DECARB CITY PIPES 2050

H/C plan

Cross-city summary
H/C Plan
Part of D3.3

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Inhoud

Introduction

In this cross-city summary the Heating and Cooling plan (H/C plan) of the cities of Bilbao, Dublin, Munich, Rotterdam, Vienna and Winterthur are summarized and compared[1].

The summary will show differences between the cities, such as size and amount of district heating grids available within the cities and the similarities, such as the approach of using heat-density as a method to decide where district heating is a logical alternative for natural gas heating.

Each city made their own H/C plan, with detailed information. This summary is to highlight some elements and get an overall view on making H/C plans.

In general all cities have a big challenge ahead in changing the way the building stock is heated and cooled into a fossil free based alternative. The solutions at hand differ per city.

[1] The city of Brastislava, also part of this EU project, does not participate in this delivery.

Facts & figures: the context

Current situation & goals

In the table below the first comparison between the cities is made.

		Bilbao	Dublin	Munich	Rotterdam	Vienna	Winterthur
Inhabitants		350.000	550.000	1.460.000	650.000	1.910.000	110.000
Energy Mix in H/C market	**Gas**	85%	72%	50%	72%	42%	41%
	DH	0%	0%	30%	18%	39%	20%
	Oil	5%	17%	0%	0%	4%	29%
	Other	10%	10%	20%	10%	15%	10%

As can be seen from the table, the cities are different in size and the way heating is organized is also different per city. All cities made a H/C plan showing a future plan of the city where the heating and cooling sector is decarbonized.

Cities work towards “carbon neutrality”, “climate neutral”, “carbon neutrality”, “zero-emission” or “natural gas free heating”. Although all cities use different terminology to define their goals, they all work towards decarbonizing the way the existing building stock is heated and with that moving away from fossil fuels for heating. The H/C plan made by the cities show in what way this decarbonisation can be realised (vision). Just as the goal also the end date differs per city, from 2035 tot 2050. In the table below the cities goals are summarized.

City	Goal	End year	Other values & heat transition goals
Bilbao	Carbon neutrality.	2050	2030: reduction of 40% GHG emission. Goal for buildingstock is translated to zero fossil fuel use in 2050
Dublin	Net zero	2050	National Climate Action Plan target: 10% of all residential and commercial heating to be supplied via district heating by 2030.
Munich	Climate neutral	2035	Identify potential energy savings and for the efficient, climate-friendly provision of energy for the heating and cooling of the building stock
Rotterdam	Natural gas free heating	2050	Work towards sustainable energy (incl. air quality) , smart, energy justice, resilient (e.g. affordable, reliable, inclusive etc.)
Vienna	Carbon neutrality	2040	phase-out of fossil fuels for heating, cooling and hot water production; reducing the carbon emissions per capita about -55% till 2030 and neutral in 2040 (compared to 2005); reducing the final energy consumption -45% till 2040 (compared to 2005) – for heating/cooling -30%
Winterthur	Net zero	2040	This goals are translated: various parts of gasnetwork will be decommissioned. Gas is used for peak supply. And in 2033 green gas should replace fossil natural gas. .

Despites these differences in definiton, all cities aim for decarbonizing the heating and cooling of the built environment. It is clear that in order to decarbonise, there is a need for heating and cooling plans to give direction to the city's transformation paths. The H/C Plan the cities made, are not final plans. New insights, innovation and more accurate data will be used to update and improve the H/C plans.

Cooling

Cooling is considered important. All cities paid to a certain level attention to cooling, but it is not yet integrated in the H/C plans. The cities aim to make cooling part of the updated versions of the H/C plans. Because this cooling demand might influence the preferred heat option.

Most cities already analysed the cooling demand (density), e.g. Vienna looked at expansion of cooling networks (as separate system) and Bilbao used the heating/cooling ratio to decide where the use of heat pumps is preferred. Rotterdam analysed the cooling demand and a made plan is made how to deal with this cooling demand. Munchen integrate cooling for non residential buildings in the H/C plan, showing potential district cooling. Winterthur analysed the cooling demand by regarding the data about industry affiliation from the company statistic. Areas with high cooling demand are identified in the H/C-Plan to be considered in the further development of district heating planning.

In the H/C Guideline for cities there is a paragraph on cooling.

Heat demand

The estimated energy use for heating is known in the cities and all cities have calculated the potential heat demand reduction in time. Most cities have insight in the type of buildings and calculate potential reduction on assumptions on the way the building stock can be retrofitted. At this moment the retrofitting rate in most cities is about 1% per year, the ambitions however are higher.

All cities use standard building data to calculate the heat demand and potential reduction (retrofit). The different types of buildings (e.g. building year, ground bound / apparmtent flats and ownership) are taken into account. Dublin incorporated behavioral aspects in the energy demand calculations. The found that the reboud effect, the percentage of the theoretical savings compared to the real saving, is 26,7% for home owners and 41,3% for tenants. This difference between theoretical and actual energy consumption (also called preformance gap) is caused by behavioural aspects. For example often more rooms are heated in well insulated homes, than in badly insulated homes. Bilbao warns in their H/C plan for overestimation of the potential effect of (retrofit) interventions. Old buildings have often lower energy consumption then calculated, not only due to the mentioned behavioural aspects, but also because in many of those buildings retrofit measures took place, but are not yet part of the calculations.

The cities of Vienna and Dublin expect a significant growth of the population the coming decade(s), this will lead to a increase of heat demand, the amount will be limited compared to the existing building stock, because most buildings are expected to be built to nearly zero emission standards.

Energy supply

For the decarbonisation of the heating and cooling demand, fossil-free energy sources are needed. All cities still have more than 50% fossil fuel based heating, most of the time natural gas is used. This natural gas is used for the heating of the building stock, either directly via gas boilers in the buildings or via CHP's and in peak and back up systems to produce heat for the existing district heating systems.

To meet the cities goals the energy supply for heating needs to become fossil free. For the coming years (natural) gas is seen as a way to meet the heat demand and specifically the peak and back-up demand in district heating systems. In time this natural gas needs to become green (either H2 or biogas), however, all of the cities asssume there is not enough green gas to replace natural gas. So the bigger part of current gas based heating systems needs to be replaced by heating systems that can use other heat sources[2]. This is either with (individual) heat pumps or district heating networks, this transformation of heating system enables the use of a wide range of (local) energy sources to heat the building stock.

Munich, Rotterdam, Vienna and Winterthur already have district heating, Bilbao and Dublin not (yet). Most of the cities still use natural gas as the main energy source for their district heating system. Not all cities are completely dependend on natural gas for their district heating system, e.g. Rotterdam, Vienna, Munchen, Winterthur also use heat from waste incinerators. Rotteram and Vienna also uses waste heat from the industry (the first connection is made with a refinery, more are planned in the future).

