SWM intends to produce as much green electricity in its own plants as the entire municipality of Munich requires.

In 2020, a study on the future of Munich's heating sector was commissioned by SWM in cooperation with the city of Munich (so-called "heat study"). The study develops a long-term concept to reach Munich's climate goals, outlines transition paths with respective transition costs and proposes instruments and measures based on current barriers on the way to climate neutrality. The study was also used as a basis for the broader study ("Climate-neutral Munich 2035") mentioned above.

At the moment, there is still a long way to go to reach climate neutrality. The Department of Climate and Environmental Protection regularly publishes greenhouse gas emission (GHG) inventories with a two-year time lag which are final energy-based and cover both scope 1

[20] https://risi.muenchen.de/risi/dokument/v/5822571

and scope 2 emissions. Figure 33 shows the emission trend and the breakdown of GHGs by sectors. While emissions have decreased considerably by 46% relative to 1990, progress has obviously been too slow within the last five years to easily achieve city goals.

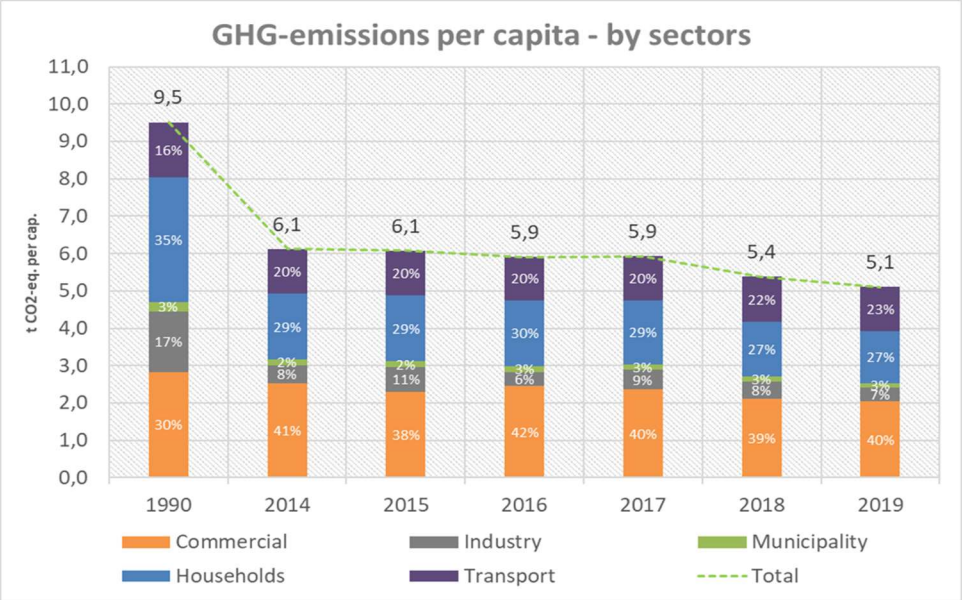

FIGURE 33: SOURCE: MUNICIPAL GHG-MONITORING, HTTPS://RISI.MUENCHEN.DE/RISI/SITZUNGSVORLAGE/DETAIL/7205164

Scenario calculations of the studies mentioned above suggest that, using ambitious but still realistic assumptions, greenhouse gas emissions can be further reduced by almost 70% until 2035 (Figure 34). The achievement of Munich's climate goals will then very likely not be completed by 2035 unless the city resorts to further measures outside the city boundary and monetary compensation schemes. The main reason for this result is the relatively slow transformation of long-lived infrastructure (like building refurbishment, expansion of the public transportation network and the district heating network, remodelling of energy generation plants). Yet, in the 2040s, climate neutrality can be reached depending on the speed of realising necessary changes in Munich and the development of favourable framework conditions.

