DECARB CITY PIPES 2050

Dublin H/C Plan

Deliverable 3.3

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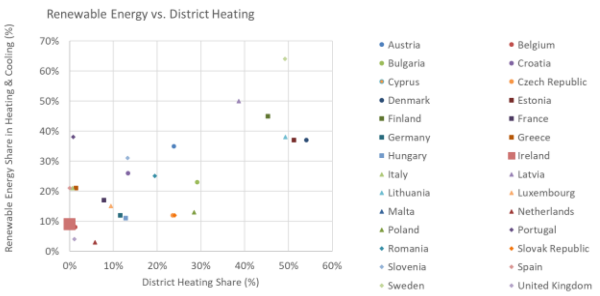
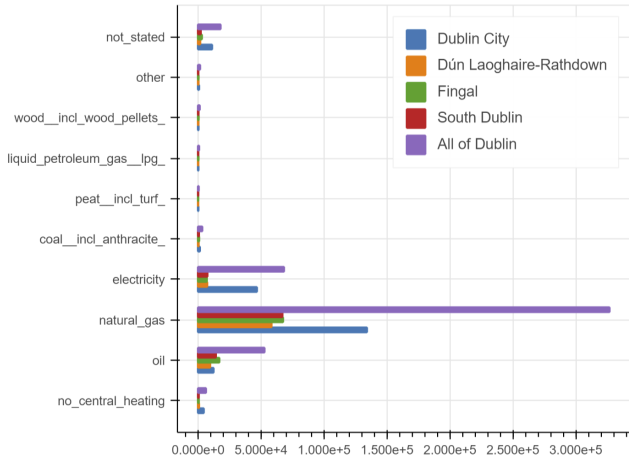
Table of Content

Introduction

Heating is a hugely important sector in Ireland when it comes to decarbonisation as it represents approximately 40% of energy demand (twice the demand of electricity) and is the worst performing sector in terms of renewable proportion (currently at 6.3% of total heat production) behind both electricity and transport.

District heating networks potential to enable greater uptake of renewable and waste heat sources is shown in the figure below where there is a strong correlation between DH and renewable heat proportions.





The majority of buildings in Dublin use gas fired heating. The gas grid covers practically the whole city, developed at national level by semi-state-owned companies without considering where DHC grids may be a better option. The figure below shows the breakdown of type of heating technologies currently installed in Dublin. This shows that gas is the dominant heat fuel followed by direct electric (not heat pumps), particularly in the inner city where many apartments are heated in this way. the current distribution of fuel sources in residential dwellings reads: Gas 74% (assumedly mainly individual), Electric 18% (mainly direct), Oil 7%, and Coal/Biomass 1% (percentages relating to the share of dwellings supplied by each respective fuel source).

Currently the heating sector has a very low penetration of renewable energy, Ireland is the worst performing country in the EU with a renewable heat proportion of just 6.3%.

District heating is new technology in Ireland, currently representing less than 1% of the heat market but with potential for this to be between 50% and 60% based on a 2019 study performed by the Heat Roadmap Europe researchers and results from SEAI’s National Heat Study. The potential for DH has been recognised in the national Climate Action Plan 2021 where a target of 2.7TWh of heat is to be supplied via DH by 2030. This target represents 10% the all residential and commercial heating in the country.

To support this roll out of DH there are also actions in the Climate Action Plan where the government will:

- Support through the Climate Action Fund
- Establish a system of governance for the development of district heating policy
- Perform research to support the rollout of district heating in Ireland
- Develop a regulatory framework to protect customers & suppliers
- Ensure planning framework encourages and facilitates the development of DH – zoning of areas for DH
- Identify appropriate financing mechanism to support delivery of DH including financial incentives similar to retrofit grant programs
- Update relevant regulatory & legislative tools to enable roll out of DH infrastructure

There is an agreement today that more bottom-up effort is required, but municipalities have a very low level of autonomy trying to find paths through their limited remit to influence the use of energy and emissions in their regions. Dublin has become a pioneer in Ireland for local level energy planning and DHC implementation, both of which are completely new practices in Ireland. Codema, as the energy agency for Dublin, has been building these skills and practices with the Dublin municipalities through numerous EU & national level projects. The municipality have now committed to developing a citywide DH scheme, outlined in the "Dublin City Climate Change Action Plan 2019-2024".

Importantly, Dublin intends to use its local working group to create effective leadership, policy and buy-in to the low-carbon heating/cooling transition needed to overcome barriers to the roll-out of other alternatives to gas grids. The Dublin Local Working Group is made up of local, regional & national level stakeholders who are fundamental to success of the roll-out of low carbon grids in the city. This is a new group established specifically for this project.

Dublin has made significant progress in DH in the last few years. The first large-scale DH network in the county is currently being constructed and will be operational by July 2022. This DH network is the first not-for-profit public utility in the country and the first to use data centre waste heat as its heat source.

The development of a much larger DH network in the Poolbeg area of the city is also progressing. A preliminary business case report has been produced for this project as well as extensive engagement with customers and ESCo's who may be responsible for the construction and operation of the proposed network. There has also been significant progress made in planning policy in the city to support DH with requirements for buildings to futureproof for connection in certain areas of the city. €20 million in funding has also been secured for this project's development.

Further potential projects are also being explored by Codema looking at geothermal heat, sector integration to utilise otherwise curtailed renewable electricity for heating, further data centre projects, etc.

Facts & figures: the context

Population and Population Growth

The most recent census has the population of Dublin County at 1.34 million inhabitants. Increases in the building sector energy demand to 2030 can be attributed to a number of variables. The main impact on future predicted energy demand can be linked to population growth which is coupled with an increase in both residential and non-residential buildings, which is driven by planning developments. The Economic and Social Research Institute (ESRI) has published population projections and annual average population growth rates for Ireland, this is further broken down by region (table below). For Dublin it has been estimated that the population from 2016 to 2040 would increase annually by an average of 0.9%.

TABLE 1: ESRI POPULATION GROWTH RATES BY REGION[1]

	Population ('000s)			Annual Average Growth		Population Share	
	2011	2016	2040	2011-2016 %	2016-2040 %	2016	2040
Border	514.9	523.2	589.0	0.3	0.5	11.0	10.5
Midland	282.4	292.3	330.5	0.7	0.5	6.1	5.9
West	445.4	453.1	534.1	0.3	0.7	9.5	9.5
Dublin	1,273.1	1,347.4	1,639.8	1.2	0.9	28.3	29.1
Mid-East	531.1	560.0	707.5	1.1	1.1	11.8	12.6
Mid-West	379.3	385.0	449.4	0.3	0.7	8.1	8.0
South-East	497.6	510.3	585.4	0.5	0.6	10.7	10.4
South-West	664.5	690.6	799.2	0.8	0.7	14.5	14.2
State	4,588.3	4,761.9	5,634.8	0.8	0.8	100.0	100.0
Northern and Western	837.4	847.4	961.6	0.2	0.6	17.8	17.1
Eastern	2,209.5	2,328.5	2,839.2	1.1	0.9	48.9	50.4
Southern	1,541.4	1,585.9	1,833.9	0.6	0.7	33.3	32.5

The National Planning Framework2 (NPF) for Ireland is projecting a need for 550,000 more homes by 2040, of which 25% of these (137,500 homes) have been planned for Dublin. The NPF has also identified that over recent years there has been an 'ongoing shift in population and jobs towards the east counties'.

[1] https://www.esri.ie/system/files/publications/RS70.pdf

[2] https://npf.ie/project-ireland-2040-national-planning-framework/

The figure below shows the current average occupancy per dwelling by small area, which has been sourced from the 2016 census. Mean dwelling occupancy was calculated by dividing the total number of occupants per household ("T6_3_TP" or "Total Persons") by the total number of dwellings ("T6_3_TH" or "Total") in each small area. The legend represents the mean number of occupants per dwelling in each small area where red and green indicate a higher and lower number of occupants respectively. In Ireland the average household size was 2.75 people per dwelling[3]; in the Dublin region this is approximately 2.72 people per household.

