ADE Analysis: Heat Network Growth Curve & Supply Chain Modelling for the North Yorkshire Combined Authority

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Acknowledgements

A number of companies have provided data that fed into this report. The ADE is very grateful for their collaboration and assistance. Out of sensitivity to competition law, where data have been provided in this way, the sources have been anonymised and averages taken from multiple sources so that costs cannot be traced back to any one company or individual.

The various stages of this report's analysis were presented at ADE Forums and Workshops – the ADE is very grateful to all members who provided feedback on the analysis during the report's development.

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Neil Smith

North Yorkshire Combined Authority: executive summary

The North Yorkshire Combined Authority has the potential to increase the heat it has from heat networks by 65x over the next 30 years and bring in more than £1.6 Bn in capital investment. With zoning coming into force in the next couple of years, the key decision point in achieving this are now whether the public sector had sufficient funding to decarbonise its buildings now or later – a decision that would likely set back investment 15 years, if not reduce it altogether.

Currently, newbuilds and private non-domestic buildings collectively account for the majority of heat demand that is currently met by heat networks across the North Yorkshire Combined Authority. According to EPC data, both newbuilds and private non-domestic buildings account for 9.8 GWh each of the 23.7 GWh of heat we can estimate networks currently meet in the area.

Contrasting our high and low-ambition scenarios, we get the following headline figures (these do not include domestic retrofit, as this is treated separately in our high ambition scenario):

- Under a high ambition scenario, heat networks could meet 1.5 TWh of demand by 2050, with most of this demand added to networks in the late 2020s. This falls to 1.3 TWh of demand in a low ambition scenario, in which most of the demand is added in the late 2030s and early 2040s.
- The high ambition scenario predicts an estimated £1.6 Bn in capex, with investment peaking in 2029. Our low ambition scenario predicts a total capex of £1.4 Bn, but with investment peaking in 2041.
- Our high ambition scenario would involve 321 km of primary pipework, compared to 227 km of primary pipework in the low ambition model. As with the total investment, the majority of pipework in the high ambition scenario is frontloaded to the late 2020s, while the majority of primary pipework in the low ambition scenario is laid down in the late 2030s.
- Across all scenarios, heat demand – and therefore investment – is primarily driven by public buildings and large private non-domestic buildings.
- Under a medium ambition scenario, in which large blocks of flats are connected to networks from the 2030s, domestic retrofit could add 36 GWh of demand to networks by 2050.
- Cost estimates for generation and distribution capex, including some individual components of the supply chain, are provided across all three ambition scenarios.

ADE Analysis | Heat Network Growth Curve & Supply Chain Modelling | North Yorkshire Combined Authority

Summary

For 9 Combined Authorities across England facing election on 2nd May 2024, the ADE has used publicly available EPC data to estimate how much heat is being met by heat networks in each of these areas. From these baselines, the potential heat demand that could be met by heat networks has been modelled across low, medium and high ambition scenarios and split out across domestic newbuild, domestic retrofit, public buildings and public non-domestic buildings. Using a combination of published data, dialogue with industry and industry purchasing catalogues, capex estimates have been generated to estimate the investment needed to meet the heat demand projected in each scenario (including km of pipework required). Collectively, the aim is for this to provide a flexible, modular tool to allow relevant stakeholders to quickly estimate the impact that heat networks could have across their area.

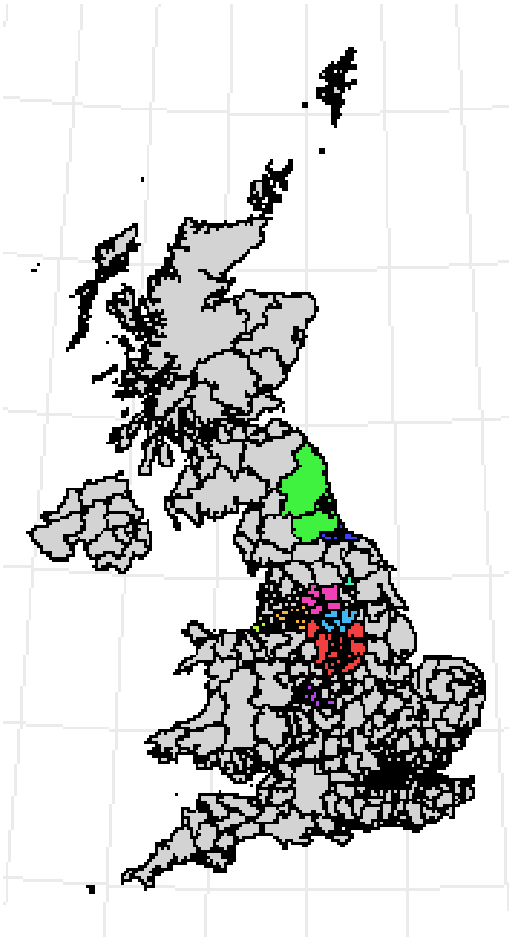
EPC data: baseline level of heat demand and projecting this forward

The ADE is using open-source data hosted by the Department for Levelling Up, Housing and Communities (DLUHC) to access Energy Performance Certificates (EPCs) and display Energy Certificates (DECs) for the whole of the UK[i]. When analysing the UK's building stock, these data allow us to identify the following criteria:

1. The type and method of heating that is supplying the building, and the type of fuel that is supplying this heat;
2. The category of building – whether it is a domestic building or a non-domestic building and, further to this, whether non-domestic buildings are public buildings or private buildings (further subdivisions in domestic buildings also available, e.g. flat VS house);
3. The date the EPC or DEC assessment was made; and
4. The thermal energy usage of the property. This is recorded in the EPC data in KWh per square m, so the KWh/m is multiplied by the total floor area of the property (which is also recorded) to get an estimate of total heat demand.

With this information, we can ascertain how much heat has been supplied by heat networks over the years for which we have the data and, from this baseline, establish projections for how much heat could be supplied by heat networks under various growth scenarios. This is done at the scale of Combined Authorities so that a defined urban area (e.g., the East Midlands Combined Authority) has the baseline level of heat supplied by heat networks established, and then low growth, medium growth and high growth scenarios modelled for how heat networks might meet heat demand in this area up to the year 2050.

Overview of Combined Authorities for which analysis was conducted



Analysis was conducted for 9 Combined Authority areas that collectively represent 63 Local Authorities. These are:

East Midlands
Greater Manchester
Liverpool City Region
North East
North Yorkshire
South Yorkshire
Tees Valley
West Midlands
West Yorkshire

Ambition scenarios for heat demand networks could meet

Please note that there is a separate report for high ambition domestic retrofit.

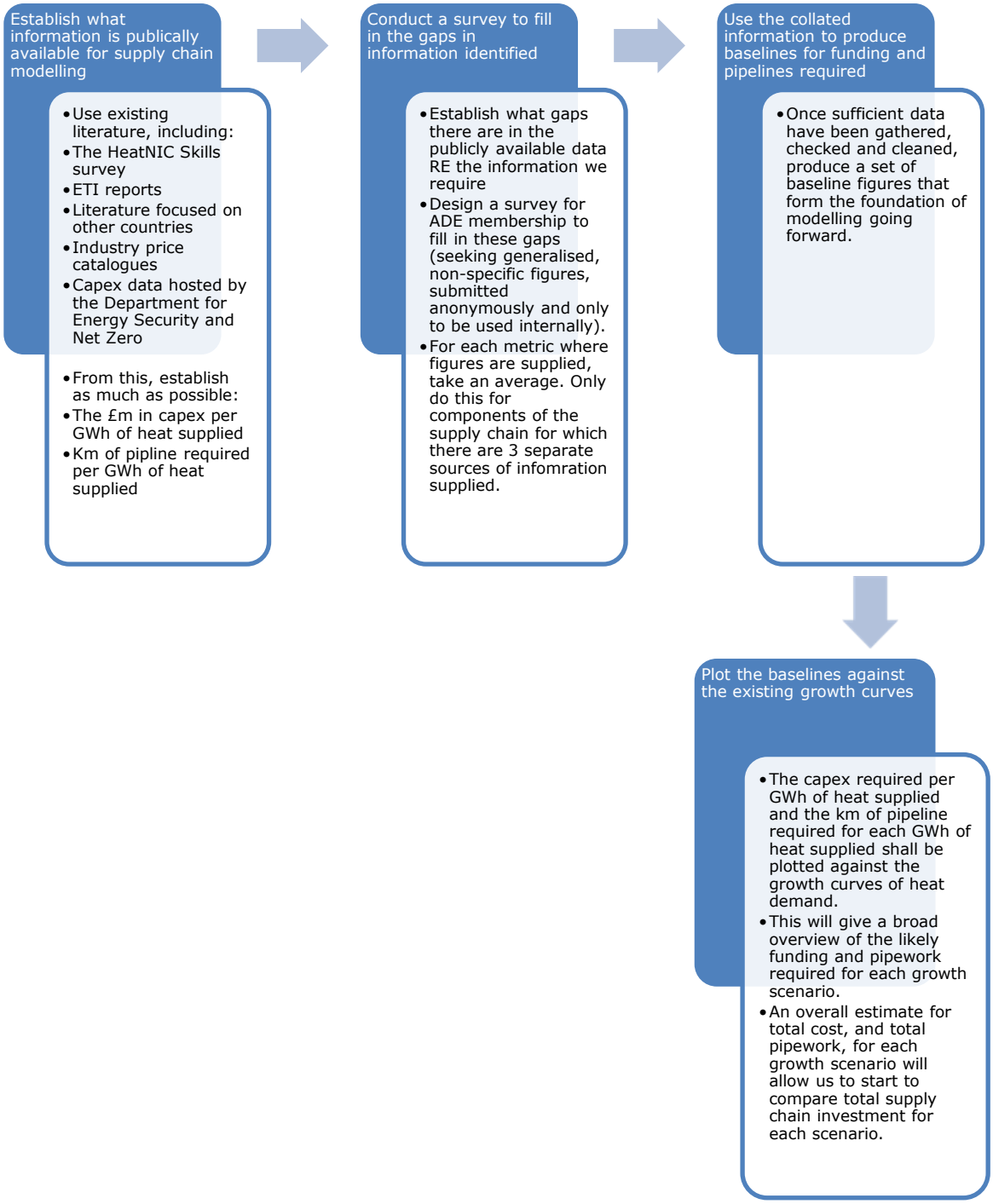
Market	Low Ambition Scenario	Medium Ambition Scenario	High Ambition Scenario
Newbuild	20% of newbuilds are added onto a heat network from 2024 onward	50% of newbuilds are added onto a heat network from 2024 onward	90% of newbuilds are added onto a heat network from 2024 onward