Each city looks at district heating as one of the solutions for decarbonisation of the heating sector. CHP's, using natural gas, are widely used to produce heat for the district heating systems, besides the production of electricity. Dublin stated in their H/C plan that the amount of CHP enabled power plants will decrease due to the growth of green electricity production.

There are many different heat sources for district heating, the most import ones are summarized in the table on the next page.

[2] This will be distric heating using geothermal heat, aquathermal heat and/or waste heat, heatpumps using electricity or a combination of district heating and heatpump using both the heat sources as well as electricity.

Heat source for district heating systems	**Remarks**
(deep) geothermal heat	All cities except Bilbao look at the potential of geothermal heat
Industrial waste heat	Cities with industrial complex nearby, e.g. Rotterdam, use or are planning to use this kind of heat. The future availability of waste (or recoverable) heat, due to decarbonisation of the industry itself is a point of attention. How much heat and at what temperature will be available in the future is to be analysed.
Waste incinerator	Most cities use or are planning to use heat from the waste incinerator (Dublin, Munich, Rotterdam, Vienna, Winterthur). The circular economy (no waste strategy) is considered to influence the amount of available heat in the future. How fast this no-waste future will unfold and what impact it will have on waste to energy plants is unknown.
Lower temperature waste heat *(e.g. heat from data centre, local industry)*	Especially heat form data centres are looked at, although not all cities have this potential. Moreover, a lot of low temperature sources are available in the urban fabric areas (e.g. bakeries, supermarkets) – all together the have a high potential for low temperature networks or for direct use of neighbour buildings.
Aqua thermal energy *(e.g energy from surface water, waste water, ground water)*	This type of heat needs to be upgraded by heat pumps, either individual or by large-scale heat pumps. All cities look at different kinds of aquathermal heat, however the availability is compared to the heat demand is low
Electricity	Cities will not be able to produce enough electricity within the city (excluding offshore wind) for all the electricity demand. Cities mainly look at solar solutions (rooftop) within the built environment and using win-win solutions while using pv elements for shadowing public places or to combine green elements with pv on buildings. Rest of production of electricity will come from wind (both on and offshore) and hydro power, produced mostly outside this cities. Electricity can be used for the production of heat by heat pumps (both large scale as part of district heating as well as individual heat pumps to heat the individual buildings).
Green gas (H2, biogas)	All cities assume especially up to 2030 a limited availability of green hydrogen[3] and biogas. This high value energy carrrier and source is preferably used for industry (in need of high temperatures or as a feed stock), heavy transport and/or to balance the energy system. This balancing is needed for both the electricity as well as heating systems. For example the city of

[3] H2 is, unlike biogas not an energy source but an energy carrier, it is made in an electrolyser using (green) energy sources.

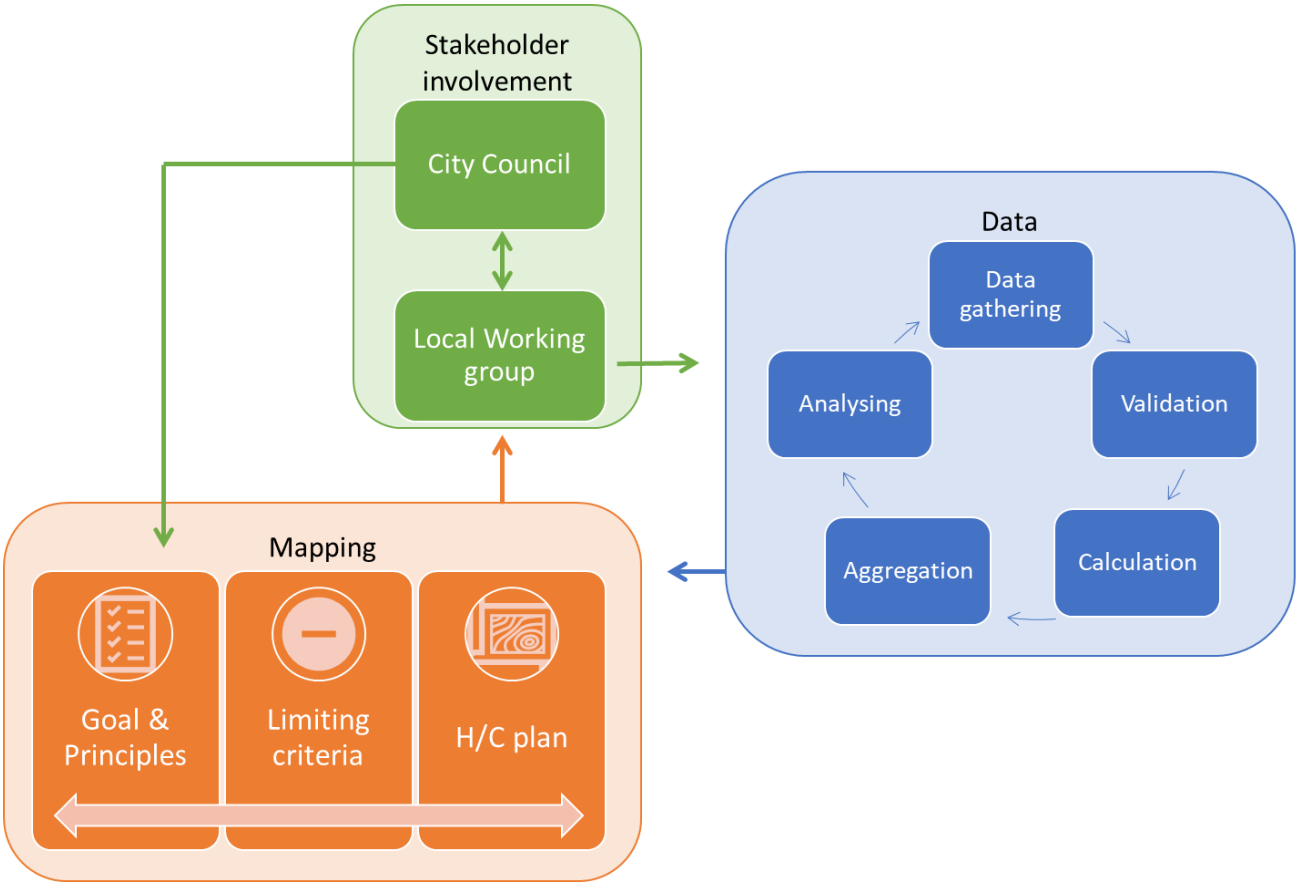
	Munich is looking if there is enough H2 to use it in their current peak and back up and CHP plants.

Process, Framework & principles

Process

Making H/C Plan helps to decarbonize the city and having political support is important. This political support can be given at the start (e.g. council or board asks for a H/C plan), but can also be given later in the proces (e.g. council and board approve (draft) H/C plan). This political support is especially important in the next phase where the plan needs to be put in realisation.