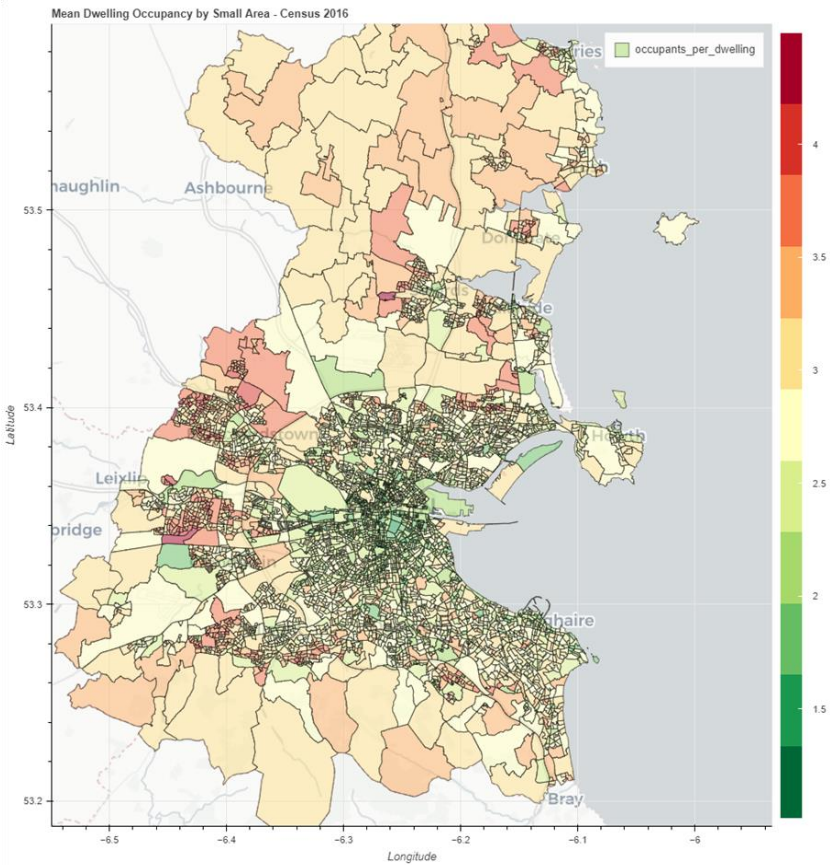


FIGURE 1: AVERAGE DWELLING OCCUPANCY BY SMALL AREA IN 2016 (SOURCE: CENSUS 2016)

It should be noted that even though the number of buildings (both domestic and non-domestic) are set to increase, building regulations, particularly for new builds, have set out strict guidance on energy performance in buildings.

All new buildings are to be built to nearly zero-energy building (nZEB) standards, which is defined as a building that has a very high energy performance, as determined in accordance with Annex I of the Energy Performance in Buildings Directive, i.e. the Dwelling Energy Assessment Procedure (DEAP) and Non-domestic Energy Assessment Procedure (NEAP). Codema have used typical heat demand figures for these nZEB buildings and assumed a similar floor area per capita requirement for housing and commercial buildings to calculate the additional heat load for this population increase.

[3] https://www.cso.ie/en/releasesandpublications/ep/p-cp1hii/cp1hii/od/#:~:text=In%202011%20there%20were%20on,increased%20from%202.40%20to%202.48.

Dwelling Ownership

Home and business tenure is an important consideration for building energy upgrades. People living or have a business in rented accommodations are less likely to take on any upgrades to their property, whereas owner occupied buildings are more likely to be retrofitted as the owner occupier will be seeing upgrade benefits in the reduction of consumed energy costs. This often means that for rented accommodation and business properties, building owners would have very little incentive to invest in costly measures to improve energy efficiency as they do not directly benefit from them. Introducing minimum energy performance standards for rented buildings might be a way to increase the rate of retrofits in these buildings.

This map of Housing Percentage Ownership was created using the open-access Small-Area Population Statistics (SAPS) 2016 data provided by the CSO. Ownership was calculated by dividing the total number of dwellings owned with a mortgage (T6_3_OMLH":"Owned with mortgage or loan"), together with the dwellings owned outright (T6_3_OOH":"Owned Outright") by the total number of dwellings ("T6_3_TH":"Total"). The colour ramp represents percentage ownership of the housing stock where red and green indicate a higher and lower ownership, respectively.

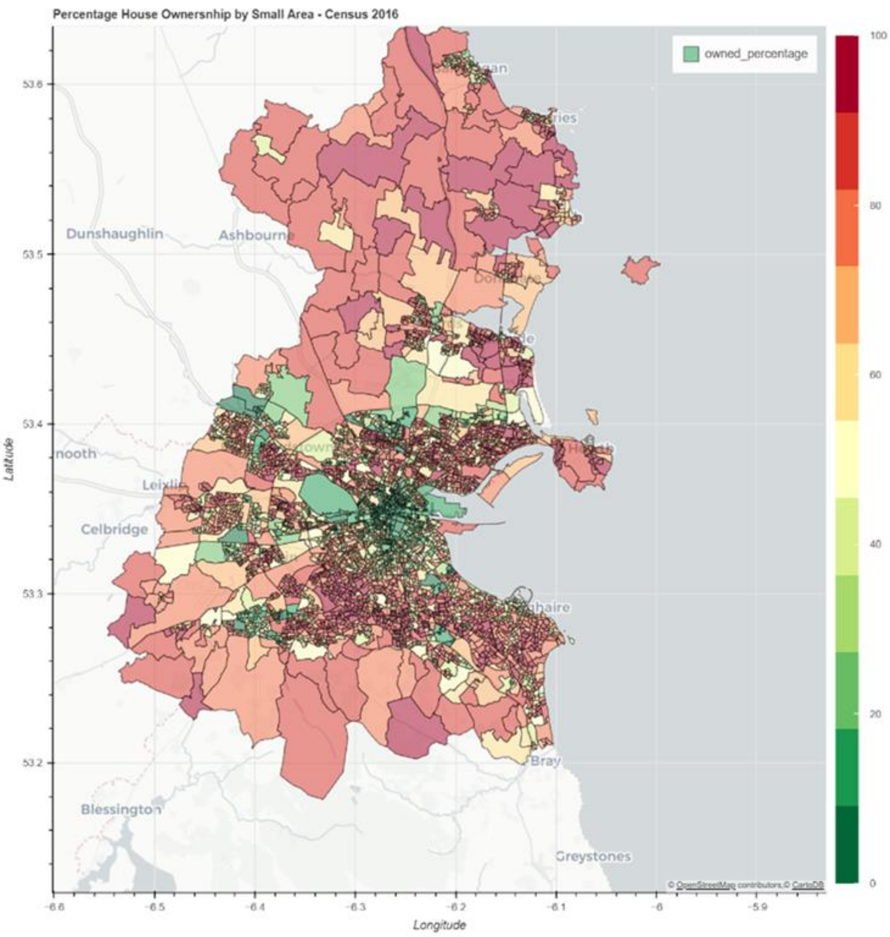


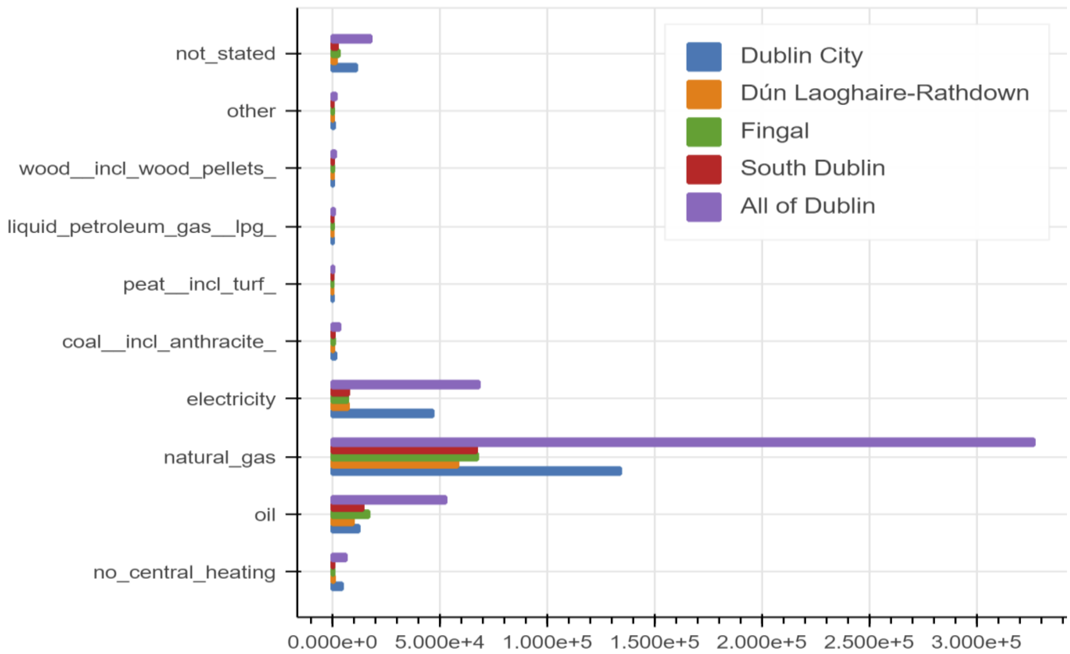
FIGURE 2: HOME OWNERSHIP PERCENTAGES IN DUBLIN BY SMALL AREA (SOURCE: CENSUS 2016)

The figure above shows the home ownership percentages in the Dublin Region. The lowest home ownership can be found in the inner city area and these areas overlap with areas that have a high number of apartments. For example, 52% of all residential buildings in Dublin 1, 2, 7 and 8 are apartments; these same areas also have poor BERs, with 68% of the residential stock with a D1 BER or worse. Therefore, these buildings (inner city apartments) will be some of the hardest to retrofit.