Domestic Retrofit	Continuation of status quo: average annual heat demand met by heat networks over the last 10 years is added from 2024 onward	Only large blocks of flats (>49 dwellings) are retrofitted onto heat networks from the mid-2030s onward as gas boilers are phased out	All domestic houses are added onto heat networks from the mid-2030s onward as gas boilers are phased out, at a rate pro-rated to a region's population, based on total UK-wide boiler replacements at 1.6m a year (please note, this is dealt with in a separate report).
Public Buildings	There is a lag of 20 years behind a region's official targets for net zero (e.g., if target is a net zero city by 2030, assume all public buildings not connected until 2050). Heat pumps are installed in the 2020s for 20 years and Councils struggle to access sufficient capex funding until the 2040s/2050s	Councils have difficulty accessing sufficient capex funding during the initial period of network development. Assuming that this funding is only available at the end of the mandated period (the 2030s), assume a lag of 10 years behind the council target (e.g., if target is a net zero city by 2030, assume all public buildings not connected until 2040)	Councils have adequate access to capex funding, starting at the beginning of the mandated period (the early to mid 2020s). All public buildings are connected to a heat network in line with ambitious council targets (e.g. if there is a target to become a net zero region by 2030)
Private non-domestic Buildings	All private non-domestic buildings with an annual heat demand of 100 MWh or higher are obliged to connect to a heat network by 2050	All private non-domestic buildings with an annual heat demand of 75 MWh or higher are obliged to connect to a heat network by 2050	All private non-domestic buildings with an annual heat demand of 50 MWh or higher are obliged to connect to a heat network by 2050

Capex and supply chain data

In addition, we model the potential supply chain requirements to meet these various growth scenarios. In particular, the priority has been to establish estimates for capex required, including a breakdown into generation and distribution capex. This was done using published Project Pipeline data, hosted by the Department for Energy Security and Net Zero (DESNZ)[ii]. In addition to this, the Km of pipework required and the cost of this (excluding trenching costs), as well as the cost of HIUs required, has been modelled. These costs were taken from a combination of published data and data sourced from industry and then anonymised and aggregated.

Process overview, obtaining capex data

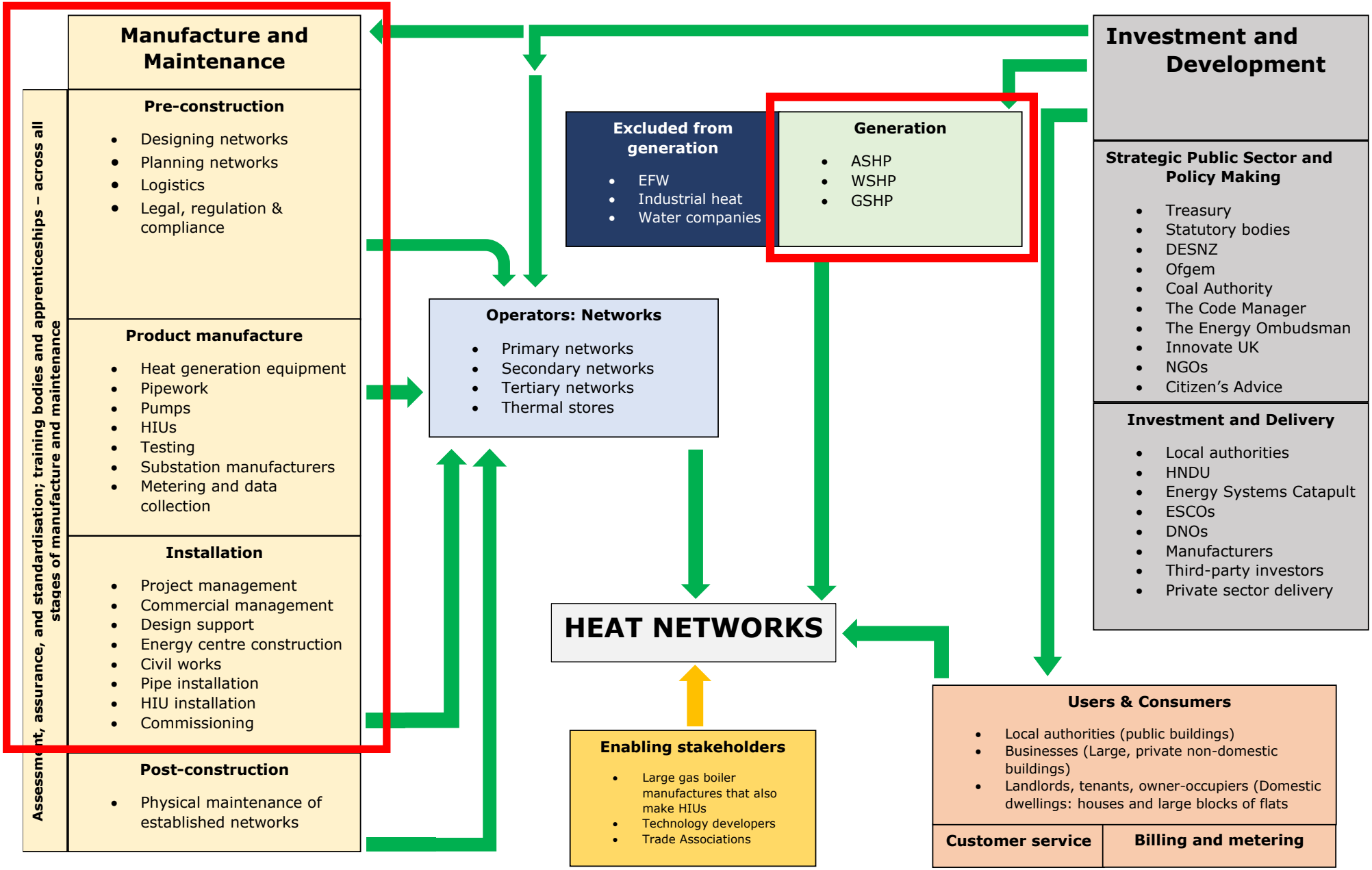


Overview of stakeholders identified

The ADE has identified key stakeholders operating in the heat network sector. These have been mapped and the relationships between them illustrated, to show the actors we are and are not considering as we quantify the investment required for the growth models we have produced. The full chart (Figure 3) illustrates the full ecosystem of actors that we have identified, while the areas framed in red boxes illustrate those aspects for which we have sufficient data to generate capex estimates.

Abbreviations in overview of stakeholders

- Energy From Waste (EFW)
- Air Source Heat Pump (ASHP)
- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (WSHP)
- Department for Energy Security and Net Zero (DESNZ)
- Non-Governmental Organisation (NGO)
- Heat Network Development Unit (HNDU)
- Energy Service Company (ESCO)
- District Network Operator (DNO)
- Heat Interface Unit (HIU)

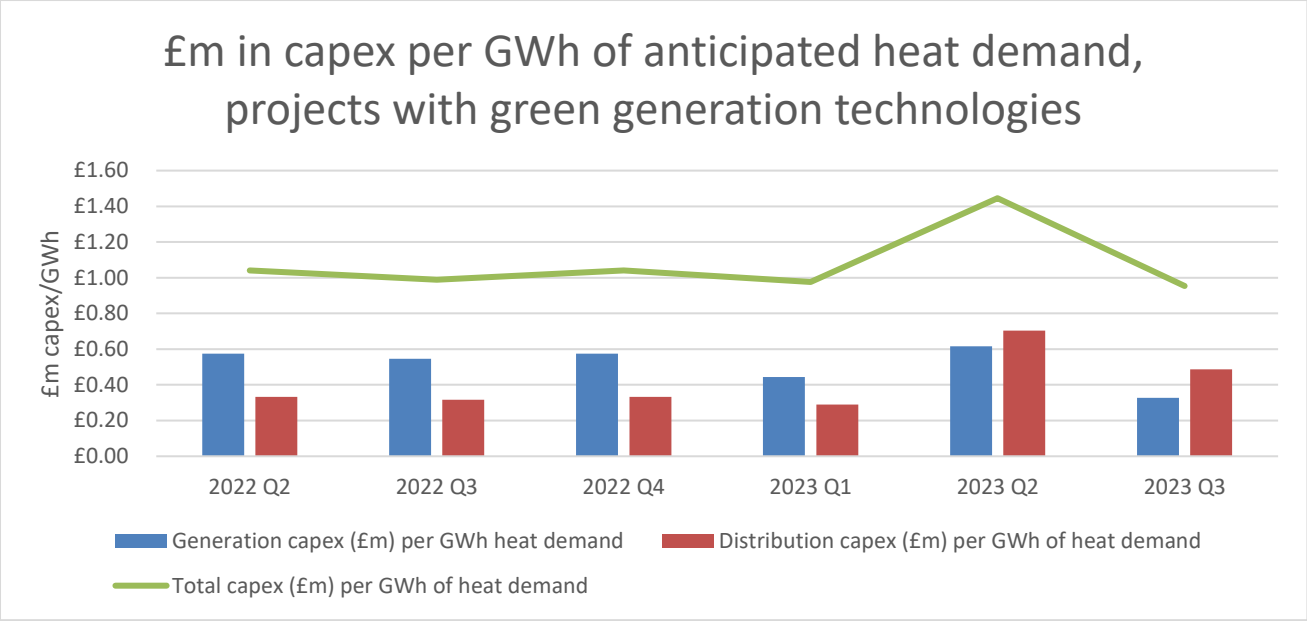

Manufacture and Maintenance
Pre-construction
Designing networks
Planning networks
Logistics
Legal, regulation & compliance
Product manufacture
Heat generation equipment
Pipework
Pumps
HIUs
Testing
Substation manufacturers
Metering and data collection
Installation
Project management
Commercial management
Design support
Energy centre construction
Civil works
Pipe installation
HIU installation
Commissioning
Post-construction
Physical maintenance of established networks
Assessment, assurance, and standardisation; training bodies and apprenticeships – across all stages of manufacture and maintenance
Excluded from generation
EFW
Industrial heat
Water companies
Generation
ASHP
WSHP
GSHP
Operators: Networks
Primary networks
Secondary networks
Tertiary networks
Thermal stores
HEAT NETWORKS
Enabling stakeholders
Large gas boiler manufactures that also make HIUs
Technology developers
Trade Associations
Investment and Development
Strategic Public Sector and Policy Making
Treasury
Statutory bodies
DESNZ
Ofgem
Coal Authority
The Code Manager
The Energy Ombudsman
Innovate UK
NGOs
Citizen's Advice
Investment and Delivery
Local authorities
HNDU
Energy Systems Catapult
ESCOs
DNOs
Manufacturers
Third-party investors
Private sector delivery
Users & Consumers
Local authorities (public buildings)
Businesses (Large, private non-domestic buildings)
Landlords, tenants, owner-occupiers (Domestic dwellings: houses and large blocks of flats
Customer service
Billing and metering

Data from Heat Network Project Pipeline

Project pipeline data, hosted by the Department of Energy Security and Net Zero[iii] were used to estimate the ratio of £m in capex required per GWh in demand a heat network provides. These ratios of £m/GWh were obtained for total capex, generation capex, and distribution capex. These were then applied to the heat demand estimated in the growth models to estimate the capex required to meet the level of heat demand forecast. In addition to generation and distribution capex, the project pipeline data also provide data on "other" capex that does not fall neatly into generation or distribution capex. We do not plot or model "other" capex separately, though it is still included in total capex when aggregated with generation and distribution capex.