All cities drafted the H/C plan by taking (some of) the next steps:



Usually it is the city council that set goals, principles and criteria and a local working group gathers data and aggregate information so it can be analysed and finally mapped. The outcomes are presented to the city council for approval. This process can be done in a iterative way, getting feedback and renewed input during the different steps.

The stakeholders involved in the local working group differ per city, sometimes the city is in the lead and other stakeholders, such as energy companies or grid owners, are involved later in the process. Other cities worked from the start with a local working group with all the stakeholders involved.

The limiting criteria can be the availability of alternative heat sources, limiting the type of solutions. But is can also be spatial limitations due to spatial planning decision or principles that give direction to the end result, e.g. the energy supply for the end users need to be affordable and reliable.

Reduction of heat demand

All cities consider reducing the heat demand by insulating the buildings as an important step in the transition toward (almost) zero emission heating.

The level of insulation is dependent on what is possible and what is needed. The options of refurbishment are for example in historic monumental buildings limited. Also not all levels of refurbishment are cost efficient. Different heating solution lead to different possible temperature levels and give direction tot level of insulation needed.

In the cost analyses the (costs of) level of insulation are taken into account.

Framework & principles

The H/C plans are made by analysing and plotting data available and using different kinds of framework calculations. The most important frameworks & principles cities use to map there H/C plan are listed below.

Heat density

One of the main classification criteria used for mapping the H/C potential is heat density, several researches show[4] that heat density is a good method to decide where district heating is an economically efficient fossil free alternative. The cities have used this method in different ways.

Winterthur uses 400 MWh/ha*a as economical profitable threshold for district heating systems. The heat demand is calculated based on the future heat demand, taking decrease of heat demand due to retrofitting into account. Bilbao calculated both the heat demand per m2 usable floor area as well as the heat demand per area. The first indicates the potential for retrofitting and the second the potential for district heating systems.

Cost calculations

Besides heat density also cost calculations are made to decide what type of solution are the best solution per area. In these calculations the investments needed in the buildings[5] and in the energy system[6] together with the annual costs of different solutions are compared. Both Dublin as well as Rotterdam did such calculations, both showing a high potential for district heating in dense urban areas. The city of Dublin first made a heat density analyses, then a cost analyses, this last method showed an even higher potential for district heating systems.

The best (lowest cost) combination of measures on building level (insulation) and neighbourhood level (energy system) give direction to the best solutions per area. In order to find the economic best combination calculations can be done. Rotterdam and Dublin made such calculations.

For middle and high temperature solutions buildings are connected to a district heating system that heats up the buildings with a temperature of 70 degrees Celsius or higher. Insulation measures are not needed, but are desirable to reduce the energy demand. For

[4] See D3.2. H/C guidelines

[5] Costs in the building: insulation, change of heating system & electrical cooking

[6] Costs in the energy system : decommissioning of gas grid, reinforcement of electrical grid and/or realisation of new district heating network as well as the explorations of new energy sources

low temperature solutions buildings are connected to the electricity grid (using heat pumps) or are connected to low temperature district heating systems. These options use heat of a temperature of 40 degrees Celsius. These kind of low temperature heating are most efficient when they have high levels of insulation and air tightness.

Temperature	**Above 70 degrees**	**Below 50 degrees**
Cost at buildings level	Low (cost efficient)	High
Costs at systems level	High	Low

Current system

The current energy systems also give direction to the H/C plan. Areas with district heating networks have district heating as preferred future heating solution. In some cities buildings connected to district heating also have gas connections (for heating district heating and for hot water gas or gas just for cooking, e.g. in Vienna) or buildings are not yet connected to the district heating network at all (e.g. Rotterdam, Munich) in these areas disconnecting from the gas grid is incorporated in the H/C plans.

Energy availability

All cities consider H2 and biogas not as high potential for decarbonising the heat demand. Both the limited (future) availability of any sort of green gas as well as the fact that these kinds of high-value energy sources can better be used in sectors where high-value energy is the only option, are reasons for the city to focus on district heating and (individual) electrical heating, by using heat pumps. Which of these solutions are possible depend on the potential availability of energy sources that fit those specific systems.

The availability of energy sources are taken into account, for example as mentioned above the limited availability of green gas is taken into account. The city of Bilbao looked at both the availability as well as the proximity of heat sources for the development of district heating networks. The city has no high temperature heat potential, so all district heating solutions are mid or low temperature. The city of Munich calculated that 80% of the future heat demand in the current district heating system can be delivered by geothermal heat. So expanding the district heating network does not make sense, the H/C plan of Munich therefore focusses on the current district heating network. Furthermore the northern part of Munich the district heating network can hardly be expanded, due to limited availability of geothermal heat.

Although energy potential supply from the different energy carriers are looked at, sector coupling and system integration are not yet analyses as part of the H/C plans. Cities see this as a next step. In general having a district heating system will improve resilience of energysystem, more energy sources can be used and more types of convertion are made possible. How this should be incoperated in the H/C plans is not part of the current H/C plans.

Building stock

Not all buildings can easily be retrofitted, especially old and historic buildings. The option for heating in these buildings are taken into consideration in mapping the solutions of district heating in the cities. The city of Munich uses another approach for buildings where retrofitting is not possible, a building oriented approach is used there. Especially buildings

close to areas with (planned) district heating are considered to be connected to district heating (even if the heat density is low).
Also the ownership of buildings is taken into account. In Dublin it was found that the lowest percentage of ownership is in the inner city area and overlap high number of apartments. These areas are considered hard to retrofit.

Spatial aspects
Every choice has also spatial impact (under and above the ground), and not all solutions are easy to fit in the built environment. The city of Bilbao explicitly used urban planning limitations to weight the different strategy, e.g. limitation in placing heatpumps on the roof in certain areas. In the other H/C plans these kind of limitations were not part of the H/C mapping. In Rotterdam it will be part of the next step, the H/C plan is the WHAT map (what solutions seems to fit best in what area) and the next step is the WHEN map (which area will be transformed first). In this WHEN map also spatial constraints or opportunities are taken into account.

Other
The legal framework is considered of great importance for all cities to realise the H/C plans. Cities do not have a complete set of regulatory and financial instruments to realise the H/C plans, the next steps are part of the roadmap (WP4).

H/C plans
The H/C plan differs per city. The cities of Dublin and Rotterdam mapped the preferred heating solution per area compared with the alternatives. While the city of Bilbao mapped three strategies, each showing per strategy in what areas it is most applicable, ending up with three potential maps.