Analysis of the rebound effect in residential dwellings, Aydin et al4 compared theoretical consumption (based on that expected from the Energy Performance Certificate/Building Energy Rating) to actual consumption (based on metered gas consumption) for 710,000 buildings in the Netherlands. It was found that as energy efficiency gains change, the perceived cost of energy services generates shifts in consumption patterns in what is referred to as the Rebound Effect. In simple terms, the Rebound Effect is the percentage of the theoretical savings that are not realised in reality. The results of this study show a rebound effect of 26.7 % among homeowners, and 41.3 % among tenants. These figure were used to derive more accurate future heat demands for dwellings whose fabric will be upgraded.

Current Situation - Heating Technologies

The majority of buildings in Dublin use gas fired heating. The gas grid covers practically the whole city, developed at national level by semi-state owned companies without considering where DHC grids may be a better option. The figure below shows the breakdown of type of heating technologies currently installed in Dublin. This shows that gas is the dominant heat fuel followed by direct electric (not heat pumps), particularly in the inner city where many apartments are heated in this way. the current distribution of fuel sources in residential dwellings reads: Gas 74% (mainly individual), Electric18% (mainly direct), Oil 7%, and Coal/Biomass 1% (percentages relating to the share of dwellings supplied by each respective fuel source).



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[4] Aydin, E., Brounen, D. and Kok, N., 2013. The Rebound Effect in Residential Heating. https://www.tilburguniversity.edu/sites/tiu/files/download/The%20Rebound%20Effect_EA300813.pdf

Current Energy Infrastructure

The main piece of heating infrastructure in Dublin is the gas network. The current gas network in Dublin is approximately 5,700km in length. A breakdown of the gas network by pressure and pipe construction material can be seen in the table below.

TABLE 2: DUBLIN GAS NETWORK PIPELINE LENGTHS

	HP (metres)	MP (metres)	LP (metres)	Total Length (m)
Polyethelene	0	2,015,406	3,367,718	5,383,124
Steel	255,795	48,680	4,278	308,753
Cast Iron	0	0	71	71
Ductile Iron	0	0	1	1
Total length by Pressure	255,795	2,064,085	3,372,067	

The other piece of infrastructure used for heating is the electrical grid. This infrastructure and its constraints have also been mapped for Dublin. The constraints based on available substation capacity can be seen in the figure below. These constraints were used to calculate the cost of grid upgrades associated with heat pump adoption by adjusting the average upgrade cost based on the portion of capacity available on the grid within a given area.

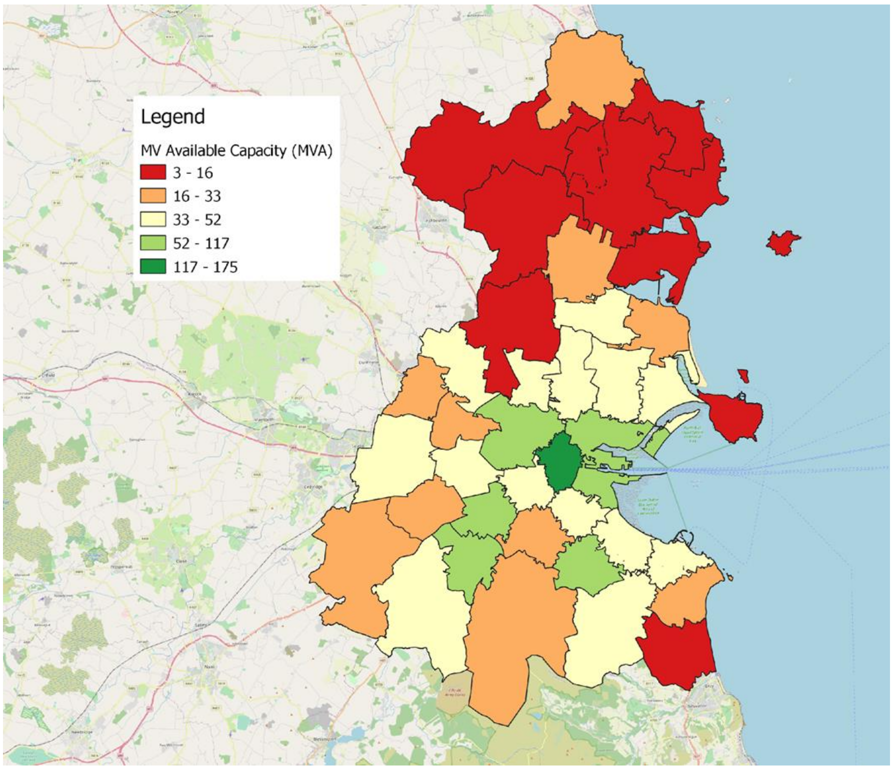

FIGURE 3: ELECTRICAL SUBSTATION REMAINING CAPACITY (MVA) MAP

Process

This section provides an overview of the process used in developing the H/C Plan. The main steps in the H/C plan process were as follows:

1. Data gathering – stakeholder engagement with CSO, SEAI, Valuations Office, Utilities (ESB on the electricity side and GNI on the gas side), Local Authorities, Academic Institutions to gather and understand available data.
2. Mapping of data in GIS (Geographical Information System)
3. Generating calculations based on data to provide insight on decarbinisation pathway to find what is the most cost-effective way to decarbonise heat for each area of Dublin using €/tCO2 saved as the primary metric which is discussed in greater detail in the Analyses and data aggregation section.
4. Draft plan discussed with the local working group.
5. Finalised cost-effective spatially mapped pathway (see 2030 map below)

The scope of the H/C Plan focused on the space and hot water heating in Dublin rather than high temperature industrial heat requirements although lower temperature industrial was included. The main goal was to identify the best technology pathway for heating in each of the almost 5,000 small areas in Dublin. The two main technologies investigated were district heating and air-source heat pumps. The preferred option was determined based on having the lowest cost of carbon abatement (€/tCO2).

Framework and principles

Pathway determined by lowest cost of carbon abatement in heating sector DH vs ASHPs (including Capex, Opex, Repex and CO_2 equivalents from methane and refrigerant leaks) for the period up to 2030 and 2050 (i.e. not just in that year). The key metric used was the €/tCO_2 saved. Decarbonisation of the gas grid limited by capacity to produce biomethane and the current technical restriction on using hydrogen in existing gas infrastructure (see emissions factor below)

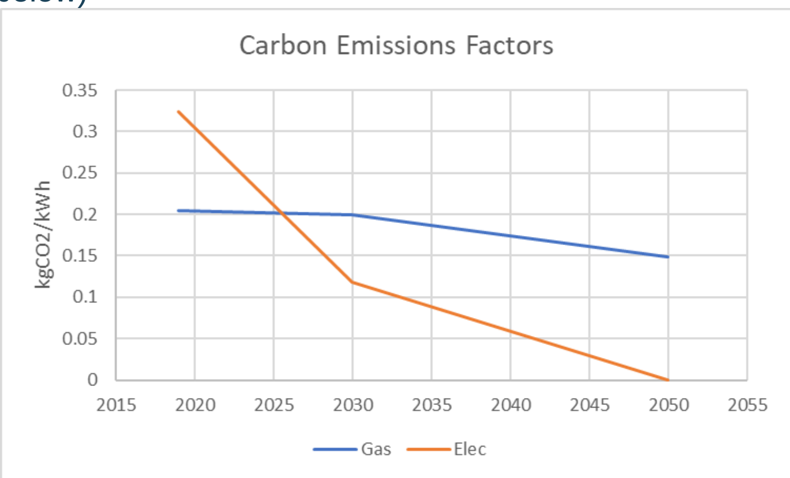

Figure 4: Carbon Emissions Factors

Green hydrogen not considered suitable for low-exergy applications such as space heating and hot water preparation due to inherent inefficiency when compared with alternatives.

Assumed that all future buildings will be nZEB and various fabric upgrade options were considered for existing buildings.

Heat Sources in Dublin

The graph below should range of 18 heat sources investigated by Codema for heat planning purposes and also includes typical temperature ranges for each heat source and highlights how that matches up against potential end use temperature requirements.