Relationship between heat demand and capex

Figure 1



Average £m/GWh from project pipeline data

Table 1

Generation capex (£m) per GWh heat demand	Distribution capex (£m) per GWh of heat demand	Total capex (£m) per GWh of heat demand
£0.51	£0.41	£1.07

The heat demand forecast in our models can then be multiplied by the £m/GWh ratios shown in Table 2 to generate estimates of the capex needed for these levels of heat demand to be met.

Calculating pipework requirements

Calculating length of pipework

For pipework calculations, we assume that the distance between residential houses is 10m, and that the distance between residential flats is 8m[iv]. We assume that very big non-residential buildings can conceptually be treated in a similar manner to a very large block of flats, and that the unit length of pipe is 10m. Working on the basis that the average annual heat demand of a house is 12 MWh[v], that for a flat average annual heat demand is 8 MWh[vi], and that for a non-domestic building this is 73.2 MWh[vii], we can estimate a linear heat density in MWh/m that we can then apply to the heat demand estimated in our models, and from this get an estimate of the pipework required. This is summarised in Table 3.

Estimating MWh/m

Table 2

Building type	Unit length of pipe (m)	Average annual heat demand for building type (MWh)	Estimated MWh/m to apply to heat demand models
Domestic house	10	12	0.83
Domestic flat	8	8	1
Large non-domestic	10	73.2	7.32

For each sector, the heat demand projected by our model can be multiplied by the relevant MWh/m ratio to estimate the length of pipe required.

Calculating cost of pipework

The cost of 1m of pipe was taken from Spons Civil Engineering and Highway Works Pricebook 2023[viii]. From this, we took the cost of 300mm steel pipe, and the cost of 82mm polyvinyl pipe. These are £206.96 and £36.13, respectively. Spons lists these costs as including labour, plant and material, but conversations with industry revealed that the unit cost of pipe quoted does not include trenching costs. It is important to note that our estimates for pipework capex are therefore an underestimate that is more likely to provide an estimate of material costs, rather than total costs associated with pipework.

From dialogue with industry, we assume that the proportion of pipework that is 300mm steel in domestic houses and domestic flats is 20%, with the remaining 80% of pipework consisting of 82mm polyvinyl, and that in large non-domestic buildings 100% of pipework is 300mm steel. This is summarised in table 4.

Proportions of pipework across sectors

Table 3

Building type	Proportion of primary pipework that is 300mm steel	Proportion of primary pipework that is 82mm polyvinyl
Domestic house	0.2	0.8
Domestic flat	0.2	0.8
Large non-domestic	1	0

Calculating HIU capex

As HIUs are a one-off cost per building, it is hard to take unit costs and then find a relationship between these and heat demand such that an estimate of £/MWh can be used. Rather, the average cost of domestic and non-domestic HIUs was generated from a combination of conversations with industry and publicly available price catalogues. From this, we then multiplied the number of buildings in the model by the appropriate average HIU cost. For newbuilds, where we directly specify in the model how many dwellings are added to a network each year, this is relatively straightforward. For the other sectors, where the model adds anticipated annual heat demand (and not a specified number of buildings), the number of buildings is estimated by taking the heat demand the model is adding, then dividing this by the average heat demand for a building in this sector (as illustrated in Table 3).

Average HIU unit costs across sectors

Table 4

HIU Type	Average unit cost (£)
Domestic	1498
Industrial	1861.62

Overview of outputs

For each Combined authority, we have calculated the following:

- The baseline level of heat that heat networks are meeting in the area, according to EPC data hosted by DLUHC
- The cost of heat network projects that rely on "green generation" technologies, according to the Project Pipeline data hosted by DESNZ, from which we can estimate the capex costs of a heat network in £m/MWh
- The heat demand that heat networks in the North Yorkshire Combined Authority could potentially meet under high, medium and low ambition scenarios
- The estimated capex costs of these scenarios, split into: total capex, distribution capex, generation capex, with an additional breakdown of estimated costs for pipework (NOT including trenching), km of pipework, and HIUs (NOT including installation). All costs are given in 2023 prices.
- For our high ambition scenarios, domestic retrofit is treated separately and is given its own section to reflect the difficulties associated with high-ambition, suburban domestic retrofit and exactly what a high-ambition scenario for this sector might look like.

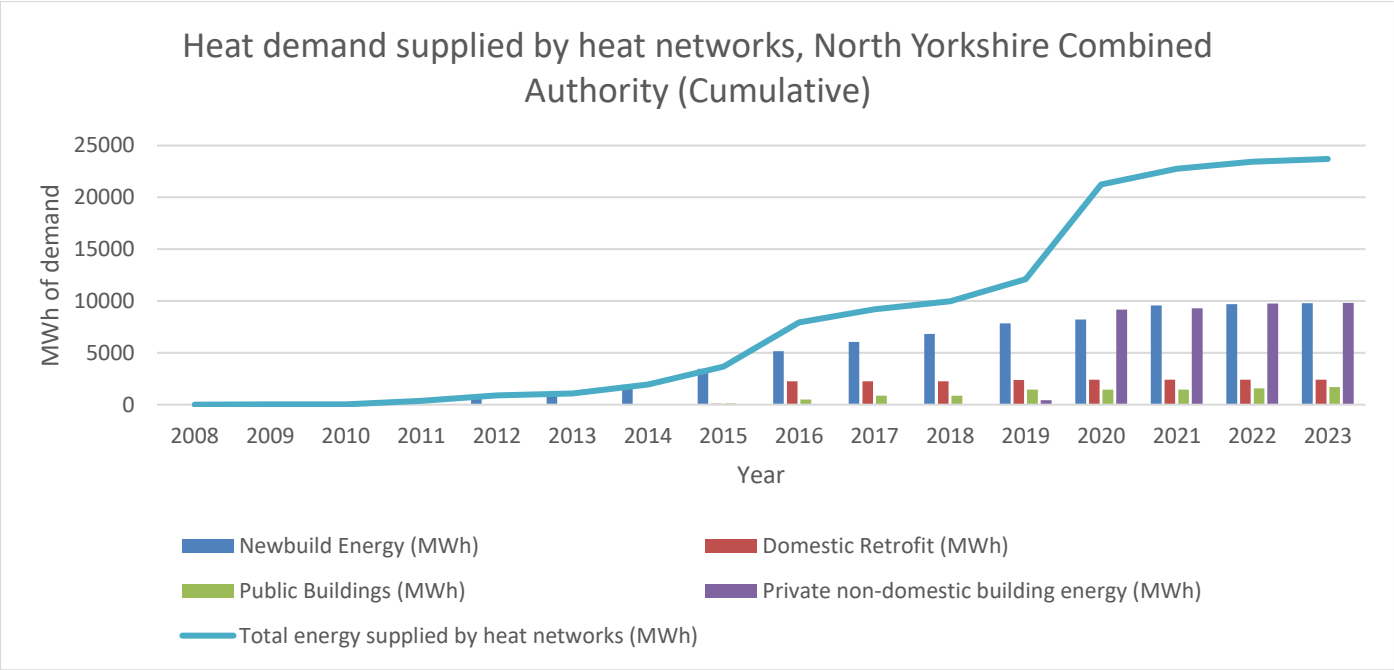
North Yorkshire Combined Authority

North Yorkshire Region Baseline

Using EPC data allows us to forecast the baseline level of heat met by heat networks. From this, we can project forward using our ambition scenarios.

Baseline level of heat met by networks in the North Yorkshire Region

Figure 2



Baseline levels of heat met by heat networks for each sector, North Yorkshire Region

Table 5

Newbuild Energy 2023 baseline (GWh)	Domestic Retrofit 2023 baseline (GWh)	Public Buildings 2023 baseline (GWh)	Private non-domestic buildings 2023 baseline (GWh)	Total energy supplied by heat networks (GWh)
9.77	2.42	1.69	9.81	23.71

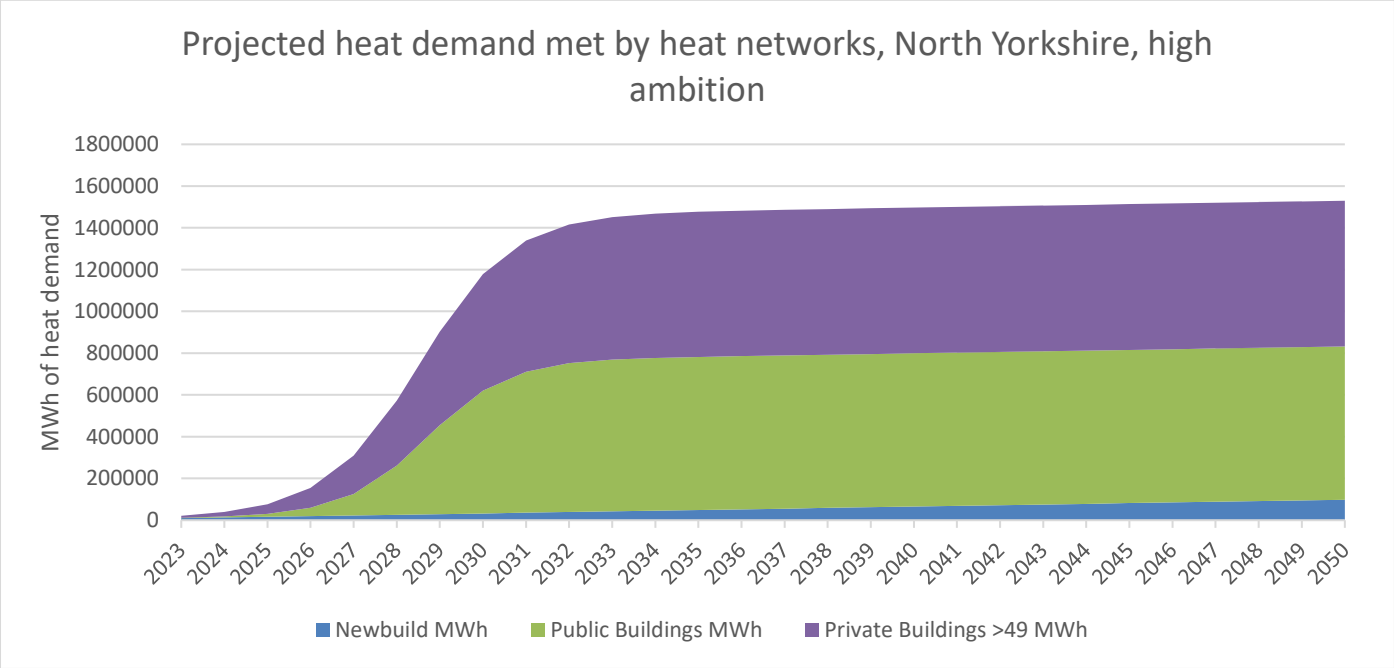
North Yorkshire Region, projections of heat demand met by networks

North Yorkshire Region, high ambition, heat demand met by 2050

Note, the domestic retrofit sector of the high ambition scenario is dealt with in a separate section.