Most of the cities focussed on mapping the future heat supply technology, cooling is not yet a fully integrated part of the plans. All cities do consider cooling an important element in the energy transition, that needs to be incorporated in future H/C plans. Some cities did look at the cooling demand and potential solutions. For example Bilbao looked at the cooling demand for the non residential buildings and Munich analysed the expansion of current district cooling system (using ground water) to replace individual air conditioning for non residential buildings. Winterthur shows in the map in which areas a significant cooling demand is expected as information for the utility to decide whether a cooling system shall be installed or not. Rotterdam made a separate map of the cooling demand and heat island effects in the city. Furthermore cities do see potential in low temperature systems that use heating and cooling from same system (heat/cold storage), for now this is mainly in new buildings installed.

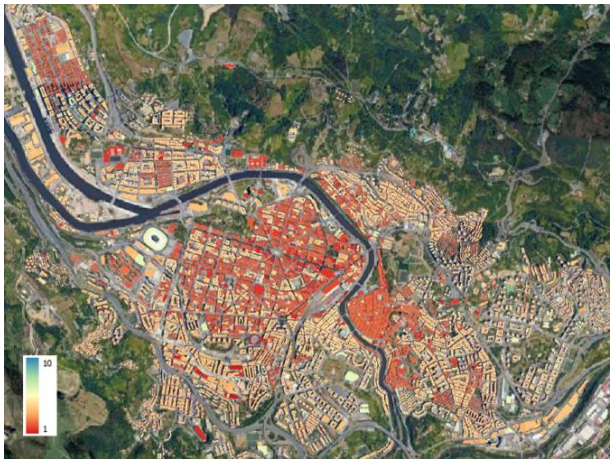
Cities where the grid owners are publicly owned, and especially where the electricity-, gas- and heat grid are owned by one company (e.g. in Winterthur and Vienna), making future integrated systemic H/C plans seems easier then in places where there are more owners and energy companies without strong public ownership and core values.

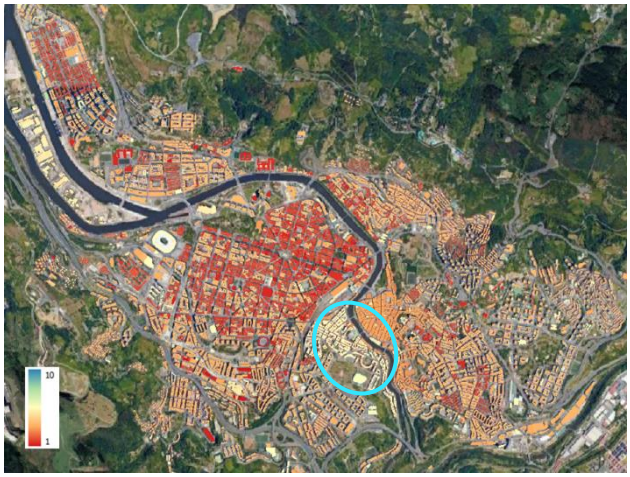
H/C plan per city

Bilbao

Bilbao mapped the potential of three scenarios in three different maps. The maps are not yet integrated into one H/C plan, that is the next step that will require more detailed analyses. Bilbao focusses on increasing building refurbishment with high energy efficiency requirements. 50% of the buildings will be “nearly-zero” in 2050. In order to have no direct use of fossil fuels by 2050 in the building sector natural gas needs to be replaced. The use of forms of green gas are considered unlikely.

Strategy 1: deep renovation of building blocks. No area has a higher potential for refurbishment. There are large areas with a very low score (red), due to the great weight of building characteristics, especially protection, which affect almost 40% of the city's buildings.





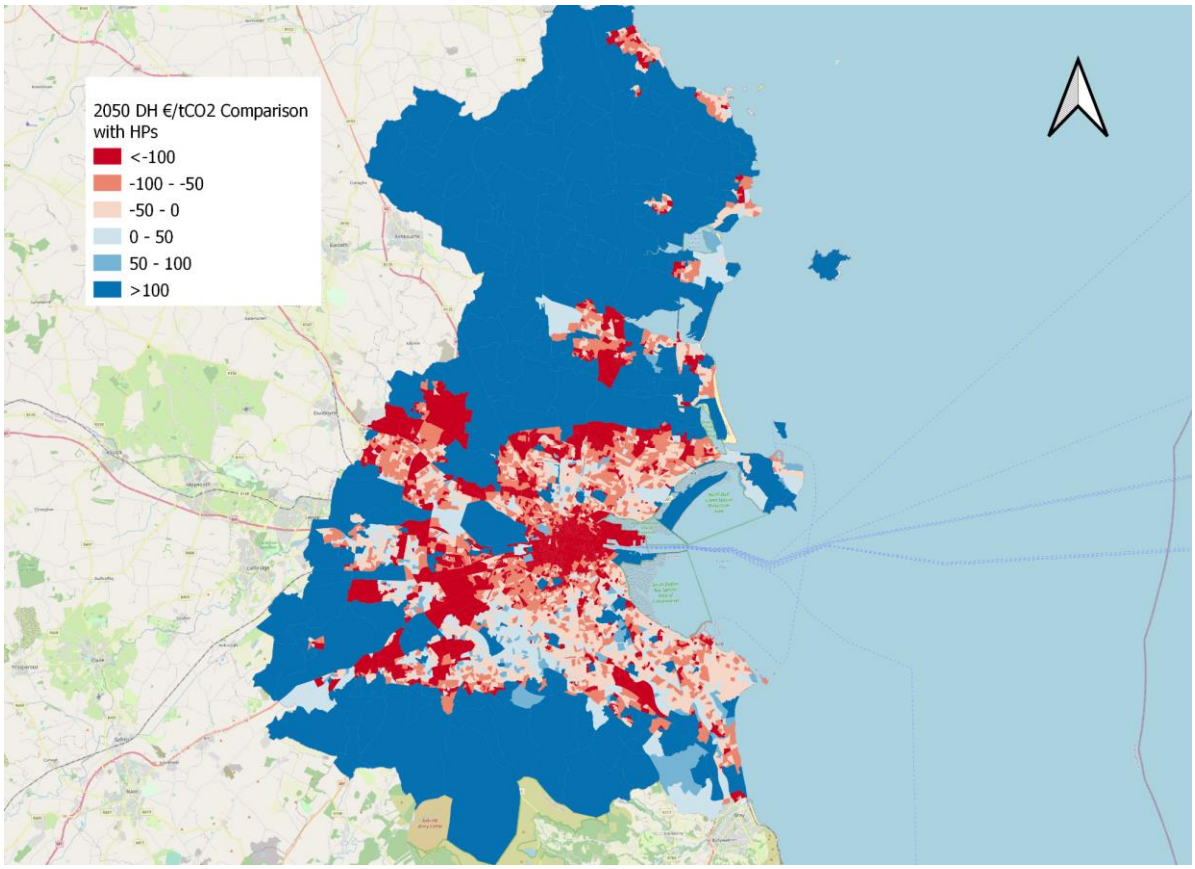
Strategy 2: individual heat pumps. For the implementation of aerothermal systems, urban planning as welll as buildings characteristics are considered in detail. New construction areas have a greater weigth since interventions are much simpler and they do not form part of heritage areas. Although there are no areas with a particularly high score, the area that includes the neighbourhoods of San Francisco and Bilbao la Vieja, stand out from the rest, as it is within an area of incorporated plans and without any type of protection.