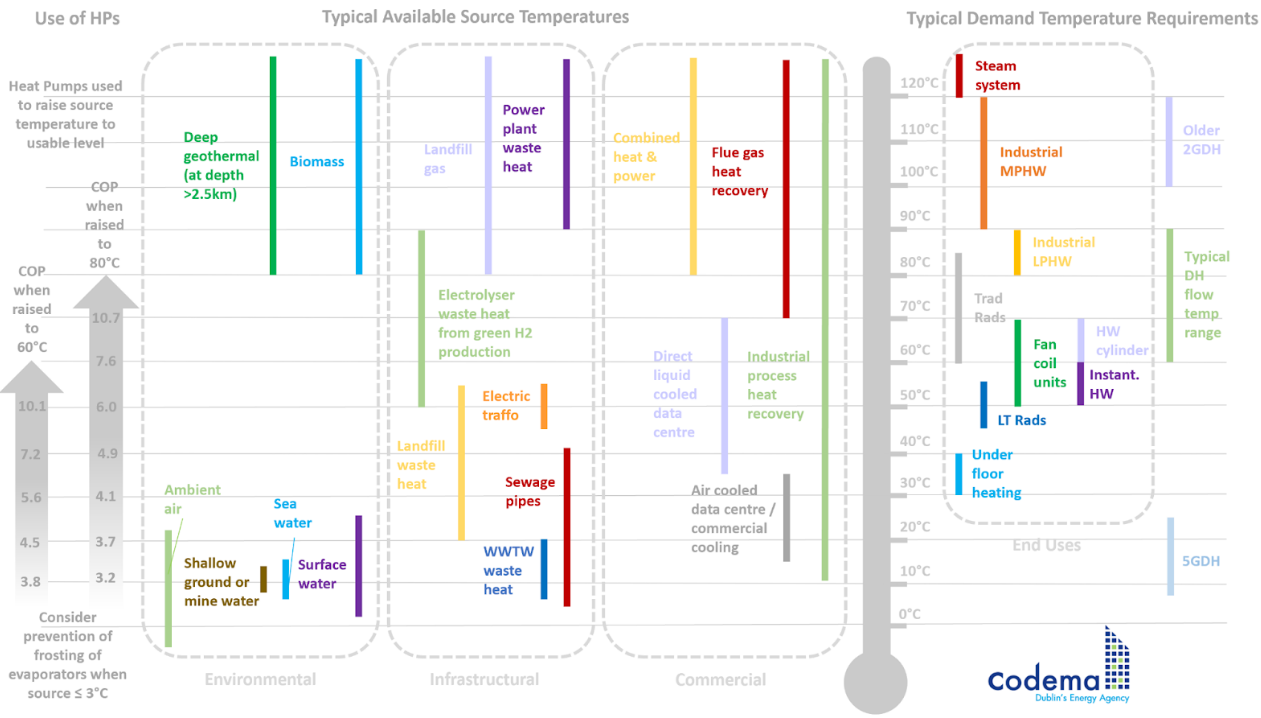

FIGURE 5: HEAT SOURCE AND END-USE TEMPERATURES

The graph below shows the breakdown of heat sources available in Dublin for the current and future scenario. It can be seen from this graph that the main changes over this period is the significant reduction in heat available from power plants as renewable electricity generation increases. This reduction is offset by increased heating potential from data centres and from renewable electricity generation which would otherwise be curtailed.

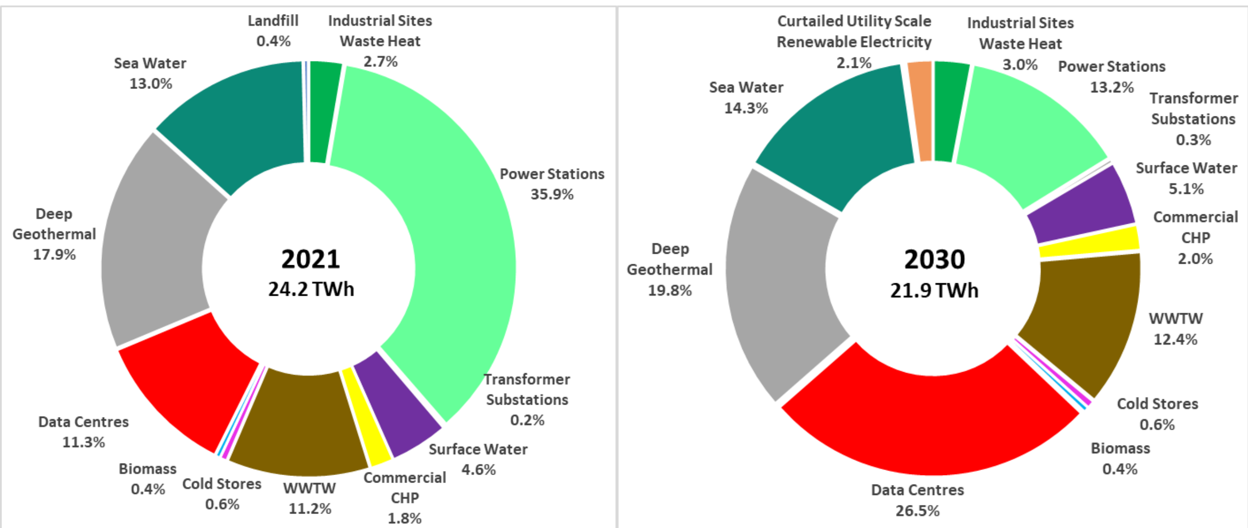

FIGURE 6: HEAT SOURCE BREAKDOWN FOR 2021 AND 2030

It should also be noted that the capacity figure for the surface water heat loads shown in the figure above is a conservative one, as it is based on the Q95 flow (i.e. dry weather flow). This flow rate was chosen based on the assumption that the source waterways are fisheries and as such, have limits on the degree to which their original temperature can be altered without adverse impacts on the fishery. This also assumes a constant heat extraction rate. It may be possible to have variable extraction controlled by the source temperature to prevent excessive cooling of the source. Under these conditions, the mean flow could be used; this would increase the potential heat capacity from surface water. If it was assumed that there is no impact on fisheries and therefore that the reduction in river temperature is only limited by technical constraints, then this capacity could increase further compared to what is shown in the graph.

These sources have been broken down based on their average supply temperatures in the graphs below. This provides an indication of the quantity of higher temperature heat that could be utilised for direct use in DH networks (>60°C) without requiring heat pumps. The medium temperature sources which can supply heat between 20°C and 60°C would likely require a heat pump to bring them up to a usable temperature for typical DH networks but these could achieve very high COPs, likely to be above 3.5 and perhaps up to 12 (i.e. 12 units of heat for every 1 unit of electricity). The low temperature range (<20°C) would require heat pumps to raise their temperature to a usable level. Even when using the same sources as individual building heat pumps, these large-scale heat pumps generally provide better COP than the smaller alternatives. This is due to a number of reasons; these large-scale HPs are continually monitored to ensure their performance is optimised, they have continual maintenance to ensure efficient operations and the economies of scale allow for use of two-stage compression, which improves efficiency when using lower temperature sources.

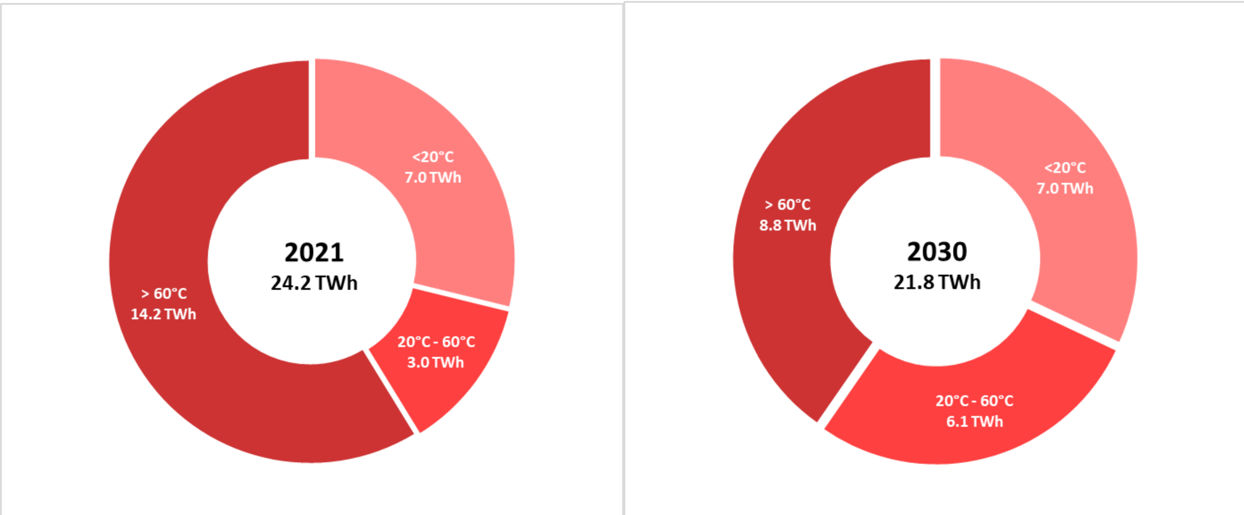

FIGURE 7: HEAT SOURCE BREAKDOWN BY TEMPERATURE FOR 2021 AND 2030

Analyses data and aggregation

The analysis outlined in this section is based on analysis performed by Codema as part of the Dublin Region Energy Masterplan.