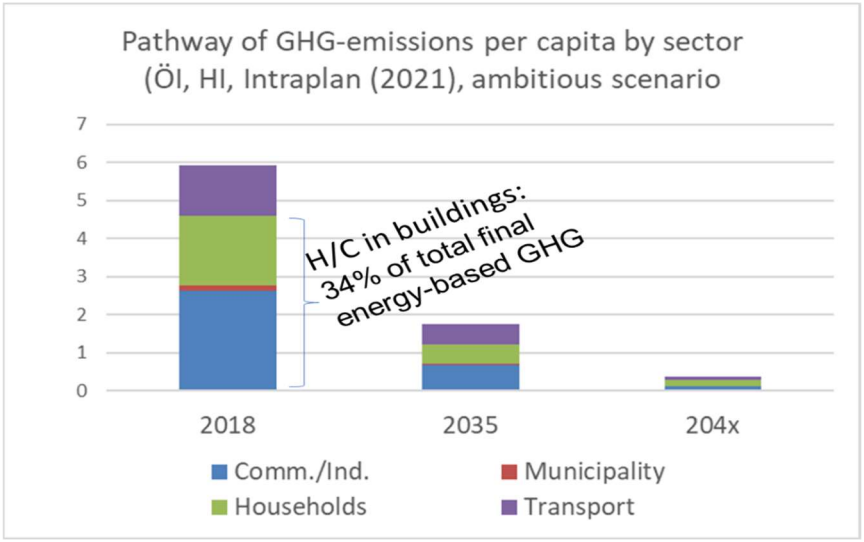

FIGURE 34: SOURCE: ÖKO-INSTITUT ET AL. (2022)

Outlook H/C-sector

Currently (2018), fossil fuels still dominate as energy carriers in the heat sector: of total heat energy consumption, 53% originates from natural gas, 35% from district heating (predominantly still based on natural gas and coal in cogeneration plants), 9% from heating oil, and with 3% from other sources. According to the heat study mentioned above, Munich will see a considerable shift in the way heat is provided (Figure 35) and a change in the composition of energy sources (Figure 36).

In particular, there will likely be higher shares of district heating (about 50% in 2035, about 70% in 2050) in final energy consumption and, in parallel, the decarbonization of district heating will unfold. This is mainly possible via very favourable conditions for deep geothermal energy: Up to two thirds of energy generation for district heating in 2035 will originate from this energy source, with an installed capacity in 2035 of up to 510 MWth (MW of thermal power) (including heat pumps for reheating at generation sites). Currently, only 80 MWth is based on deep geothermal energy.

In parallel to the rise of geothermal energy in base load and partly mid-load district heating, the burning of coal in one of the CHP plants will cease by the late 2020s. Gas-fired CHP and heat plants will be partly refurbished and continue to operate until 2035. (Note: The study was finished before the war in Ukraine and the resulting energy crisis). By 2035, all existing CHP plants (and also heat plants) are assumed to switch to hydrogen as energy carrier and will only operate when national electricity demand cannot be covered by renewable energy. Consequently, CHP plants will operate much less in 2035 given the expected costs of hydrogen at this time. Their share will only rise in later years.

To cover the remaining mid- and peak load in district heating, largescale electric heat pumps at generation sites will play an important role. Also, additional renewable heating capacity for peak load is likely to be necessary (based on biomass or power to heat). Overall, the transformation of the generation plants for district heating will lead to a much higher reliance on local renewable energy sources than today (70% in 2035, 56% in 2050).

While Munich has generally quite favourable conditions for district heating in terms of heat density, suitable buildings etc., district heating and the expansion of the district heating grid is not a suitable option in all parts of the city (Figure 35). In these other areas, oil and gas boilers will have to be replaced mainly by individual heat pumps and/or local heat grids. According to scenarios in the heat study, these decentralised solutions make up for about 15% of final energy consumption in 2035 and up to 30% in 2050.