Projected heat demand, high ambition, North Yorkshire Region

Figure 3



Projected total heat supplied by networks to each sector by 2050

Table 6

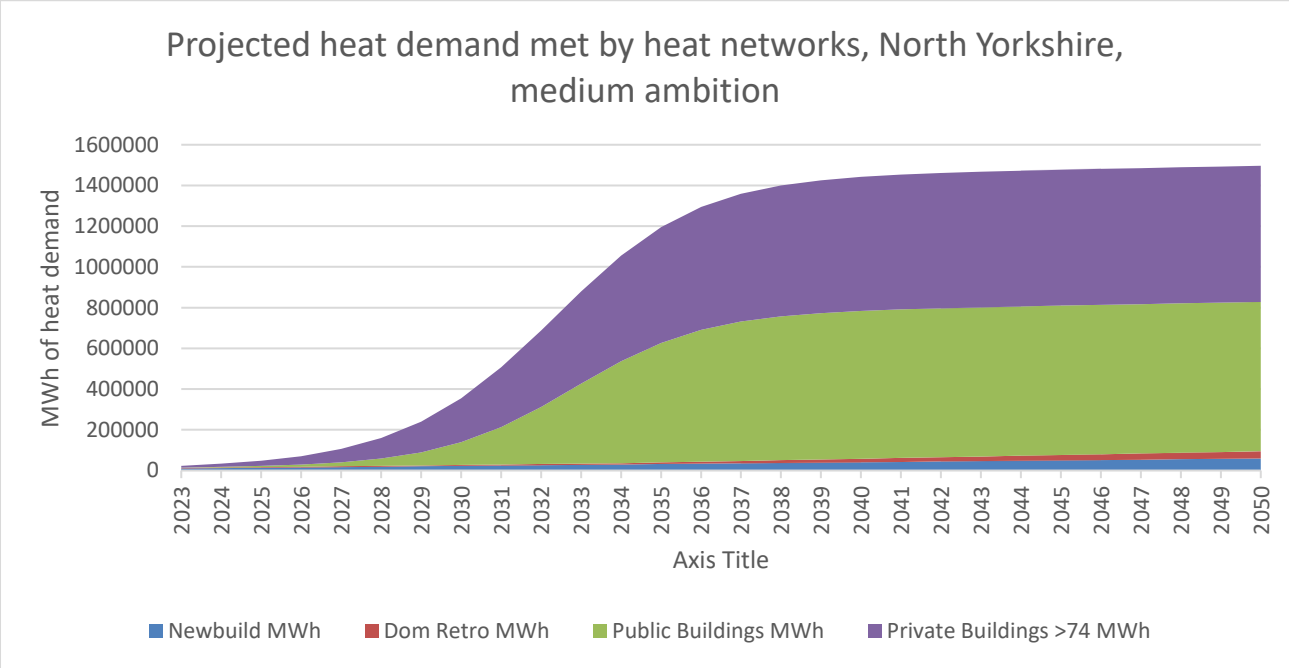
Newbuild (GWh by 2050)	Public Buildings (GWh by 2050)	Private Buildings with >49MWh of annual demand (GWh by 2050)
98.22	733.87	697.83

This assumes that public buildings are connected to a network by 2034, that 80% of them achieve this by 2030, and that 80% of all private non-domestic buildings that have an annual heat demand of >49MWh are connected by 2035

North Yorkshire region, medium ambition, heat demand met by 2050

Projected heat demand, medium ambition, North Yorkshire Region

Figure 4



Projected total heat supplied by networks to each sector by 2050

Table 7

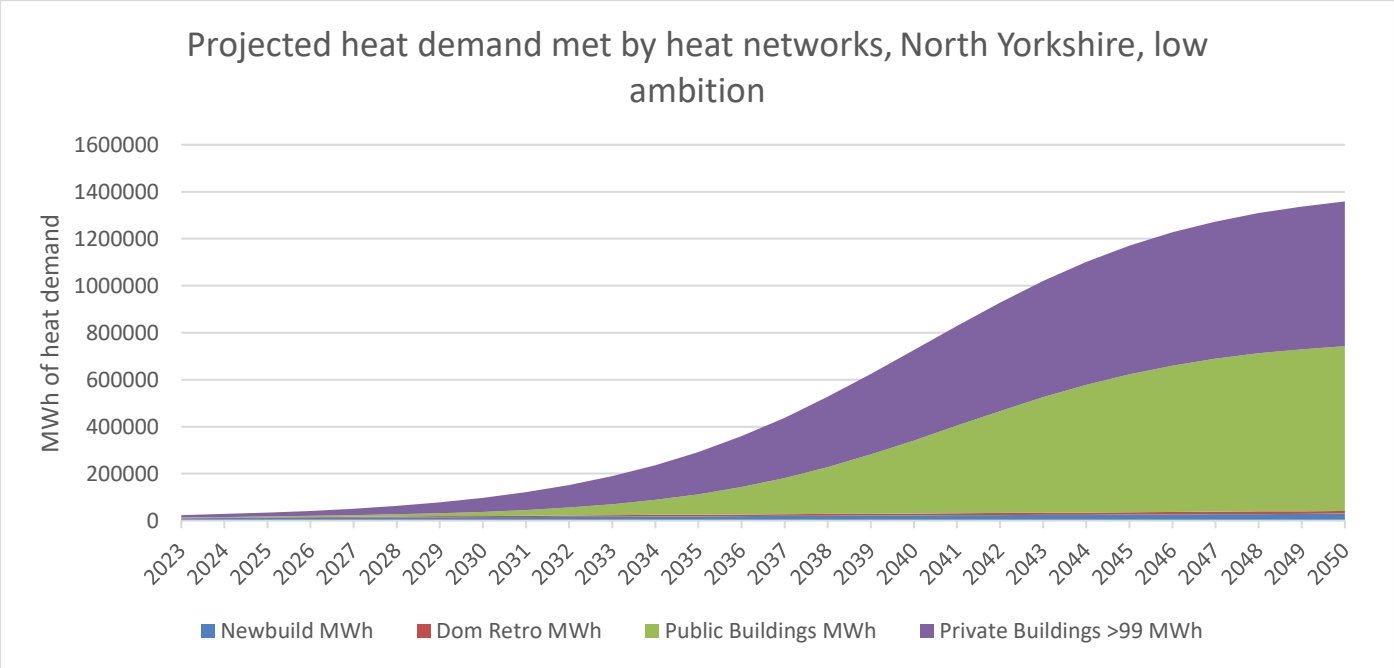
Newbuild (GWh by 2050)	Domestic Retrofit (GWh by 2050)	Public buildings (GWh by 2050)	Private buildings with >74 MWh annual demand (GWh by 2050)
58.91	35.64	733.86	668.47

This assumes that 100% of public buildings are connected by 2038 and that 80% of public buildings are connected by 2034, and that 80% of private non-domestic buildings that have an annual heat demand of >74 MWh are connected by 2035.

North Yorkshire region, low ambition, heat demand met by 2050

Projected heat demand, low ambition, North Yorkshire Region

Figure 5



Total projected heat supplied by networks to each sector, 2050

Table 8

Newbuild (GWh by 2050)	Domestic Retrofit (GWh by 2050)	Public buildings (GWh by 2050)	Private buildings with >99 MWh annual demand (GWh by 2050)
29.43	11.77	701.65	615.90

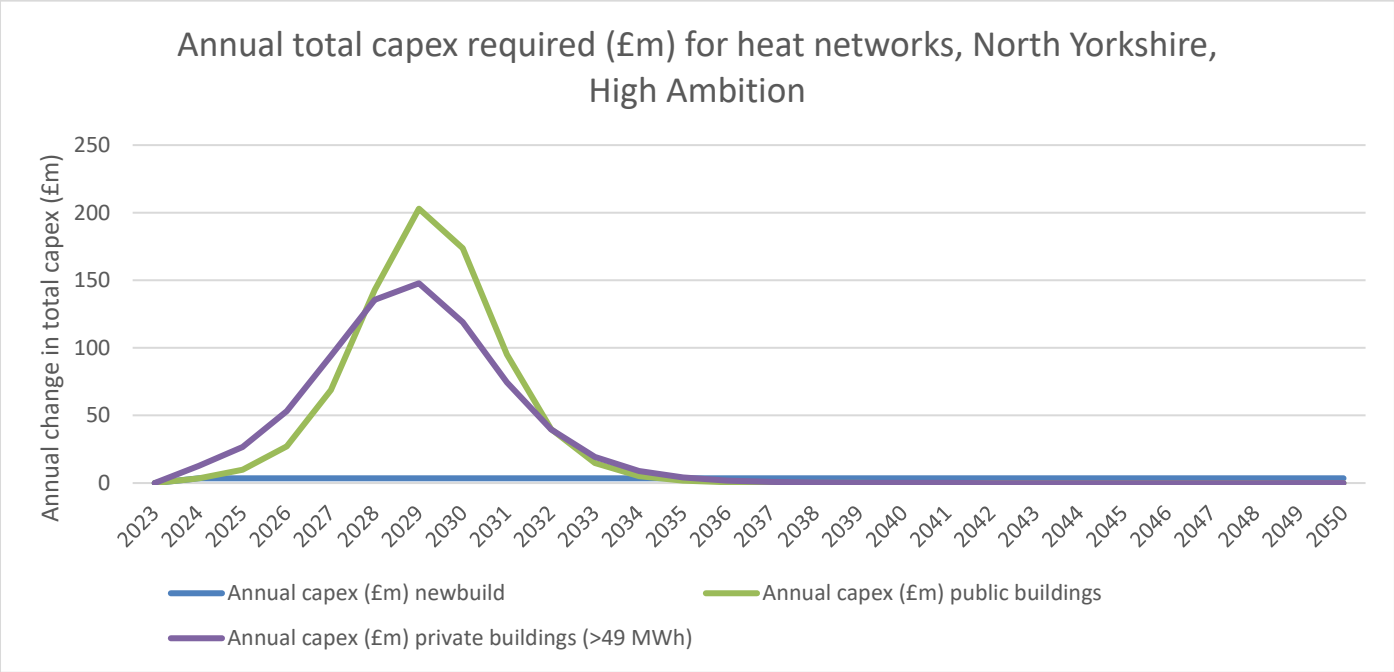
This assumes that all public buildings attempt to connect by 2050 and that 80% of them achieve this by 2045, and that all private non-domestic buildings that have an annual heat demand of >99 MWh attempt to connect by 2050 and that 80% of them do so by 2045.