Initial Assessment of Heat Demand

The heat demand was calculated using domestic building energy rating (BER) information for the dwellings for which this was available and these demand demands were then extrapolated to the full buildings stock based on the age and location of the dwellings for which the BER was not available. Codema created a synthetic building stock model to facilitate this and to allow future fabric upgrades to be analysed. This building stock model allows for the u-value of various elements of a dwellings envelope (walls, windows, etc.) to be adjusted and for a new heat demand to be generated based on these changes. Commercial building heat demands were calculated using the building floor areas and CIBSE benchmarks. Public sector heat demands were based on metered consumption.

The maps on the next page show the heat demand density in TJ/km² for each CSO small area in the county. This metric is one of the key indicators for DH suitability. An interactive version of these maps is available on the Codema-dev GitHub page. The breakdown of demand categorised as very feasible, feasible, not feasible, etc. can also be found on this webpage. The table below provides indicative figures for DH suitability based on this heat demand density metric alone. The DH vs HP assessment in the next section of this report builds on this analysis and directly compares the two low-carbon heating options based on the cost of carbon abatement. Interestingly the carbon abatement cost analysis shows district heating as a better option for even more of Dublin than the analysis based on demand density alone.

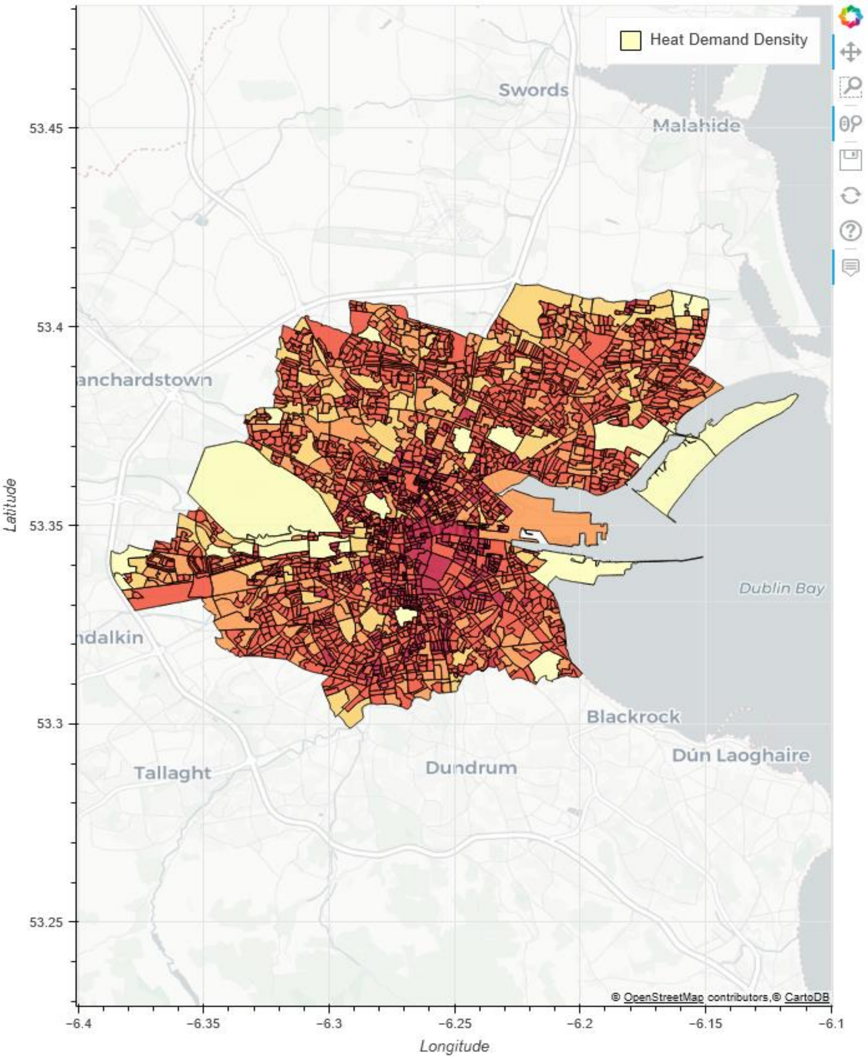

FIGURE 8: EXAMPLE OF HEAT DEMAND DENSITY MAPS PRODUCED

The table shows that 83.5% of heat demand in Dublin city is suitable for DH (above 120TJ/km^2) and that this could increase to 96.6% with supporting regulations in place.

TABLE 3: BREAKDOWN OF SUITABILITY FOR DUBLIN CITY

Feasibility	Residential [MWh/year]	Non-Residential [MWh/year]	Total [MWh/year]	Band [TJ/km²year]	% Share [MWh/year]
Not Feasible	23733	7803	31535	<20	0.7
Future Potential	89688	34996	124683	20-50	2.7
Feasible with Supporting Regulation	430562	172766	603327	50-120	13.1
Feasible	2229477	431259	2660736	120-300	57.7
Very Feasible	627162	561711	1188872	>300	25.8

Final Assessment of DH vs Heat Pumps

Two main heat decarbonisation strategies were assessed; one based on the adoption of district heating networks and the other looking at the widespread adoption of air source heat pumps. This analysis was performed for every CSO small area. The total number of CSO small areas in Dublin is 4,884. The determining factor in choosing one technology over the other was the cost of carbon abatement. The technology with the lowest carbon abatement cost (€/tCO_2 abated) was chosen as the preferred decarbonisation pathway. The cost and carbon abatement figure was calculated based on local conditions within each small area as discussed below.

District Heating Costs

The network length within each small area was determined through the use of random sampling. In this sampling exercise, indicative networks were drawn on multiple areas of a certain urban fabric. An example of the network routes drawn can be seen in the map below in red. The network length was then compared to the road centre line lengths from open street map (OSM). This relationship was then used to estimate the network length required within each small area.

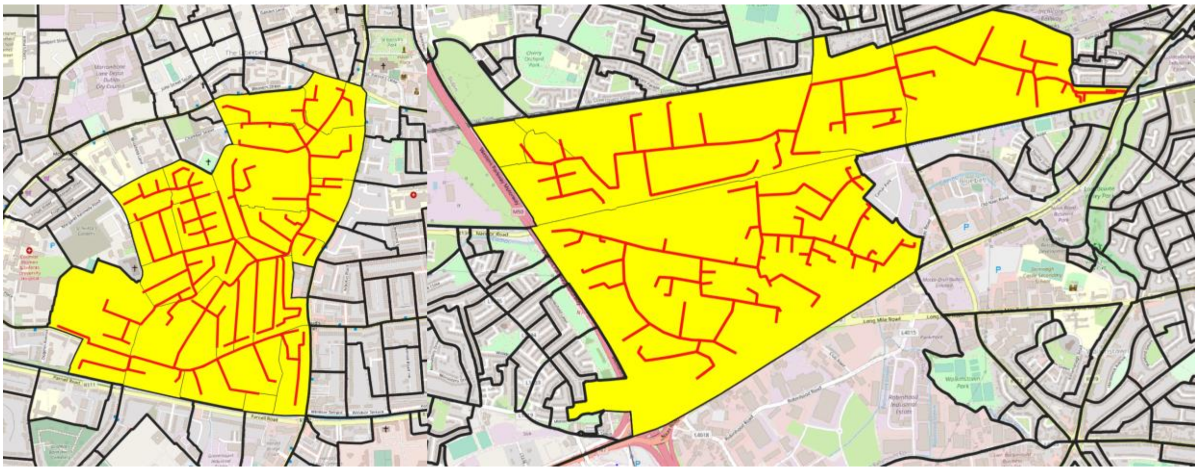

Figure 9: Example of Network Length Analysis Performed

The average DH pipe diameter rounded to the nearest standard pipe size was estimated for each small area based on the linear heat density using the following relationship[5]:
Average DH Pipe Diameter (mm) = (0.048*ln(Linear Heat Density in MWh per metre) + 0.063)*1000

The capital cost of the heat production equipment was estimated based on a representative €/kW figure, which includes the capital cost of the main heating plant, backup heating plant, and auxiliary and automation equipment. The kW used to determine the cost was based on an average diversified peak heat demand for each domestic dwelling plus the diversified peak commercial demand based on the calculated annual heat demand and a typical equivalent run hours for commercial buildings.