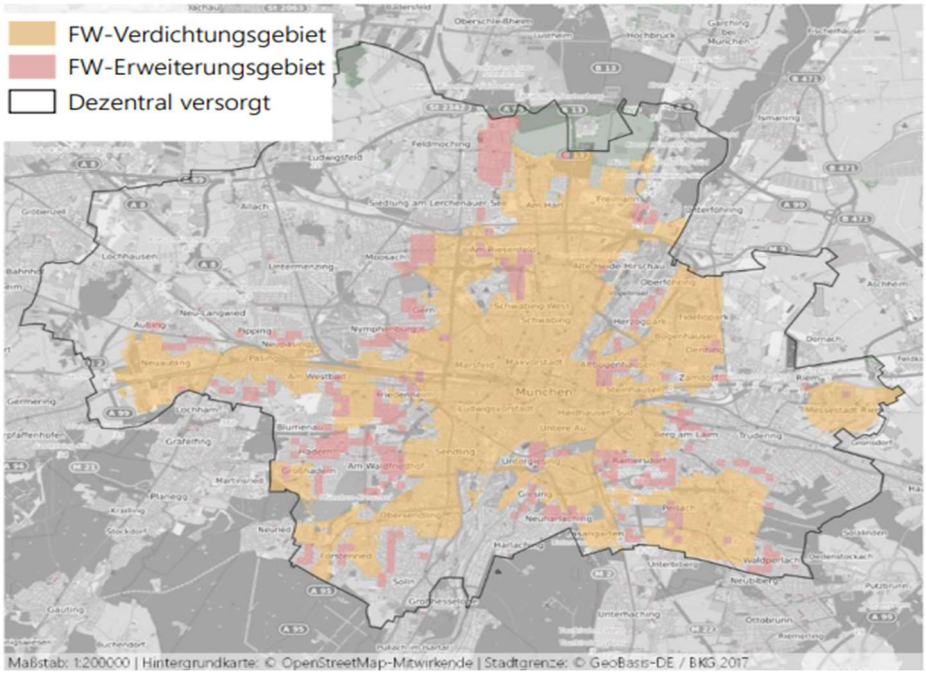

FIGURE 35: EXISTING AND EXPANDED DH AREA, ACC. TO ÖKO-INSTITUT AND FFE (2021)

Fortunately, Munich has also favourable conditions for near-surface geothermal energy in combination with groundwater heat pumps in many (but not all) parts of the city. Moreover, these areas are also mostly outside the currently designated district heating area. The main favourable factors for this technology are relatively high groundwater temperatures, the relatively low depth to the water table (less than 20 m), the high groundwater thickness and the high permeability of underground gravel. Apart from groundwater heat, pumps there is an additional potential for geothermal heat collectors in combination with heat pumps (using brine). They typically require more space than groundwater-based systems. Current analyses show that up to 60% of the current heat demand can technically be met by groundwater heat pumps or geothermal heat collectors without negative mutual interactions between wells.

Apart from the above-mentioned heat pumps, air-based heat pumps are also often suitable replacement options for oil and gas boilers. This is particularly the case for less densely populated areas of the city, where the spatial requirements can be met more easily or noise disturbances may be less prevalent. Moreover air-based heat pumps are currently perceived as more attractive given their relatively lower investment cost. The expansion of these more inefficient heat pumps may result in a greater need for expansion of the electricity grids.

In addition to heat pumps, there will likely be other decentralised heating sources for a climate-neutral heating sector. Solar thermal energy (mainly for water heating or in small local heat grids), waste heat (e.g. from industry, bakeries, data centres) and biomass (e.g. in some areas without groundwater potential) have to be mentioned. Also, thermal and chemical storage will play an increasing role given limits to renewable electricity use for heat pumps. However, the importance of these latter energy sources is likely to be limited from a city-wide perspective.

In parallel to changes on the supply side, it is crucial that energy consumption in buildings is further reduced. After all, there are technical and economic limits in supplying large amounts of green heat in a big city like Munich. At the same time, the potential to increase

the energy efficiency of the building stock is considerable: almost 60% of the residential buildings in Munich's have been built before the first federal heat ordinance in 1978. Another 20% has been built before 1995. Compared to current standards for new buildings, these buildings are fairly inefficient and most of them have not or only partly been refurbished afterwards. Given this potential and favourable framework conditions (i.a. rising energy prices, federal funds) the heat study assumes an increase of both the rate and depth of renovation. The rate of renovation will increase from slightly over 1% p.a. to up to 2.5% in the period 2036 - 2050, the depth of renovation will increase from a level of about 70 kWh/m2 (KfW 85) in single and double family houses and about 57 kWh/m^2 (KfW 70) in apartment buildings up to about 45 kWh/m^2 (KfW 55) in the former and about 32 kWh/m^2 (KfW 40) in the later buildings. Only in the district heating area and in historic buildings the depth of renovation will be somewhat lower. As a result, 25% (61%) of all buildings can be renovated until 2035 (2050) and final energy consumption will decrease by 16% (2035) and 35% (2050), respectively.