Strategy 3: district heating and cooling networks. In this strategy, the protection of buildings has not been considered as a constraint, as the connection to district heating networks should be in most cases feasible. Greater importance has been given to the availability of the resource and the distance to it, as well as the space available for the construction of infrastructure if necessary.There are some areas that stand out : Casco Viejo, Bilbao la Vieja and Zorrozaurre. The first two are classified as Integral Rehabilitation Areas and they are mainly occupied by old buildings with low thermal efficiency. On the other hand, Zorrozaurre is an area currently under development in which a low temperature geothermal network is planned.

Dublin

The H/C plan of the Dublin shows the areas most suited to each technology up to 2050. The areas coloured blue are most suited to heat pumps and the areas coloured red are most suited to district heating. The darker the colour the most suited that area is to either technology. The priority areas are based on lowest non-discounted carbon abetement cost.

The prices of the alternatives were compared. This pricing includes the costs of new district heating infrastructure (production, distribution and substations), upgrade of the exsiting electricity grid and the medium fabric upgrade assumed needed for both district heating and heatpumps. It is likely that heatpumps will require more. Also the emissions were calculated, including equivalent emissions (CH4 leaks, NOx emissions, refrigerant leaks (scaled down over time based on F-gas phase down).

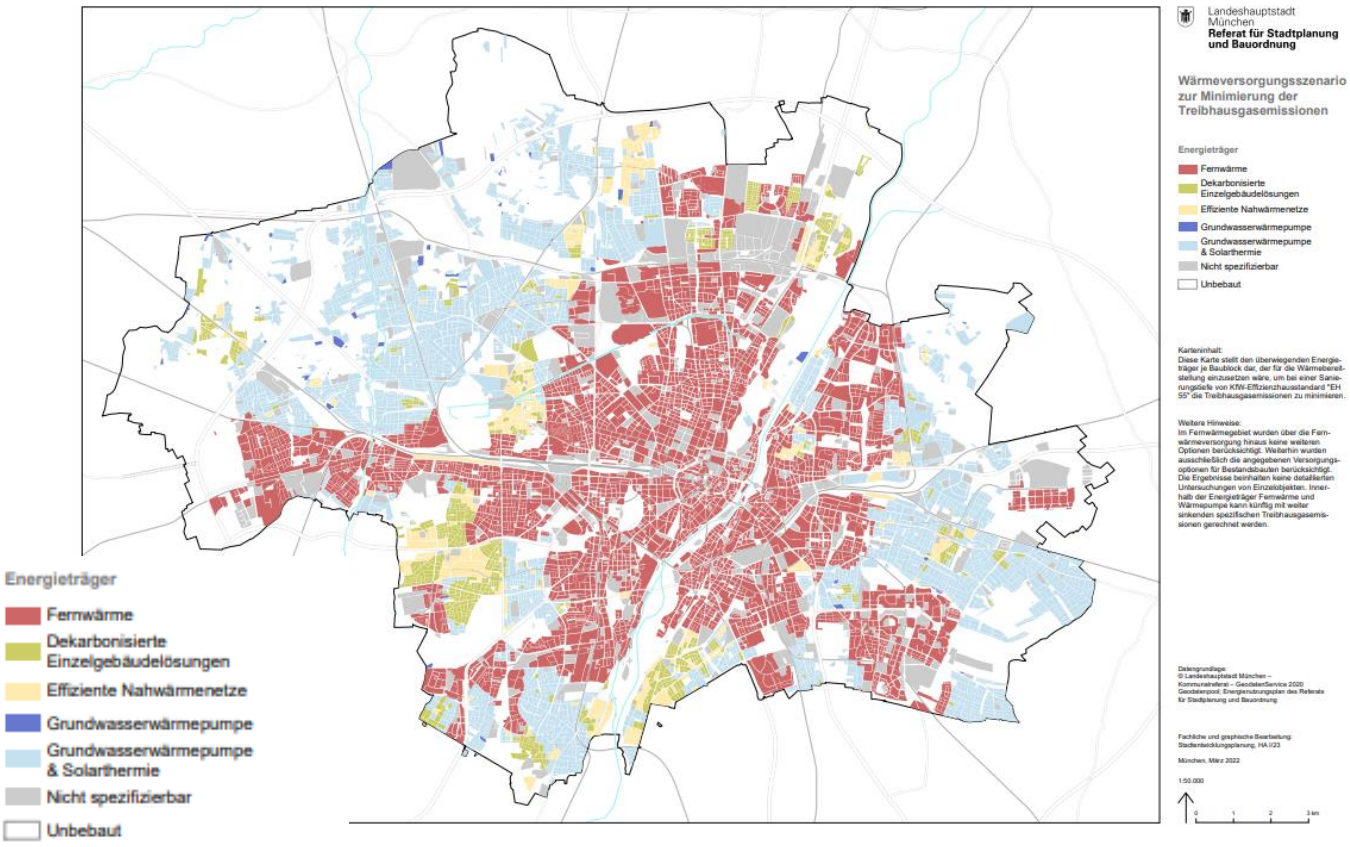


District heating is an important part of Dublin's net Zero by 2050 pathway as described in the Dublin Region Energy Masterplan. District heating is preferred for up to 87% of the cities heat demand in 2050.

New buildings will be built as nearly Zero Emissions Buildings.

High-exergy fuels should not be used for low-exergy uses like space heating & hot water production. The heat demand will move away from fossil fuels and use predominantly local sources via district heating and heat pumps.

Munich



Munich works towards climate neutrality by 2035. This means phase out oil heating and develop solutions for gas heated buildings. In order to organise this a spatial heating and cooling strategy based on the current building stock and district heating network is made.

Munich has a digital building database and identified the potential of RES for each building. The reduction of heat demand and GHG reduction potential for each building (in different retrofit scenarios) is calculated.

The starting point of the H/C map is th increase of the number of district heating connections inside the district heating area. Outside the current district heating area the use of heat pumps (groundwater) is assumed. The district heating owners work on a strategy to make the heat supply from the district heating network renewable (geothermal heat is one of the options).