North Yorkshire Region, projections of capex required to meet heat demand

North Yorkshire Region, high ambition, capex requirements

Projected annual total capex, high ambition, North Yorkshire Region

Figure 6



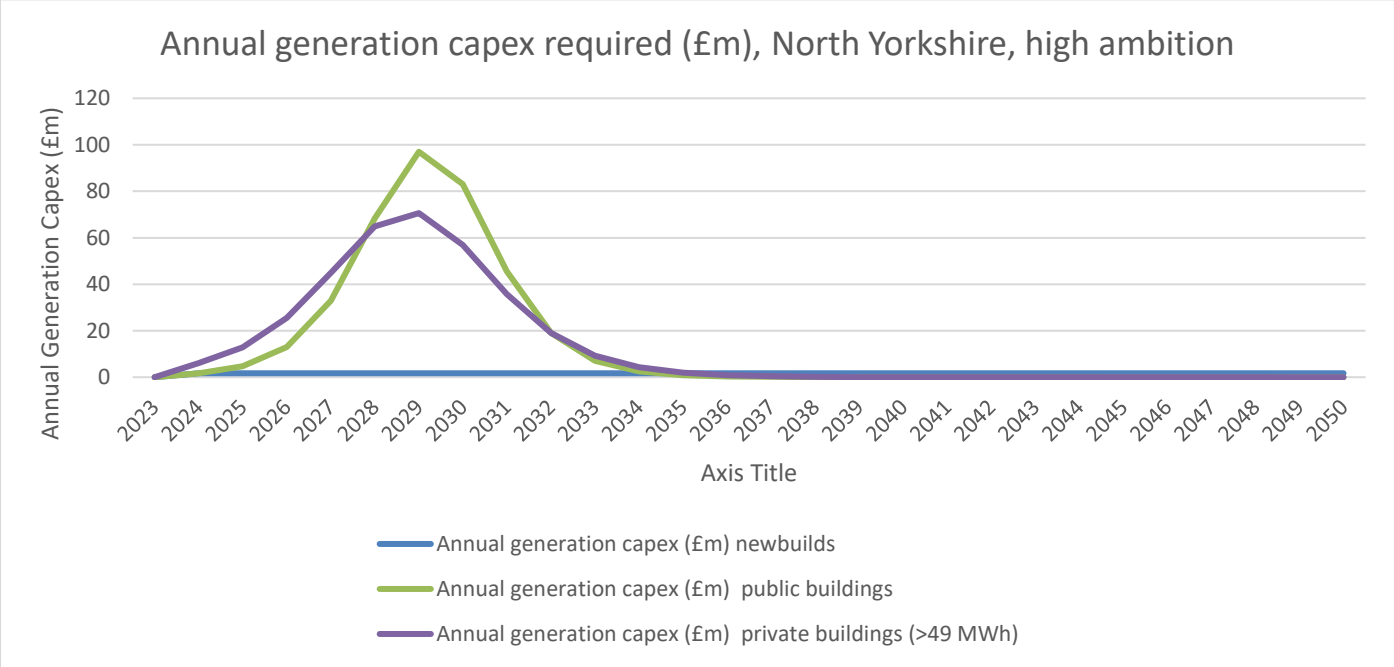
Projected total capex by 2050, North Yorkshire Region high ambition

Table 9

Newbuild total capex (£m) by 2050	Public Buildings total capex (£m) by 2050	Private Buildings with >49MWh of annual demand, total capex (£m) by 2050
95.02	786.60	739.15

Projected annual generation capex, high ambition, North Yorkshire Region

Figure 7



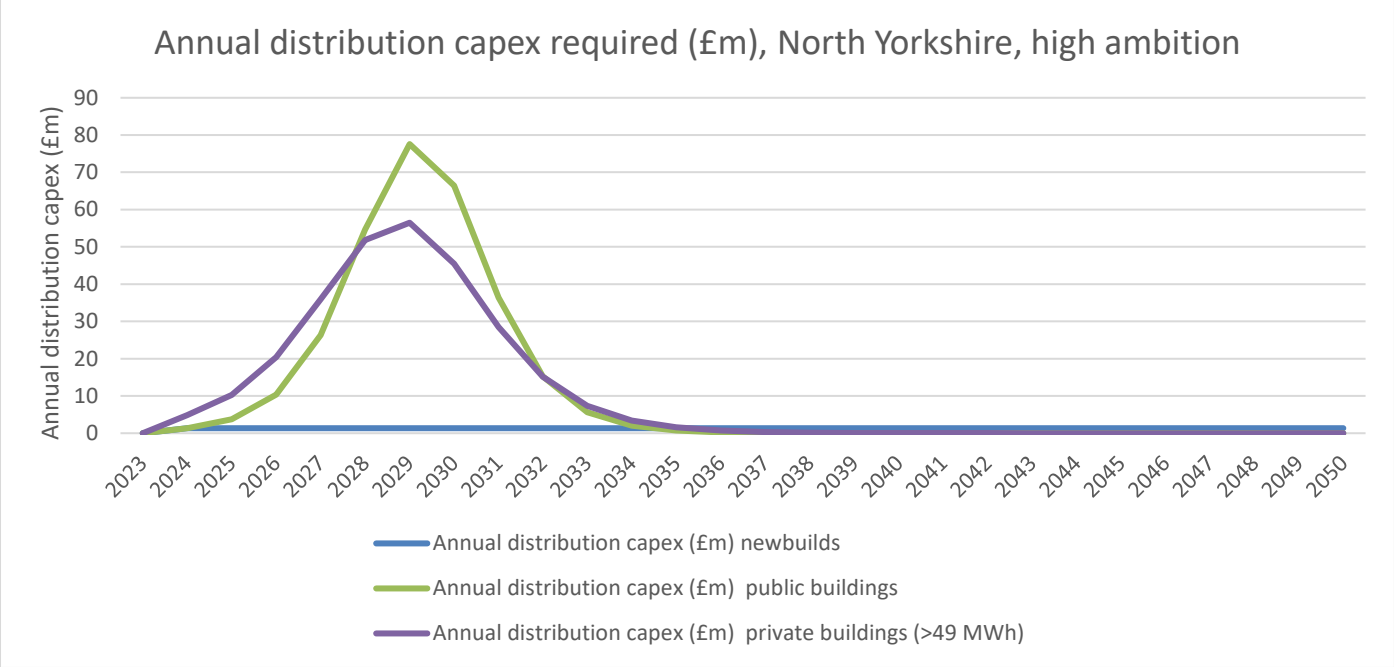
Projected total generation capex, high ambition, North Yorkshire Region

Table 10

Newbuild generation capex (£m) by 2050	Public Buildings generation capex (£m) by 2050	Private Buildings with >49MWh of annual demand, generation capex (£m) by 2050
45.40	375.85	353.18

Projected annual distribution capex, high ambition, North Yorkshire Region

Figure 8



Projected total distribution capex, high ambition, North Yorkshire Region

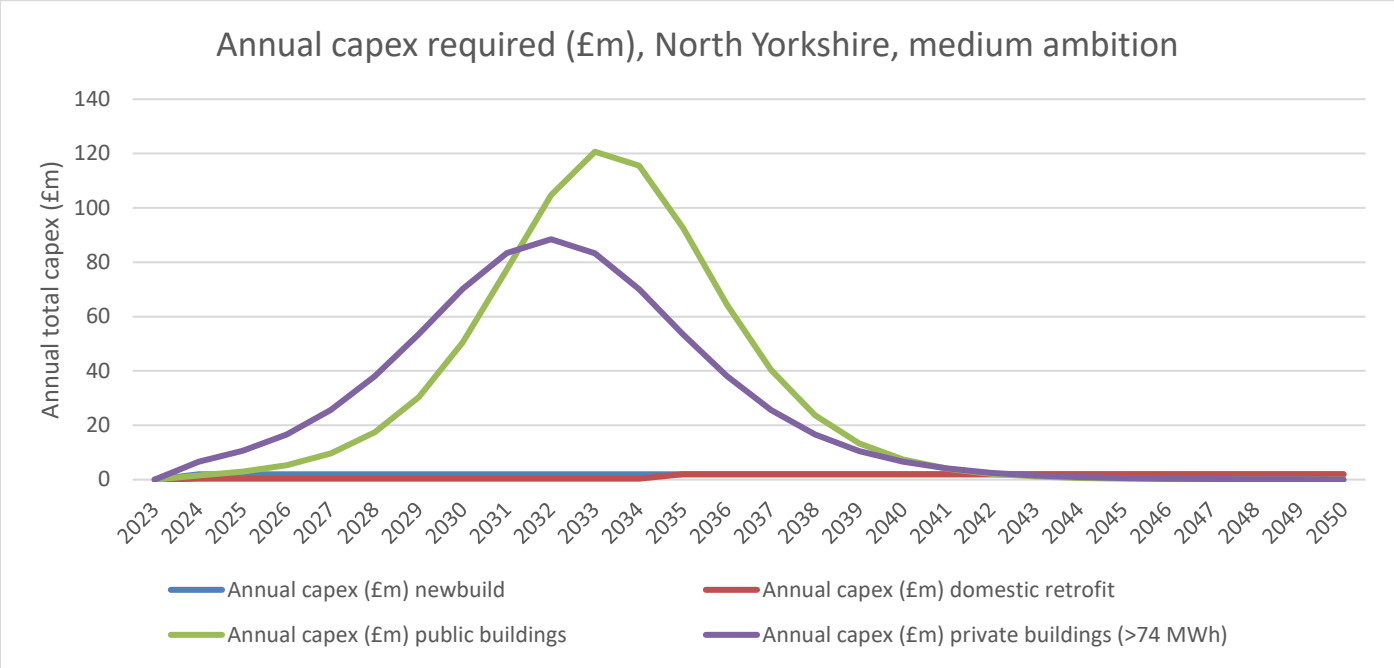
Table 11

Newbuild distribution capex (£m) by 2050	Public Buildings distribution capex (£m) by 2050	Private Buildings with >49MWh of annual demand, distribution capex (£m) by 2050
36.31	300.61	282.48