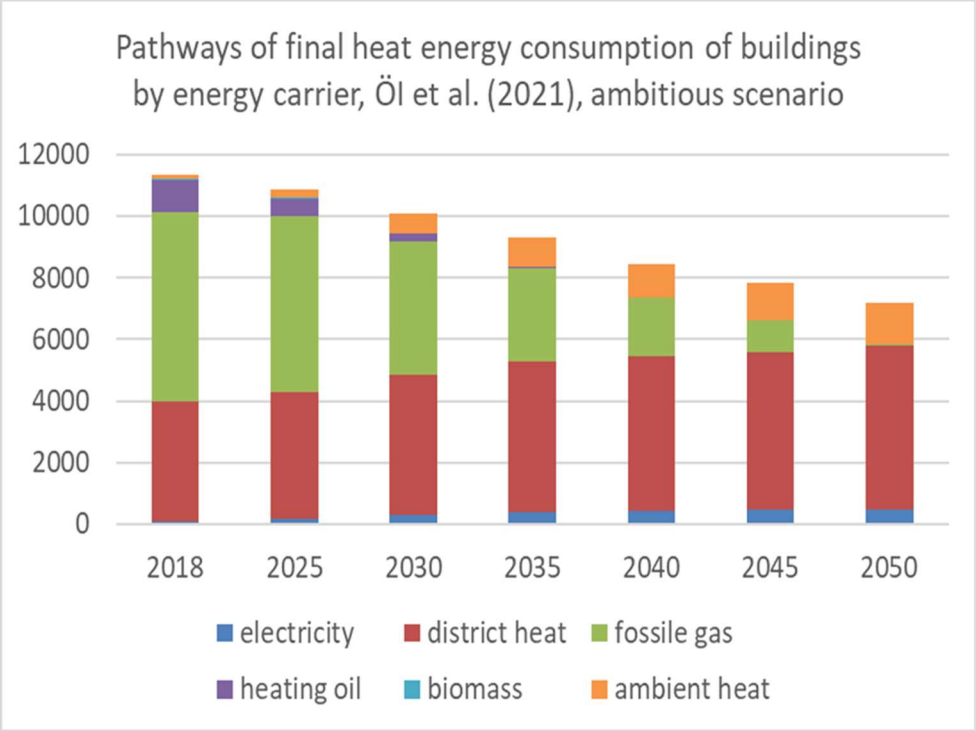

FIGURE 36: SOURCE: ÖKO-INSTITUT AND FFE (2021): KLIMANEUTRALE WÄRME MÜNCHEN 2035, SZENARIO FOKUS FERNWÄRME

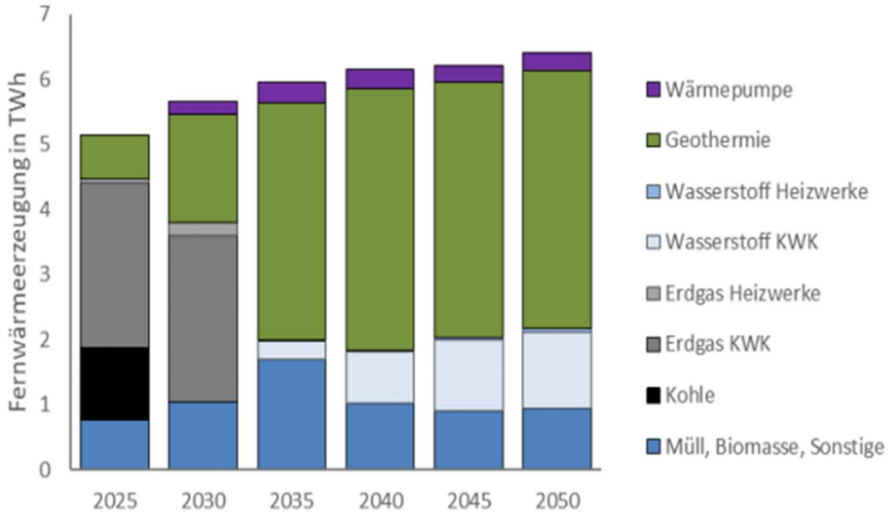

FIGURE 37: PATHWAYS OF EXPANDING AND DECARBONISING DISTRICT HEAT PRODUCTION, SOURCE: SWM, BASED ON ÖKO-INSTITUT AND FFE (2021)

The changes in the level and composition of CO_2-emissions resulting from centralised and decentralised heating are shown in Figure 38 for the two climate scenarios analysed in the heat study. While emissions decrease considerably until 2035, there are likely to be left-over emissions of 900 to 950,000 CO_2 (thereof 18% for incinerating waste that can likely not be avoided or recycled). The largest share of remaining emissions results from decentralized gas boilers where quick phase-out is challenging. Also, despite the rising share of heat pumps, the emission factor for electricity is only declining step-by-step. Emissions from district heating can be reduced substantially until 2035 given the expansion of geothermal energy and the switch from natural gas to hydrogen in remaining CHP and heat plants. Depending on further developments regarding the legal, technical and economic framework conditions, it will be seen whether the switch from natural gas to hydrogen by 2035 is possible and can take place on the scale shown (see Figure 37).