The cost of heat interface units and heat substations were also included for the DH option based on an average kW peak demand per building.

Heat Pump Costs

The capital cost of the heat pump option was calculated using a figure of €1,200/kW thermal output. This figure assumed air source heat pumps (air to water) were fully installed including fittings, buffer tank, new cylinder (existing cylinders are not deemed compatible with efficient

[5] https://hre.aau.dk/wp-content/uploads/2018/09/STRATEGO-WP2-Background-Report-6-Mapping-Potenital-for-DHC.pdf

heat pump operation due to the relatively small surface area of their coils) and controls, but excluding the heat distribution system. Excluding the distribution system may mean the cost estimate for an efficiently-operating ASHP system may be slightly underestimated in some cases.

It is understood that once heat pumps start to represent a significant proportion of the heat market, the cost of heat pumps will reduce as supply chains improve, installation overheads reduce and the equipment cost itself also reduces. This cost reduction is captured in this analysis through the annualised replacement expenditure (Repex) cost, which assumes a 20% reduction will occur[6] within the first lifecycle of the heat pumps, i.e. before 2036.

Whilst not included in this analysis, it is also worth noting that the floor area consumed by the required hot water cylinder also has a cost associated with it. For a build-to-rent apartment in Dublin, this cost is estimated at €2,350 per dwelling, for example. This cost benefit for DH was excluded as the majority of buildings in Dublin are existing buildings and already have hot water cylinders of a similar footprint installed and are designed in such a way that the floor area freed by removing these units is of limited value.

Electrical Grid Upgrade Costs for Heat Pumps

The installation of heat pumps in homes will also have an impact on the electricity grid which, in certain areas, upgrades will be required to serve these new loads. The cost of these upgrades has been estimated for the LV & MV grid and also for the HV grid using two different approaches for domestic and commercial buildings.

The LV & MV grid upgrade cost adopted was based on costs from ESB Statement of Charges[7]. For existing homes whose current connection (typically 12kVA) will need to be upgraded (assumed to 16kVA) to service additional load from the heat pump (but also potentially EV charging and greater use of electric cookers). This connection upgrade charge is stated as being €1,539 for a single urban connection. This includes MV network costs but excludes trenching within the boundary of the site. Assuming a power factor of 0.95 for the heat pump load, this translates to a LV & MV upgrade cost of €405/kWe. The additional trenching cost is estimated at €6/m based on typical rates. This trenching cost would apply to all new connections but considering that Dublin consists of predominantly existing buildings and the limited impact of such a low cost, this trenching cost has been excluded from the analysis.

For commercial buildings, the impact of heat pumps on the building’s maximum import capacity (MIC) was assessed in order to determine if the HP installation resulted in the building breaking its existing MIC threshold and thus incurring additional cost for falling within a higher MIC band. In the vast majority of cases, it was determined that the addition of a heat pump would not result in the building reaching the next MIC price band, but where it does the cost has been included.

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6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf

7 https://www.esbnetworks.ie/docs/default-source/publications/esb-networks-dac-statement-of-charges.pdf

Emissions from DH, Heat Pumps and Gas

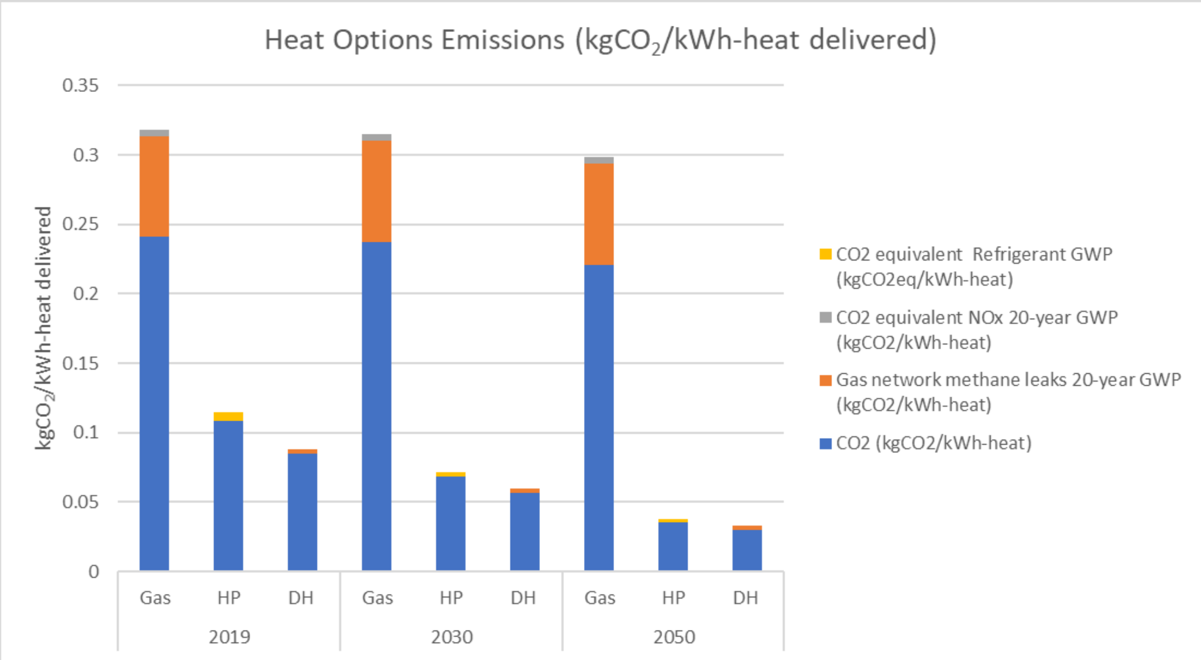

FIGURE 10: EMISSIONS (INCLUDING EQUIVALENTS) PER HEAT DELIVERED BY TECHNOLOGY

H/C planning

Based on the analysis above the following provides a summary of the findings from the H/C Plan.

Current Situation - Heating Technologies

The majority of buildings in Dublin use gas fired heating. The gas grid covers practically the whole city, developed at national level by semi-state owned companies without considering where DHC grids may be a better option. The figure below shows the breakdown of type of heating technologies currently installed in Dublin. This shows that gas is the dominant heat fuel followed by direct electric (not heat pumps), particularly in the inner city where many apartments are heated in this way. the current distribution of fuel sources in residential dwellings reads: Gas 74% (mainly individual), Electric18% (mainly direct), Oil 7%, and Coal/Biomass 1% (percentages relating to the share of dwellings supplied by each respective fuel source).

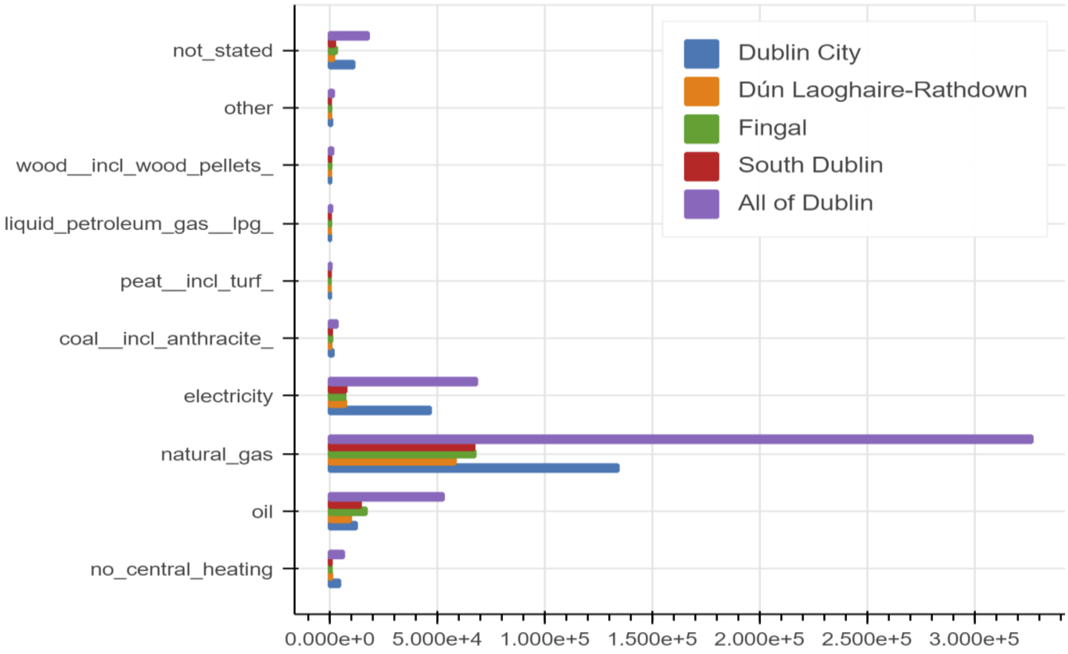

FIGURE 11: BREAKDOWN OF CURRENT HEATING TECHNOLOGIES IN DUBLIN BY NUMBER OF INSTALLATIONS

Heat Sources Available

The graph below shows the breakdown of heat sources available in Dublin for the current and future scenario. It can be seen from this graph that the main changes over this period is the significant reduction in heat available from power plants as renewable electricity generation increases. This reduction is offset by increased heating potential from data centres and from renewable electricity generation which would otherwise be curtailed.