North Yorkshire Region, medium ambition, capex requirements

Projected total annual capex, medium ambition, North Yorkshire Region

Figure 9



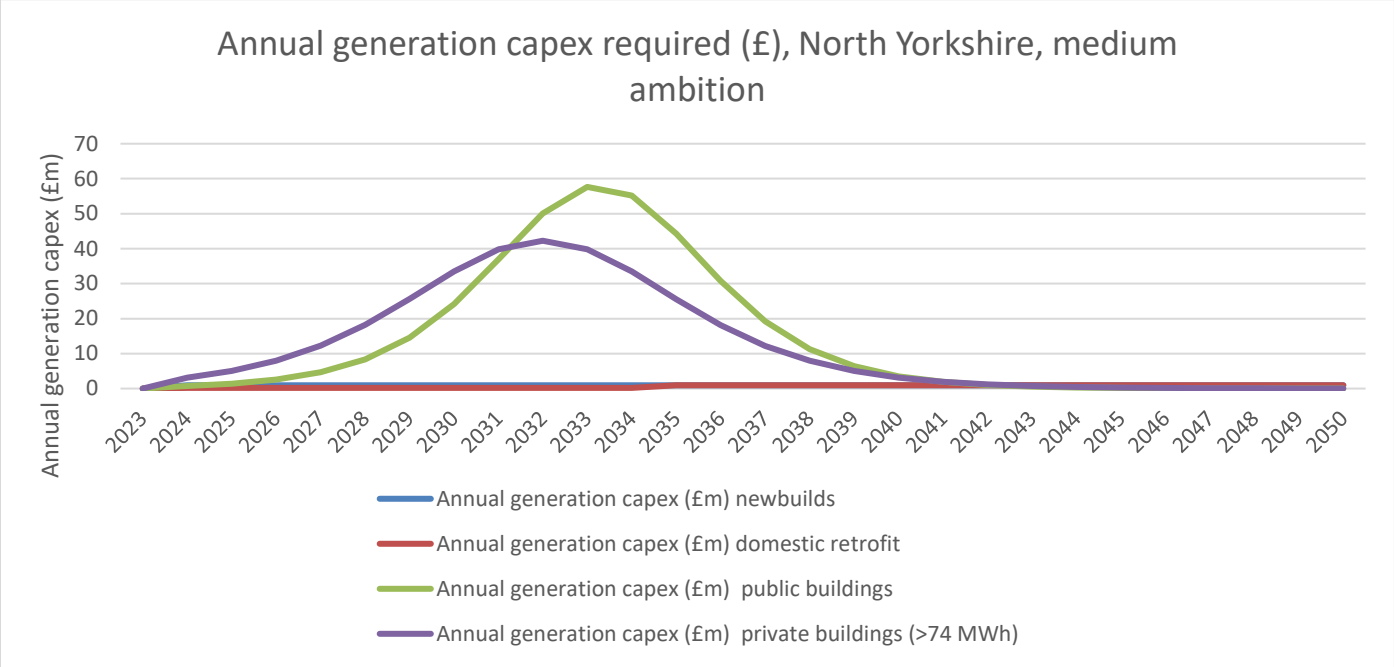
Projected total capex, medium ambition, North Yorkshire Region

Table 12

Newbuild total capex (£m) by 2050	Domestic Retrofit total capex (£m) by 2050	Public buildings total capex (£m) by 2050	Private buildings with >74 MWh annual demand total capex (£m) by 2050
52.79	35.69	786.58	707.61

Projected annual generation capex, medium ambition, North Yorkshire Region

Figure 10



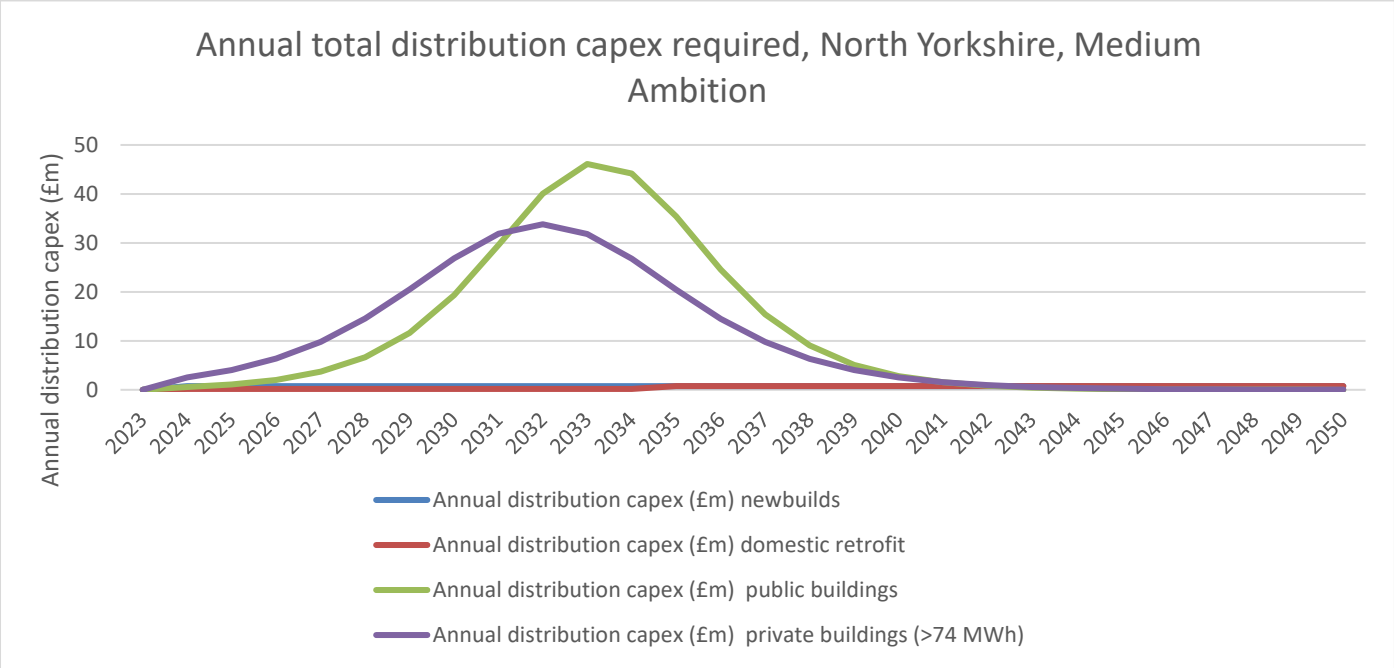
Projected total generation capex, medium ambition, North Yorkshire Region

Table 13

Newbuild generation capex (£m) by 2050	Domestic Retrofit generation capex (£m) by 2050	Public buildings generation capex (£m) by 2050	Private buildings with >74 MWh annual demand generation capex (£m) by 2050
25.22	17.05	375.84	338.12

Projected annual distribution capex, medium ambition, North Yorkshire Region

Figure 11



Projected total distribution capex, medium ambition, North Yorkshire Region

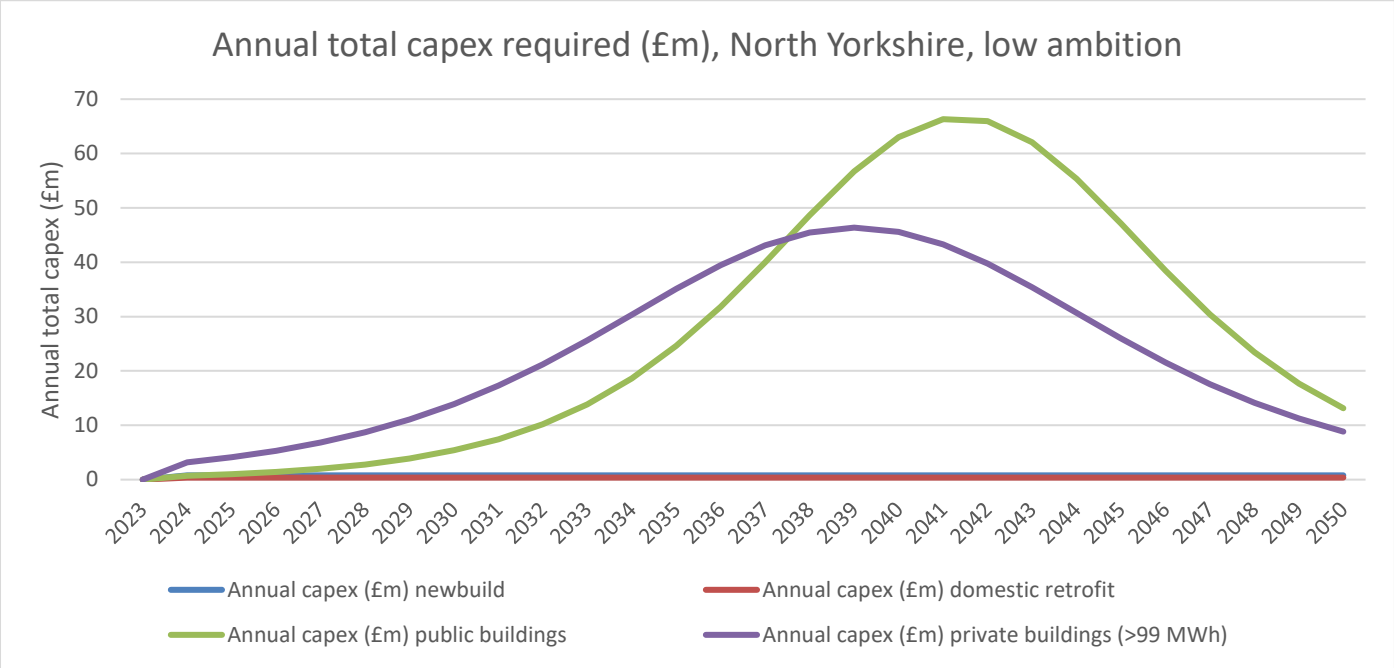
Table 14

Newbuild distribution capex (£m) by 2050	Domestic Retrofit distribution capex (£m) by 2050	Public buildings distribution capex (£m) by 2050	Private buildings with >74 MWh annual demand distribution capex (£m) by 2050
20.17	13.64	300.61	270.43