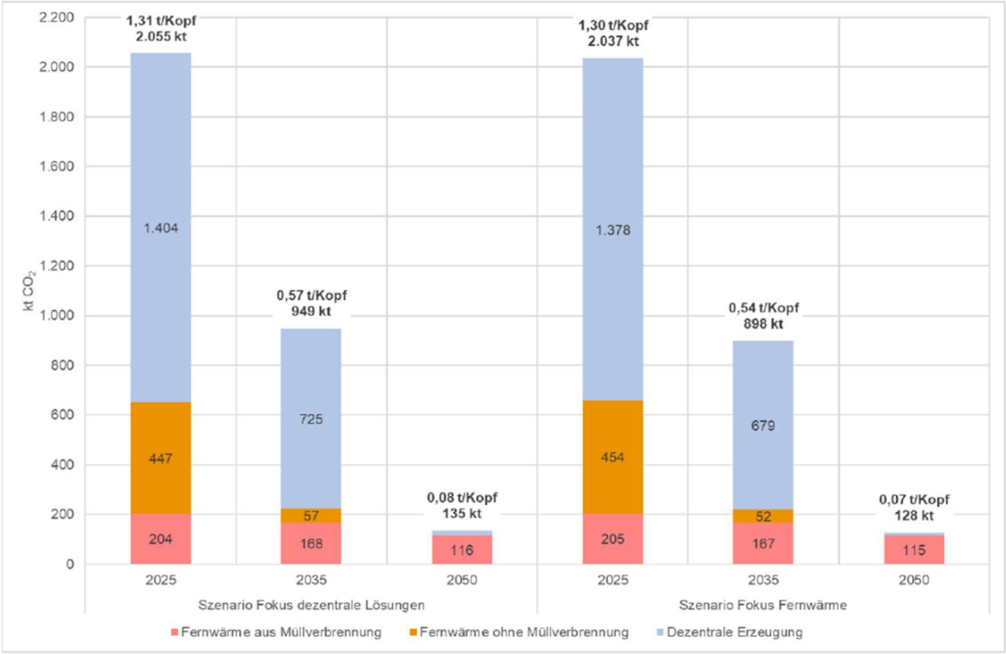

FIGURE 38: CO_2-EMISSIONS FROM HEATING IN THE SCENARIOS OF ÖKO-INSTITUT AND FFE (2021)

Key levers and strategies

a) Strategic and city-wide H/C planning

In 2022, the City of Munich and SWM started redesigning and reorienting strategic and citywide H/C-planning. Originally, the city had its own energy planning system, the so-called energy use plan, with only limited involvement of the local utility and limited integration of their energy and building data and analysis tools. Following the closer cooperation between the city and SWM during the development of the heat study and a change of responsibilities within the city administration (i.a. establishment of the Department of Climate and Environment), SWM decided to open up some of their data and tools (so-called Model Munich) to selected persons of the city for a better alignment of H/C-planning in Munich. As a result, H/C-planning now relies on more detailed and valid data sources as well as analysis tools that are easy to use and update. The main responsibility for H/C-planning still lies within the city administration as H/C-planning can be considered a service of general interest, but cooperation with SWM remains close.

Overall, H/C-planning serves to inform building owners, energy suppliers and other interested stakeholders about suitable options on the way to a climate-neutral H/C-sector. This includes energy supply technologies and heat sources, energy infrastructure and energy demand and use. At the same time, planning helps to better coordinate activities of various stakeholders and the respective interests and strategies in the H/C-sector. As a result, planning and investments of these stakeholders can be realized on a more reliable basis. Moreover, interacting and communicating with stakeholders on a regular basis ideally creates more trust and more support for Munich's ambitious journey towards climate neutrality. Finally, planning is meant to stimulate measures for implementation. The integrated neighbourhood approach is a key strategy in this regard (see below).

b) Transformation of district heating

H/C-planning serves to determine areas within the city that are suitable for either grid-bound or decentralized heat and cold supply. As already mentioned, district heating is a key pillar of grid-bound energy supply. The main responsibility for the development of future district heating lies within SWM as sole operator in Munich. Currently, SWM develops the so-called transformation plan for district heating which is embedded in city-wide H/C-planning.

The transformation plan describes the remodelling and/or expansion of an existing heat grid and system to climate-neutrality until 2045. It serves as a basis for funding of investments of both heat grids and heat production or storage installations. Similarly, building owners aiming to rely on district heating on their way to climate neutrality can only fully benefit from federal funding for retrofitting buildings if there is a valid transformation plan. The transformation plan needs to be approved by the federal level. Yet, the contents are discussed and agreed upon at the local level between SWM and the City of Munich (agreement on climate neutral district heating, link to H/C-planning).

The transformation of district heating includes the following main building blocks:

1) Grid Densification

There are still a lot of buildings in the district heating network area which are not connected to the district heating grid. Connection rates need to be increased along with change of restrictive federal tenant regulations (currently under review).