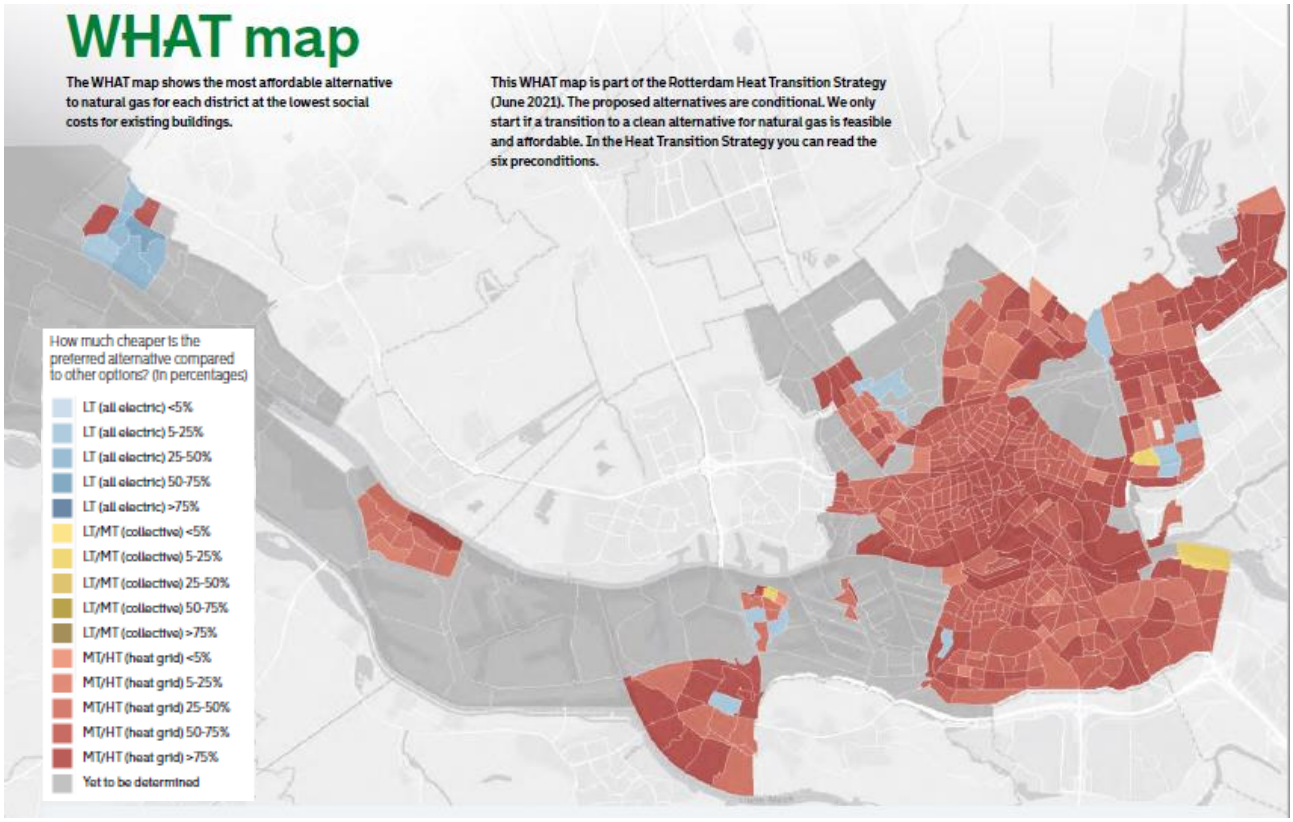
The H/C plan shows the options outside current D/C network area, retrofitting is part of the solution.

Most buildings need to be retrofitted.

Rotterdam

The H/C plan of Rotterdam is called the WHAT map. It indicates what kind of solutions are economically most attractive per area. In large parts of the city collective heating solutions are an attractive alternative to natural gas in terms of affordability for residents, landlords and businesses. A medium or high temperature heat network is the cheapest alternative for the majority of Rotterdam's districts. The advantage of a heat network is that it is suitable for using other sources of heat in the future, making it a no-regret investment.

Another sustainable alternative to natural gas is electric heating with heatpumps (all-electric). This is an individual solution per house, which is relatively expensive. Most existing houses in Rotterdam must be heavily insulated for this type of heating, making this solution, on balance, often more expensive. This is show in the WHAT map.



The WHAT map is a long(er) term strategy of potential solution in the different districts. It is not a decision for the type of solution, but a starting point for district oriented approach. It does show what solution is preferred based on in depth total costs calculations.

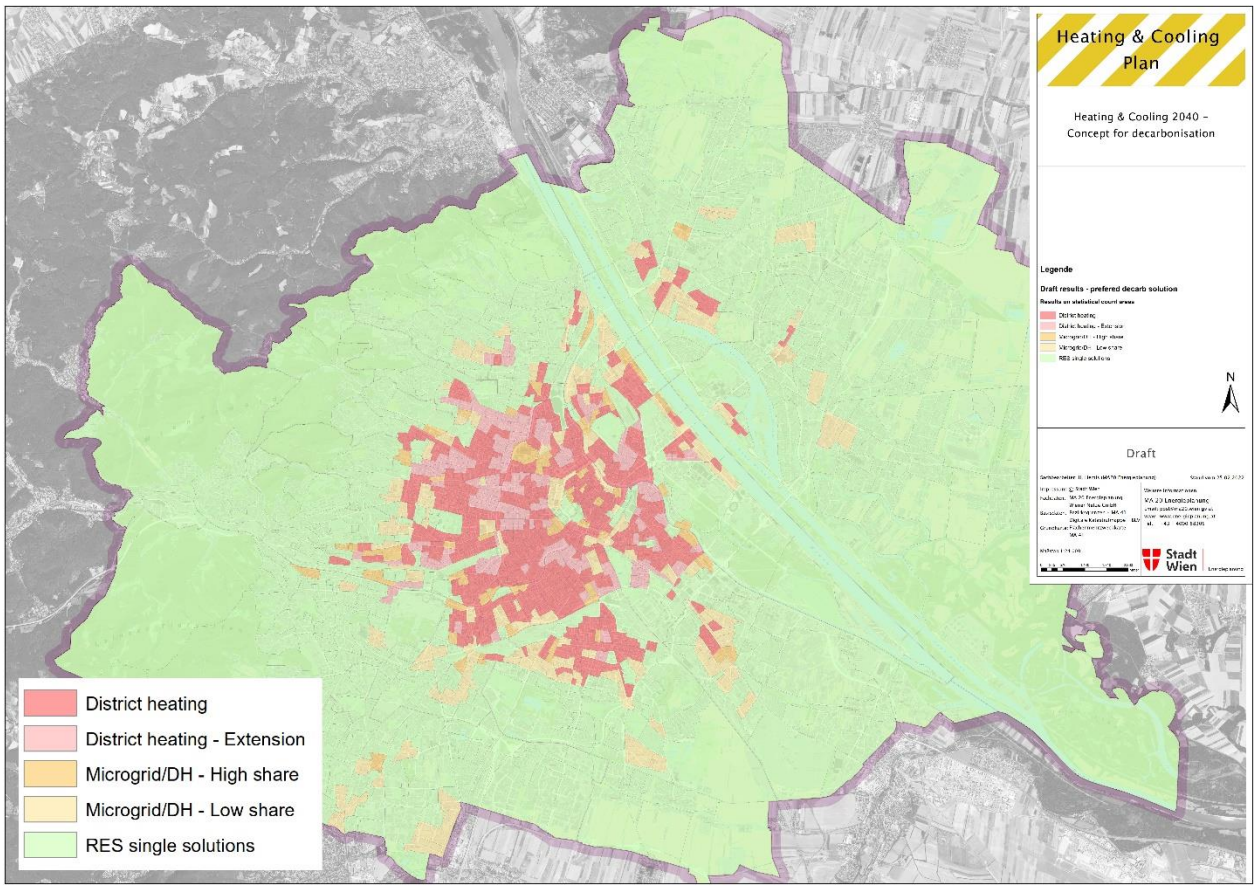
Furthermore the city of Rotterdam stated that district heating networks should be used where already available (so no other calculation needed). When district heating is not closeby then calculations are made.