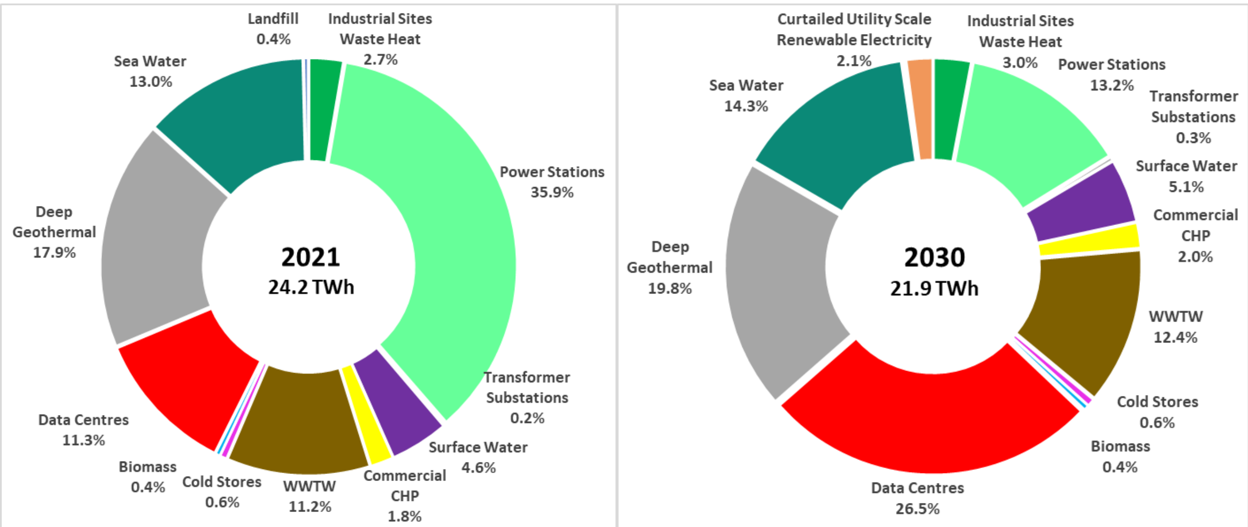

FIGURE 12: HEAT SOURCE BREAKDOWN FOR 2021 AND 2030

The location of these heat sources (totalling approximately 530 sources) is set out in the map below and can also be found online[8].

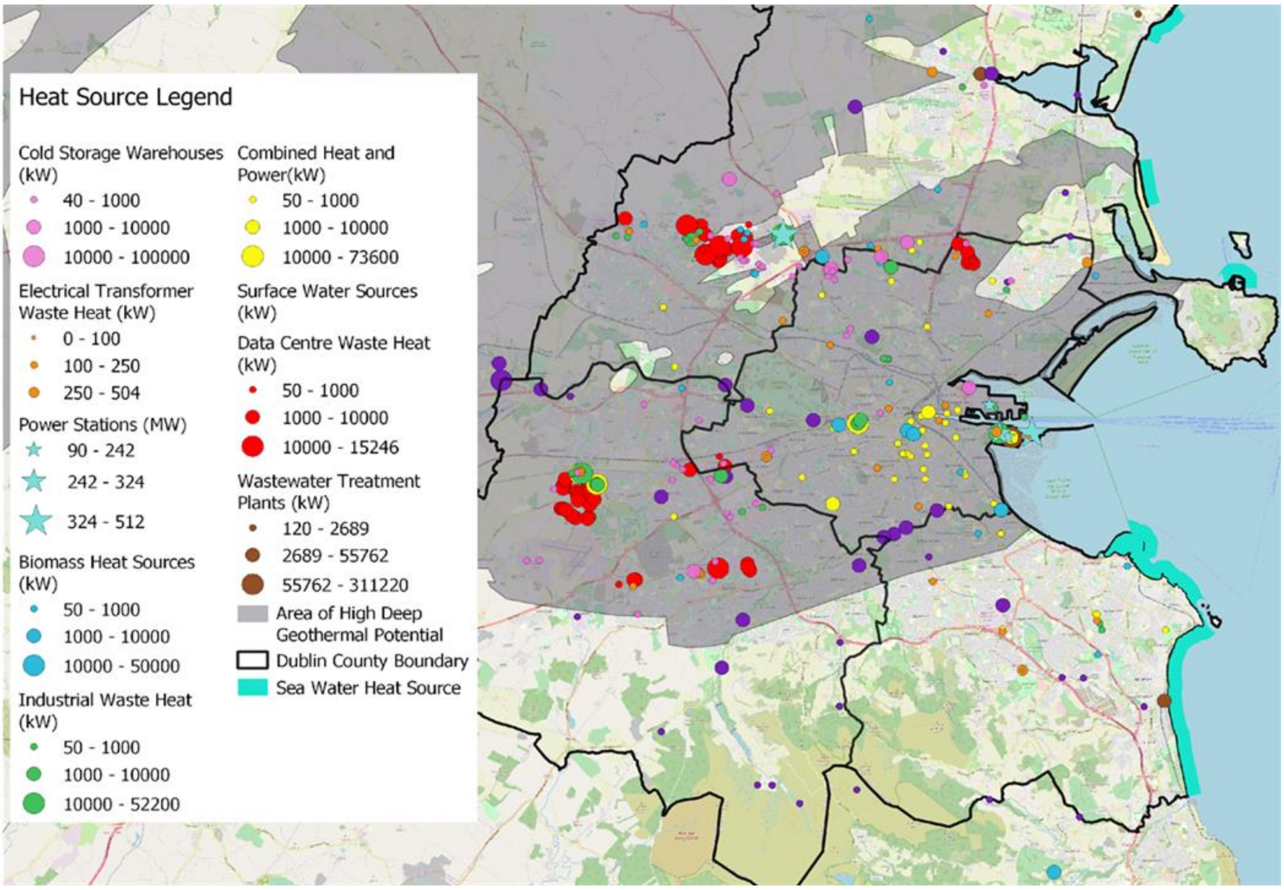

FIGURE 13: HEAT SOURCE MAP OF DUBLIN

[8] https://codema-dev.github.io/map/heat-source-map/

Preferred Technology for 2030 and 2050

The figure below shows the areas most suited to each technology up to 2030. 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 more suited that area is to either technology.