2) Grid Optimisation

A considerable share of the district heating network is still based on steam with very high temperatures and low efficiency. Major parts of this network need to be converted to hot water and temperatures need to be adapted. The optimization of the grid infrastructure needs to be closely aligned with changes on the generation side (e.g. changes of temperatures, adaptation of customer units, potential use of secondary grids etc.).

3) Grid Extension

While grid densification in the existing district heating network has generally a higher priority than grid extension, the heat study has already designated areas outside the district heating network area where expected long-term revenues of district heating are likely to exceed the cost of infrastructure provision and supply of district heating. In the currently developed transformation plan, these areas are considered more closely.

4) Generation

A fundamental shift will be necessary on the generation side where large CHP and heat plants using fossil fuels have predominated so far (see outlook on H/C-sector above). By contrast, the backbone of future district heating will be based on new generation units spread across the wider Munich Metropolitan area, mainly using deep geothermal energy.

A key element is the connection of plants located in favourable regions south of Munich to the city-wide district heating grid. For this purpose, cooperation agreements with neighbouring municipalities and new business models will be necessary. Put differently, SWM can only realize less than a third of the technical geothermal potential in the wider Munich area without such agreements.

Of course, and in addition to three existing plant locations, a number of locations for new geothermal plants are also planned or considered within the city borders. In addition to each geothermal unit, largescale heat pumps are also planned. Moreover, there are first ideas for high-temperature underground thermal storage units at current or new plant sites. They basically help to mitigate the temporal mismatch between availability and demand for thermal energy.

Despite the dominating future role of geothermal energy - and expected persistence of waste heat from incineration in district heating - other energy carriers will likely play an additional role. The use of hydrogen, biomass and additional waste heat (incl. wastewater) are currently considered more closely.

5) District cooling

District cooling is another key element of SWM’s commitment to climate protection policies. The natural eco-coldness of groundwater and urban streams is tapped to drastically reduce the power consumption in the cooling and air conditioning process. By comparison with

individually generated cooling, especially in terms of conventional domestic air conditioning systems, up to a 70 percent of the electricity requirements can be saved.

c) Integrated neighbourhood approach (“Quartiersansatz”)

A considered ‘neighbourhood’ is composed of several locally adjacent buildings including public infrastructure. It is smaller than an administrative city district and constitutes an informal level for city planning and development.

The city council has decided that the integrated neighbourhood approach is a key strategy on the way to a climate-neutral and resilient Munich. The approach will focus on existing buildings and on areas which are not formally designated refurbishment areas according to the German Building Code.

The neighbourhood approach allows to realize synergies and/or to save costs compared to either a building-by-building approach or a city-wide-only approach. Compared to the building-by-building approach, advantages include the possibility to combine refurbishment activities or to integrate renewable energies or green infrastructure at larger scale, to intelligently couple the electricity and the heat market and to realize critical investments levels. Compared to the city-wide approach, it is easier, for example, to inform and activate citizens at the neighbourhood level, coordinate and align the various interests and to test new innovative approaches or technologies.

The integrated neighbourhood approach follows two main avenues: The first is based on the development of integrated neighbourhood concepts, which are promoted by the German public bank KfW. This concept provides a more detailed analysis of a selected neighbourhood (status quo (energy use, major energy carriers, infrastructure, main actors etc.), potentials (e.g. building refurbishment, change of heat source, greening, mobility concept), costs, transition path and monitoring and accounting). It also proposes and prioritizes suitable measures for the transition and integrates local stakeholders in the process. The close cooperation with local stakeholders (e.g. house owners) aims to ensure the subsequent implementation of the concepts.

Based on the concept, the management of the refurbishment (Sanierungsmanagement) can also be promoted by KfW. This involves the implementation of the concept at the neighbourhood level (incl. stakeholder activation, networking, coordination, monitoring etc.).

At the moment, there are about eight pilot integrated neighbourhood concepts (at various stages). It is planned to learn from these initial experiences and scale the approach in the coming years, so that about 20 concepts can be launched each year from 2025 onwards.

The second avenue focuses in particular on areas dominated by single and two-family houses which are more homogenous and less complex and do not necessarily benefit from a separate neighbourhood concept. In these areas the city of Munich office individual, free and targeted energy counselling by independent experts and develops accompanying campaigns. The first such counselling campaign in the Western part of Munich has started in 2022 and turned out to be a great success. For the coming years, it is planned to have about two to four such campaigns each year. Moreover, the city offers information, counselling and training on building refurbishment, energy and new living and building concepts also through a citywide centre (Bauzentrum).