Costs of heatsource is not explicitly included in calculations, but partially it can be find in the energy use costs (based on actual energy costs by the energy/heating compagnies).

The WHEN map is the next step: where to begin with the district oriented approach. In this next step externalities will be taken into account (e.g. spatial impact, unlimited supply of heat available etc).

Vienna

The H/C plan of the city of Vienna shows areas distinguish between district heating densification, district heating extension, mirco grids and single solutions. It is a first concept plan that will be in time updated and improved, based on new data and knowledge



In the areas where there is already district heating networks the focus is on disconnecting the buildings from gas grid and densify the district heating. The first spot is set on buildings which are next or close to existing district heating pipes. At the the same district heating has to be decarbonised. New heatsources are (deep) geothermal heat and the use of large central heatpumps using ambient heat e.g. from the Danube river (Donau). The use of any forms of green gas is an ongoing discussion, current vision is to primairly use this high value gas for peak and back up heat supply or for high temperature process heat.

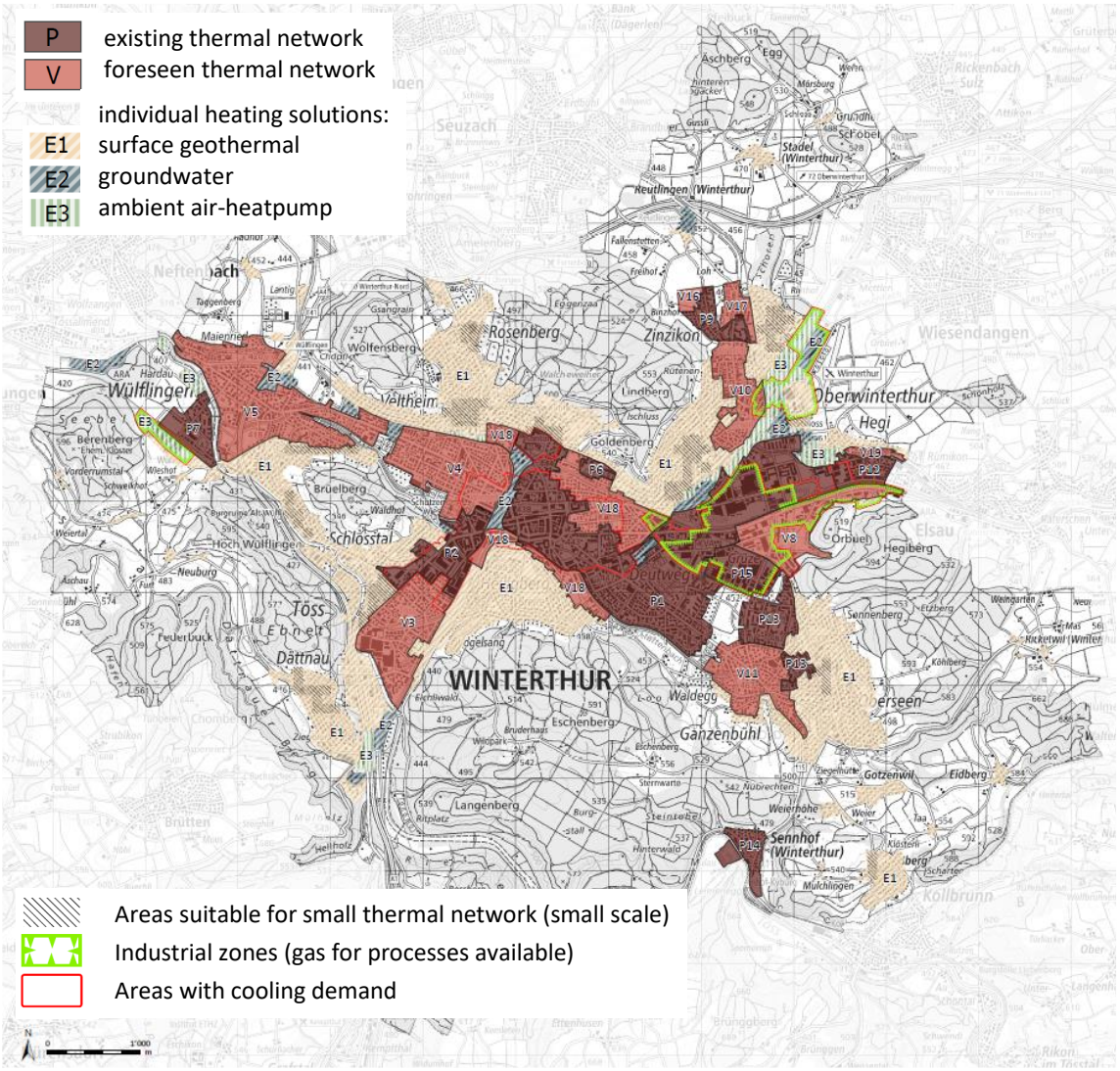
In areas where the central district heating is not possible decentralised solutions are planned. The possibility of low temperatures district heating networks is looked into (using e.g. aqua thermal heat from the Danube river or from data center), if that is not possible individual solutions are needed. The capacity of the electricity grid is taken into account when applying heatpumps (also regarding pv installations and fast charging stations for e-mobility).

Building typologies as well as renovation rate[7] are part of the scenario analyses that took place. The best decarbonised option (decarbonisation type) were examined per building type and the number of buildings and gross floor area for each category was calculated.