North Yorkshire Region, low ambition, capex requirements

Projected total annual capex, low ambition, North Yorkshire Region

Figure 12



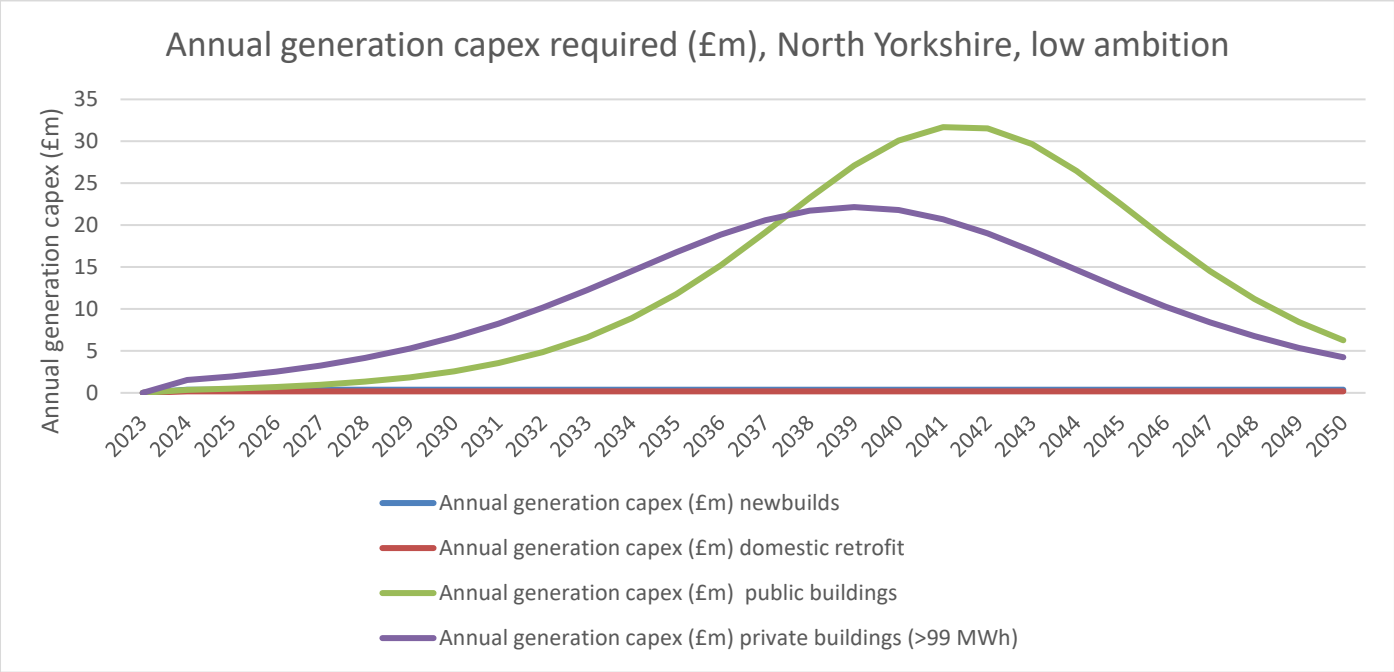
Projected total capex, low ambition, North Yorkshire Region

Table 15

Newbuild total capex (£m) by 2050	Domestic Retrofit total capex (£m) by 2050	Public buildings total capex (£m) by 2050	Private buildings with >99 MWh annual demand total capex (£m) by 2050
21.11	10.05	751.98	651.13

Projected annual generation capex, low ambition, North Yorkshire Region

Figure 13



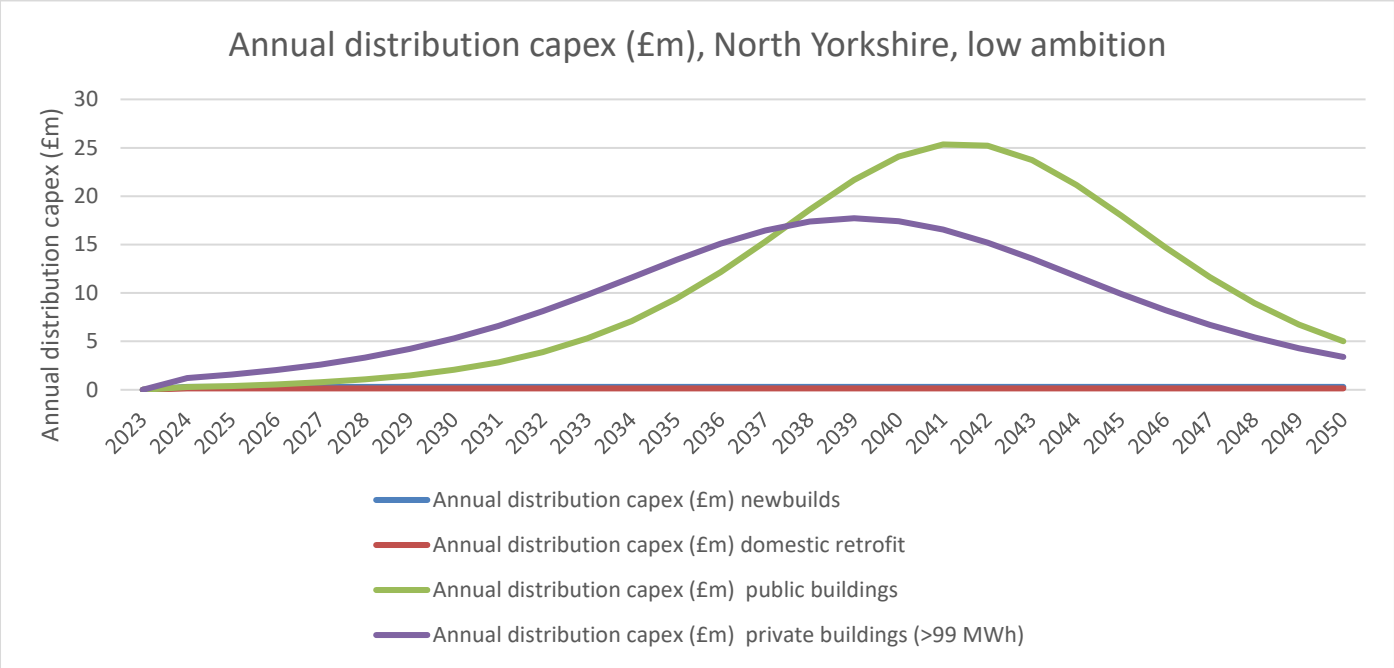
Projected total generation capex, low ambition, North Yorkshire Region

Table 16

Newbuild generation capex (£m) by 2050	Domestic Retrofit generation capex (£m) by 2050	Public buildings generation capex (£m) by 2050	Private buildings with >99 MWh annual demand generation capex (£m) by 2050
10.09	4.80	359.31	311.12

Projected annual distribution capex, low ambition, North Yorkshire

Figure 14



Projected total distribution capex, low ambition, North Yorkshire Region

Table 17

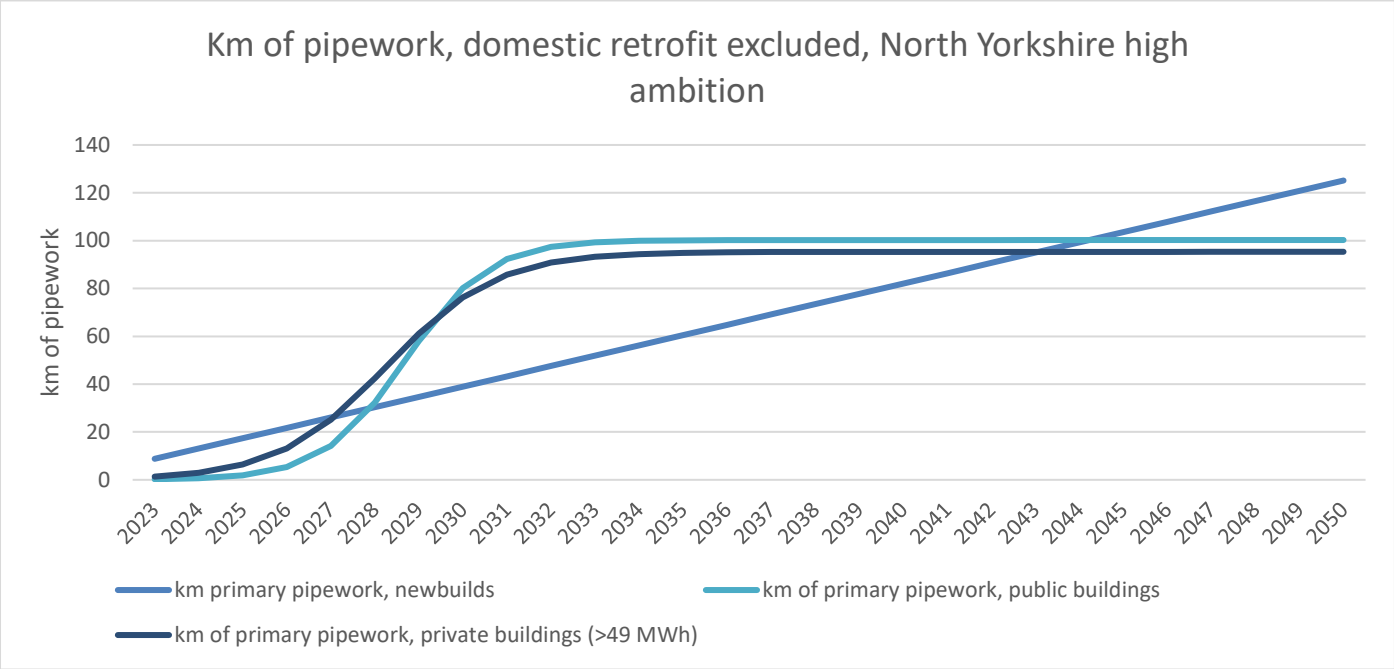
Newbuild distribution capex (£m) by 2050	Domestic Retrofit distribution capex (£m) by 2050	Public buildings distribution capex (£m) by 2050	Private buildings with >99 MWh annual demand distribution capex (£m) by 2050
8.07	3.84	287.38	248.84