Both integrated neighbourhood concepts and targeted energy counselling benefit from the energy and heat planning mentioned above. In particular, the heat planning tools allow to preselect and prioritize areas in the city that are suitable for (integrated) neighbourhood concepts and/or targeted energy counselling campaigns. They also offer valuable data and information for more detailed and fine-grained calculations and scenarios at the neighbourhood or building level.

d) Set up an energy / renovation agency

A team of experts from various departments of the city administration is basically responsible for preparing and monitoring activities at the neighbourhood level and for aligning them with goals and demands of the city council. However, much of the day-to-day work at the neighbourhood level cannot be managed by them, especially at the implementation stage of the concepts and given the plan to scale the neighbourhood approach. Therefore, the setup of a new energy and renovation agency is necessary. Such an agency would be more agile and flexible than the city administration, but still be controlled and supervised by the city and supported by the city's climate budget. Currently, city officials examine whether the Munich Society for City Renewal (MGS) - currently still part of one of the municipal housing associations - can be turned into such an agency.

e) Set up of new business fields at SWM

SWM is currently developing a new business field "decentralized heating". It is composed of two main product lines: M-Heat pump and M-Local heat. The former is oriented towards individual solutions for single buildings and includes both air- and groundwater-based heat pumps. SWM aims to develop standardized and all-inclusive service packages (selection of heat pump, installation, support in securing funding, electricity tariff, service and maintenance etc.). Given increasing competition in the individual heat pump market SWM is also aiming to quickly reach a sufficient market share.

The latter (M-Local heat) is aiming to set up local heat grids based on near-surface geothermal energy and other renewable energy sources both for new and existing buildings. While successful projects for new buildings already exist, viable solutions for existing buildings are more challenging.

f) Adaptation of electricity and gas infrastructure

SWM has recently made the strategic decisions to continuously phase-out the sale of natural gas and to not provide further connections to the gas grid whenever compatible with national energy law. By contrast, customers will be offered an alternative heat supply, typically either district heating or decentralized renewable heat (see above). The future of the current gas distribution grid and the exact phase-out strategy (timing, region-by-region approach) is currently still under discussion. However, the heat study and the climate neutrality study have shown that maintaining the entire gas distribution grid to provide hydrogen to former natural gas customers is not a viable option given the cost and competing uses for hydrogen. Therefore, only the supply of hydrogen directly to CHP and heat plants is currently considered a potential option. In addition, high-pressure gas distribution lines to supply hydrogen to selected industry customers in and around the city are probably maintained or even newly built.

The roll-out of heat pumps (and electric vehicles) has also important implications for the electricity sector. In particular, local electricity grids will face peak loads which are about twice as high as today. Together with the University of Augsburg and the Technical University of Munich, SWM is currently examining in more detail the repercussions on the local electricity sector (e.g. expansion of transformation substations, change of electric equipment etc.). Interestingly, the need to adapt is likely to vary substantially within the city, depending particularly on the heat load, the heat pump technology and load management.

Local instruments

The complexity of decarbonising the City of Munich - with its countless buildings, owners and inhabitants as well as the limited space and the limited financial and human resources - requires thoughtful planning. In addition, the path to climate neutrality is strongly influenced by market signals, citizen engagement and acceptance, and federal and state legislation. Ideally then, the right measures can be taken at the right time.

To this end, the following table provides an overview on tools to achieve the climate targets, focussing on tools currently available to the City of Munich. These instruments are constantly being further developed so that they support the implementation of the strategies and levers mentioned above.

TABLE 16: MAIN MUNICIPAL INSTRUMENTS FOR THE TRANSITION TO CLIMATE-NEUTRAL H/C

Brief description	Type	Main related strategies / levers	Status
Adaptation of planning to account for the spatial needs of the heating transition (plants, installations, grids), incl. streamlining of permitting	Planning and legal	a), b), c), e), f)	Used, increasingly important
Information on spatial requirements of the H/C transition (needs, availability), integration of concerns of the H/C transition in other (informal) plans / concepts	Information and planning	a), b), c), (e), f)	Currently establ. (City Development Plan 2040, land utilisation plan)
Provisions on RE-use and building standards related to land-use planning (particularly new buildings, buildings on city-owned ground)	Planning and legal	a), b), c), e)	Used, increasingly important
Provisions on energy supply and building standards in case of sale / lease of publicly-owned ground	Planning and legal	a), b), c), e)	Used
Notifications / permits for activities regarding near-surface geothermal energy (water rights)	Planning and legal	a), e)	Used, increasingly important
Licences for use of public ground in grid-bound energy supply	Planning and legal	b), e), f)	Used