Optimising the system is part of the H/C plans, e.g. using the return flow of the district heating network for new buildings to reduce the temperature in the whole district heating network

[7] The current renovation rate is estimated between the 1 and 2%, the ambition is 3% per year.

Winterthur



The net-zero-goal to achieve in 2040 is confirmed by voting population in November 2021. This is translated into 1 ton CO_2/person in 2033, for heat-supply 300 kg/person.

Key elements of the H/C plan are:

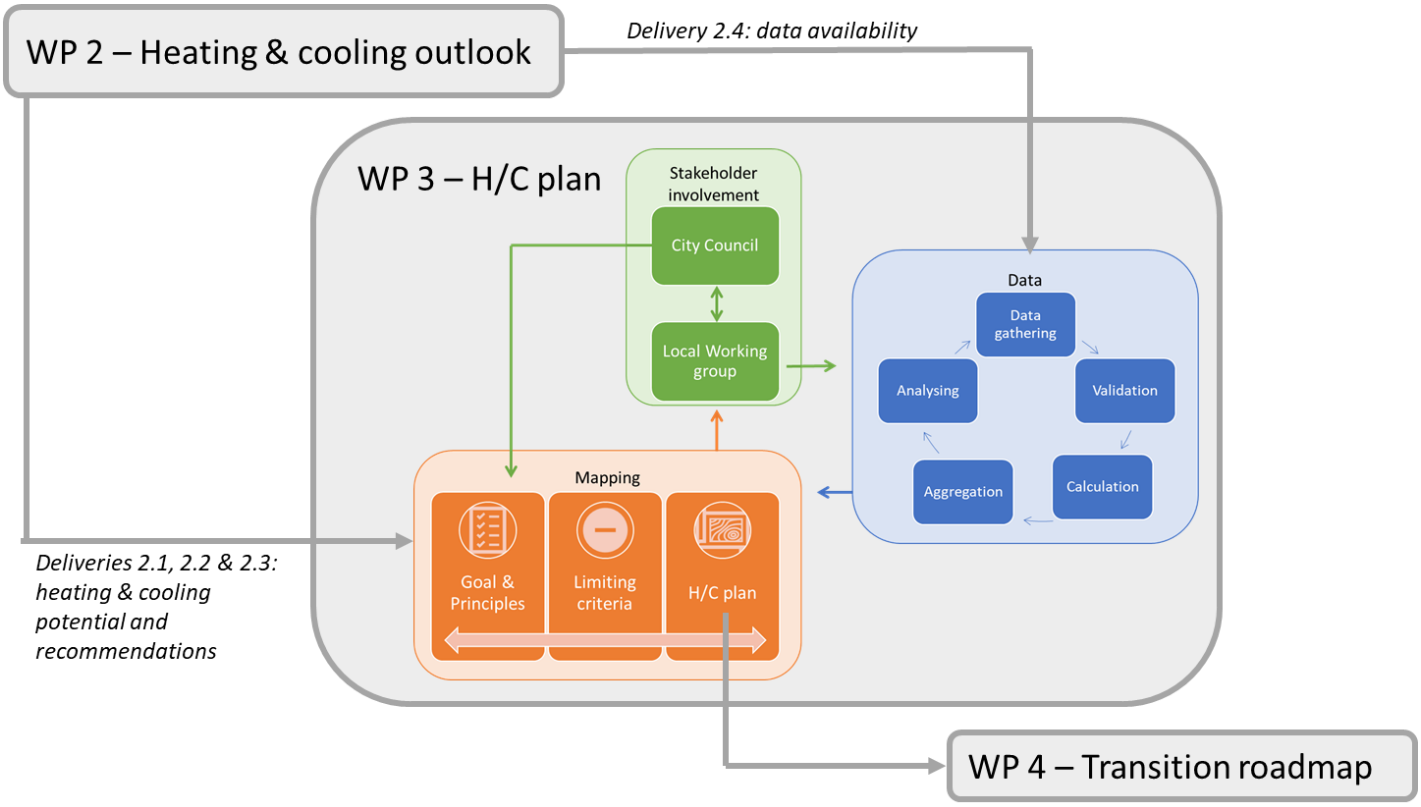
- Retrofitting
- The reduction of gas infrastructure (closure parts of the grid) and use gas only in industrial processes and peak-capacity (as of 2033 this will by forms of green gas).
- District heating in areas with heat-density more than 400 MWh/ha/a
- Other areas: heatpumps with surface geothermal heat or ambient air

The H/C plan was made in cooperation with the utility grid owners (as part of the local working group) and new ways of thinking were introduced (mind opener/ lateral thinker / thinking outside the box). This resulted in agreement and conviction of the utility so that transition will work.

This energy plan is the first step (vision) and the next steps are feasibility study, financial viability, resources potential research, etc. Current legal framework supports planning and achievement of goals, e.g. owners can be forced to connect to district heating, this legal instrument however has not been used pervious years.

Appendix: Data use

The data use and the outcome of WP3 of Decarb City Pips project are related to the other workpackages in this project. Direct connections can be found between WP 2 and WP 4:



The outcome and date used are relevant for all steps in the process. For the spatial planning data is used and processed. For more detailed information on data availability, data sovereignty, quality and exchange in the participating cities please see the deliverable 2.4.

Two points of attention are mentioned related to the use of data for making H/C plans, 1) the definitions used and 2) the availability and quality of data.

Ad. 1. Definitions

It is important to have clear definitions that will be used during the whole process. For example, how is the heat demand defined? Is it in MWh or in GJ. Are the plans made per building? Is one building also one household? Or has one building one energy grid connection? So is an appartment building with one connection the same as a ground bound house? Are you using “average heat demand per household”? Etc. etc.

Every definition has pro’s and cons and in time consequences. It is good to be clear on the definitions that are used and for what specific defintions will be used. Some defintions are useful for monitoring but not for explaining the impact of the transition for the people involved.

For example in the Netherlands often the heat demand is translated to WEQ (Household heat demand equivalent = average heat demand per household per year). This WEQ however does not give information on the number of homes, one home can use 1,5 WEQ. In time due to insulation the WEQ should be reduced, making monitoring of progress of reduction of number of gas connections very difficult. At the same time the use of WEQ can be helpful in making readable and understandable plans for also not experts.

Any definition can be usefull, as long is clear what definition is used and as long as it is used consistently.

Ad 2. Availability and quality

Another point of attention, which is also part of D2.4 is the availability of data and especially the quality of data. If you use inaccurate data to map the H/C plan the result is also inaccurate.

Sometimes the availability and quality of data makes it necessary to first have an overall general analyses (minimum variant) and in time, while getting more detailed information, work towards more and deep insight (digital twin).

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DECARB CITY PIPES 2050

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