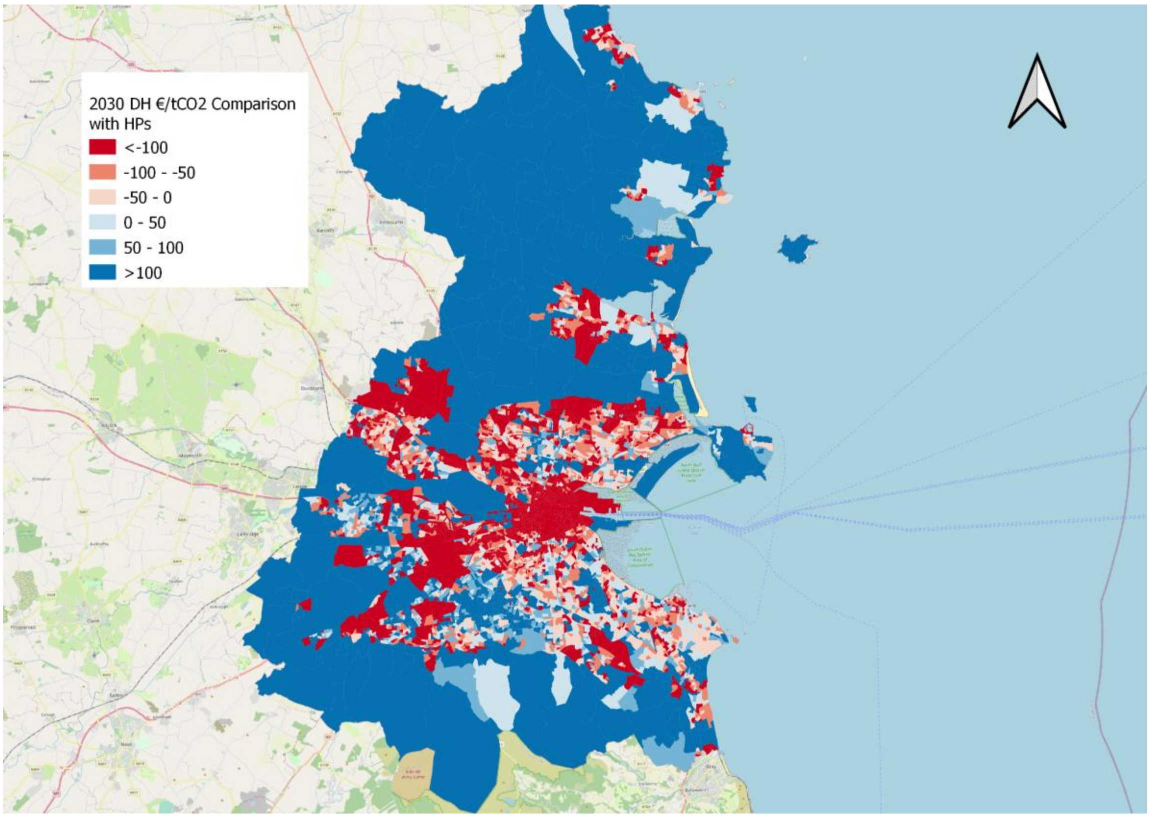

FIGURE 14: 2030 DH AND HP PRIORITY AREAS BASED ON LOWEST NON-DISCOUNTED CARBON ABATEMENT COST

District heating represents the best option for 7.43TWh of heat demand in terms of cost-effective decarbonisation, which would save 1,441.7ktCO_2 in the year 2030. However, like other technologies, the supply chain needs to be developed in order to deliver on this potential. The current national government target of 2.7TWh by 2030 reflects the supply chain growth experienced by other countries when they first began adopting DH in the 1970s. As Dublin is more advanced in the planning and development of DH systems, it is fair to assume that the majority of this target will be met by Dublin and so this was used as a reasonable interim regional target for 2030. This 2.7TWh would save 502ktCO_2 in carbon emissions and save 172.8kT$CO^2_{eq.}$ in equivalent emissions in the year 2030. The map on the next page shows the areas where DH could be first adopted (i.e. is most cost-effective) to reach this 2.7TWh target.

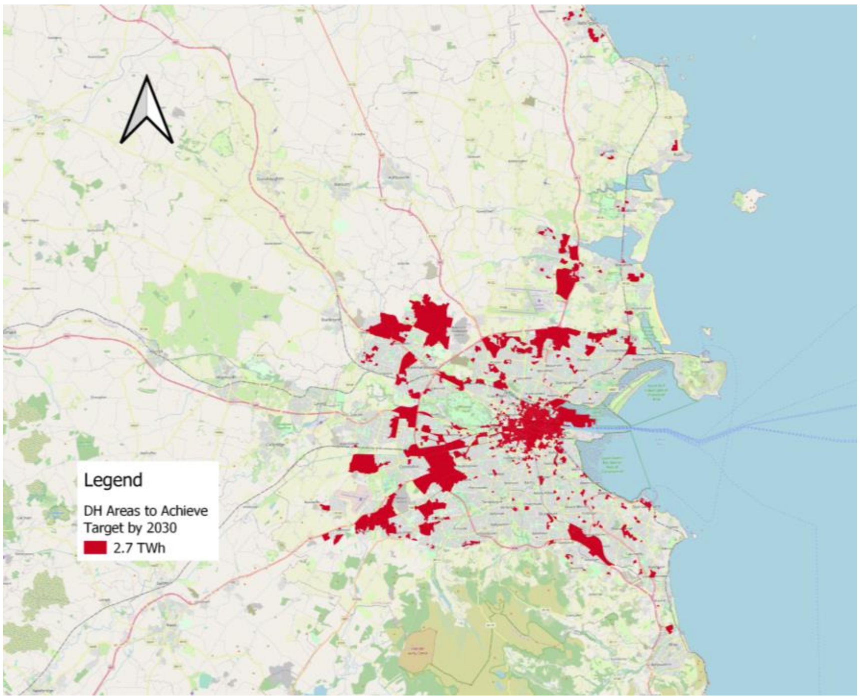

FIGURE 15: PRIORITY DH AREAS FOR ACHIEVING 2.7TWH TARGET BY 2030

The 2.7TWh target for 2030 would require 376.3km of distribution pipework and 774.5km of customer connections estimated to cost €980.4 million. The total capital cost of achieving this target is estimated at €1.1 billion with the majority of this investment staying within the local economy. This would create the equivalent of 2,281 direct local jobs per year for this period to 2030.

The figure on the next page 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. It can be seen from this map that the areas suited to DH have increased over the period 2030 to 2050. The main reason for this is that the up-front capital investment in the network infrastructure is recouped over a longer period in this scenario. It is worth noting that this effect will continue beyond 2050 making DH an even better solution over time.

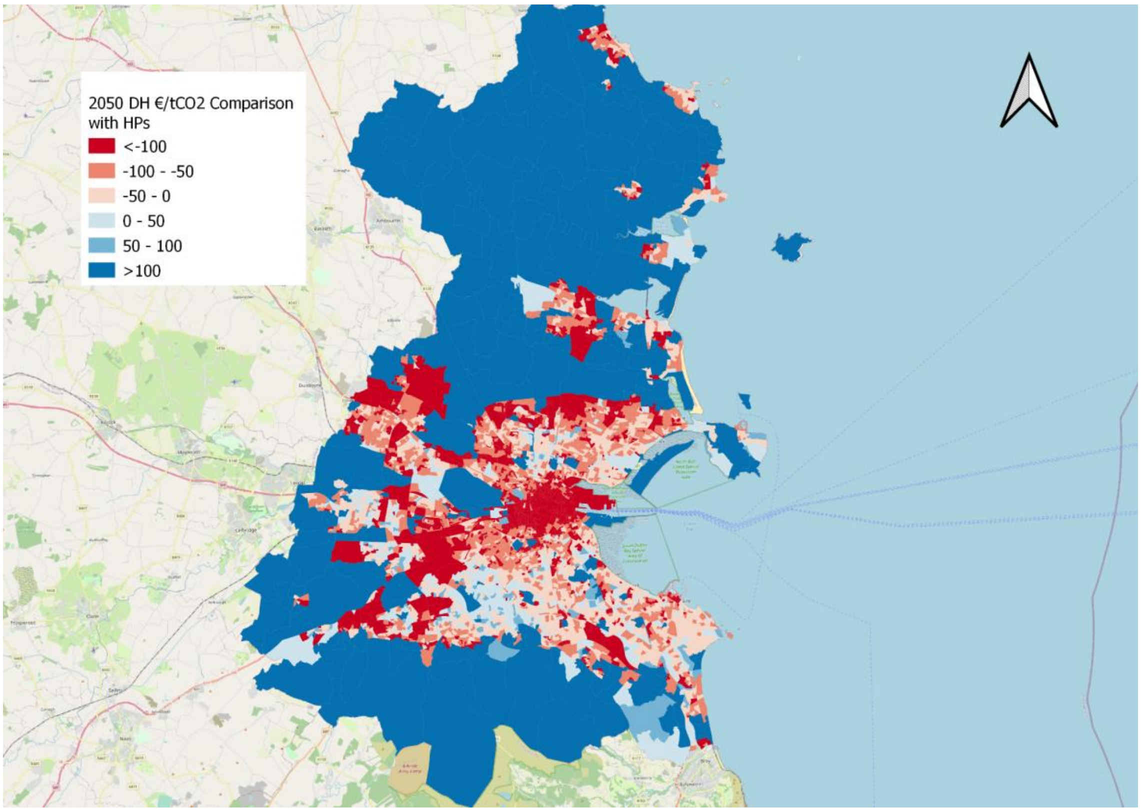

FIGURE 16: 2050 DH AND HP PRIORITY AREAS BASED ON LOWEST NON-DISCOUNTED CARBON ABATEMENT COST

By 2050, district heating represents the best option for 9.06TWh of heat demand in terms of cost-effective decarbonisation. By 2050, it is assumed that the required supply chain is in place to deliver on the full DH potential outlined. This would save 1,550.1ktCO_2 in carbon emissions and 617.6kTCO_2eq. in equivalent emissions in the year 2050.

Appendix: Data use

The data used is described in the relevant sections of the report above. Further details on data availability and quality are provided in Deliverable 2.4.

DECARB CITY PIPES 2050

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