Application of distance requirements acc. to the state building code to take account of the H/C transition (e.g. heat pumps)	Planning and legal	c), e)	Currently under review
Provisions on energy supply and/or building standards in urban development contracts	Planning and legal		Not yet used
Designation of urban renovation areas and redevelopment statutes acc. to federal building law	Planning and legal, financial	a), c)	Used, limited city-wide effect
City-wide municipal heat ordinance	Planning and legal	a), b), c), e), f)	Currently under review
Mandatory connection and use provisions for heat grids	Planning and legal	b), e)	Currently under review
Fossil fuel burning restrictions acc. to federal building law	Planning and legal	a), b), e), f)	Currently under review
Enforcement of federal and state law related to the H/C transition (building, energy, ambient pollution etc.)	Enforcement	c), e)	Obligatory
Provision of information for integrated neighbourhood concepts, energy counselling campaigns and energy concepts	Information and planning	c), d)	Used, increasingly important
Provision of information and planning tools for near-surface geothermal energy	Information and planning	c), d), e)	Used, increasingly important
Using city-owned building as nucleus in the H/C transition	Information and planning	c)	In preparation
Provision of geo-based information on the H/C transition (e.g. solar potential)	Information and planning	a)	Continuously improved
Energy counselling for citizens by city-owned building centre (Bauzentrum) and the Munich Society of City Renewal (MGS)	Information and planning	c)	On-going
Events and conferences related to the H/C transition by city-owned building centre (Bauzentrum)	Information and planning	c), e)	On-going

TABLE 17:

Brief description	Type	Main related strategies / levers	Status
Legal oversight and controlling of the new energy and renovation agency	Management of municipal companies	d)	In preparation
Co-operation with the new energy and renovation agency at the neighbourhood level	Management of municipal companies	c), d)	On-going
Complementary municipal funding of new energy and renovation agency at the neighbourhood level	Financial	d)	In preparation
Influence on statutes, guidelines, strategies of municipal companies relevant for the H/C-transition (i.e. SWM, city-owned housing companies)	Management of municipal companies	all	Used, increasingly important
Strategic agreement between the City of Munich and SWM on the transition to climate-neutral district heating	Management of municipal companies	b)	In preparation
Strategic agreement between the City of Munich, SWM and neighbouring communities on the H/C-transition (i.e. reservoir management deep geothermal energy)	Cooperation between municipalities	b), (f)	In preparation
Own municipal funding programme for climate-neutral buildings (energetic refurbishment, new buildings, H/C-installations, energy counseling, PV; individuals, housing associations)	Financial	a), c), e)	Used, further adaptation in line with H/C-planning, increasingly important
Reduction of energy demand and decarbonisation of city-owned buildings	Financial	(a), own strategy	On-going
Temporary compensation of transition costs to climate-neutral heating	Financial, social	Social/ housing	Currently under review
Involvement of city-external experts in the H/C transition	engagement and participation	a)	On-going
Public citizen involvement and campaigns (“Re:think Munich”) at the neighbourhood level	engagement and participation	a), c)	On-going
Round Table “Skilled Personnel”: education, re-education, training	Training and education	All	Recently started
Round Table “Skilled Personnel”: Attracting new personnel	Labour market	All	Recently started

The Road Ahead

In principle, Munich is well prepared to embark on an ambitious journey to climate neutrality, both in the H/C-sector as well as in other sectors. However, the outcomes in terms of emission levels, share of renewable energy or final energy consumed are not solely controlled by the city or by SWM.

There is now likely to be a more markable impact of federal- (and also EU- and state) level legislation on local energy policies than in the past. Currently, a new version of the Energy Building Law is discussed and prepared at the federal level, basically obliging building owners to use at least 65% renewable energy in case of change of boilers and to phase out fossil fuels in the sector by 2045 at the latest. With the enactment of this law the federal level would have a fairly deep impact on decisions about heating technology of individual building owners and a markable influence on planning and instrument choice at local level (incl. on what is legally allowed and proportionate at this level). In addition, other critical programmes, regulations and laws (e.g. on obligatory municipal heat planning, on the promotion of district heating or on the future use of energy infrastructures) have either been passed or are currently discussed. They indicate that the federal level is taking the H/C transition more seriously. Yet, depending on the contents of these federal activities, certain local actions may be stimulated and/or restrained.

In addition, the H/C transition is critically dependent on other factors which can only be influenced by the city to some extent. Notably, implementing widespread energy refurbishment and change of heating technologies relies on planners, energy counsellors and manufacturers. Moreover, the political, social and market acceptance of the H/C transition is very important, but not very well known and not easy to be sustained.

Therefore, designing a transition roadmap at the local level is not a one-time exercise. It needs to be revised and adapted based on changing circumstances and continuous learning.

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