North Yorkshire Region, projections of pipework required to meet heat demand

North Yorkshire Region, high ambition, pipework requirements

Total Km of pipework, high ambition, North Yorkshire Region

Figure 15



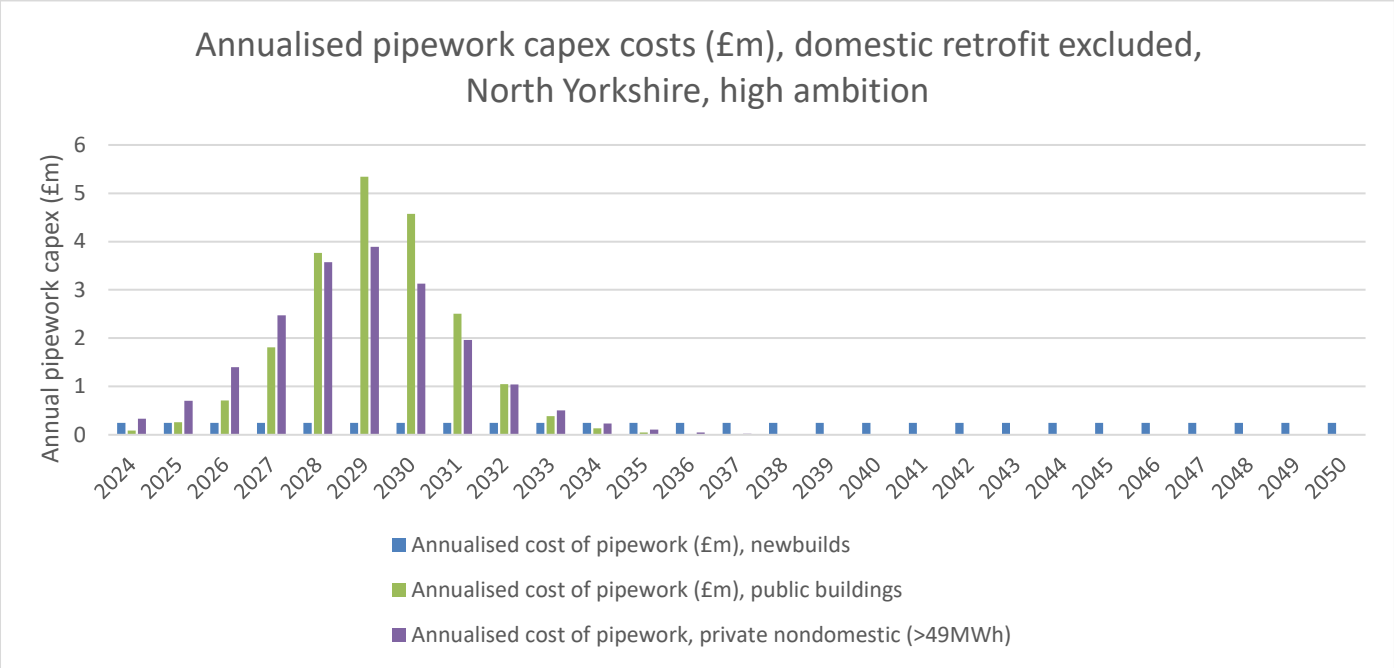
Total km of pipework, high ambition, North Yorkshire Region

Table 18

Newbuild pipework (km) by 2050	Public Buildings pipework (km) by 2050	Private Buildings with >49MWh of annual demand, km (km) by 2050
125.13	100.26	95.33

Projected annual pipework capex, high ambition, North Yorkshire Region

Figure 16



Projected total pipework capex, high ambition, North Yorkshire Region

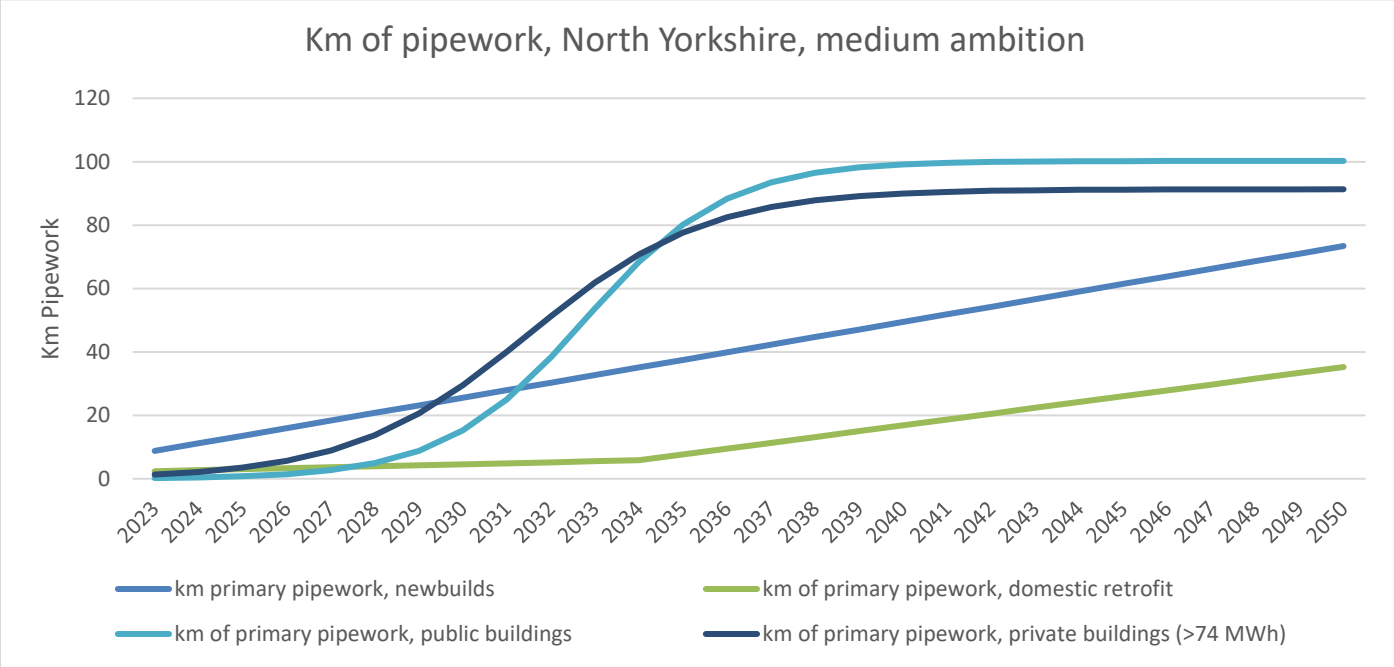
Table 19

Newbuild pipework capex (£m) by 2050	Public Buildings pipework capex (£m) by 2050	Private Buildings with >49MWh of annual demand, pipework capex (£m) by 2050
6.60	20.70	19.45

North Yorkshire Region, medium ambition, pipework requirements

Total Km of pipework, medium ambition, North Yorkshire Region

Figure 17



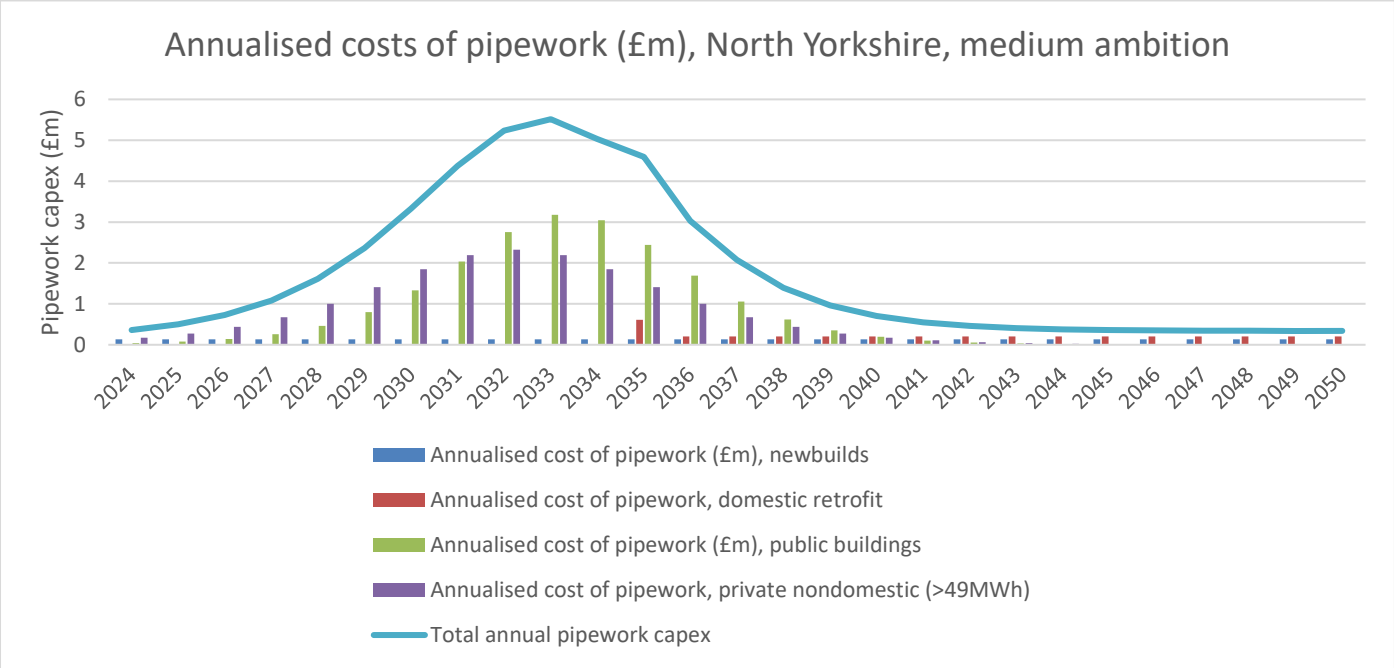
Projected total km of pipework, medium ambition, North Yorkshire Region

Table 20

Newbuild pipework (km) by 2050	Domestic Retrofit pipework (km) by 2050	Public buildings pipework (km) by 2050	Private buildings with >74 MWh annual demand, pipework (km) by 2050
73.42	35.24	100.25	91.32

Projected annual pipework capex, medium ambition, North Yorkshire Region

Figure 18



Projected annual pipework capex, medium ambition, North Yorkshire Region

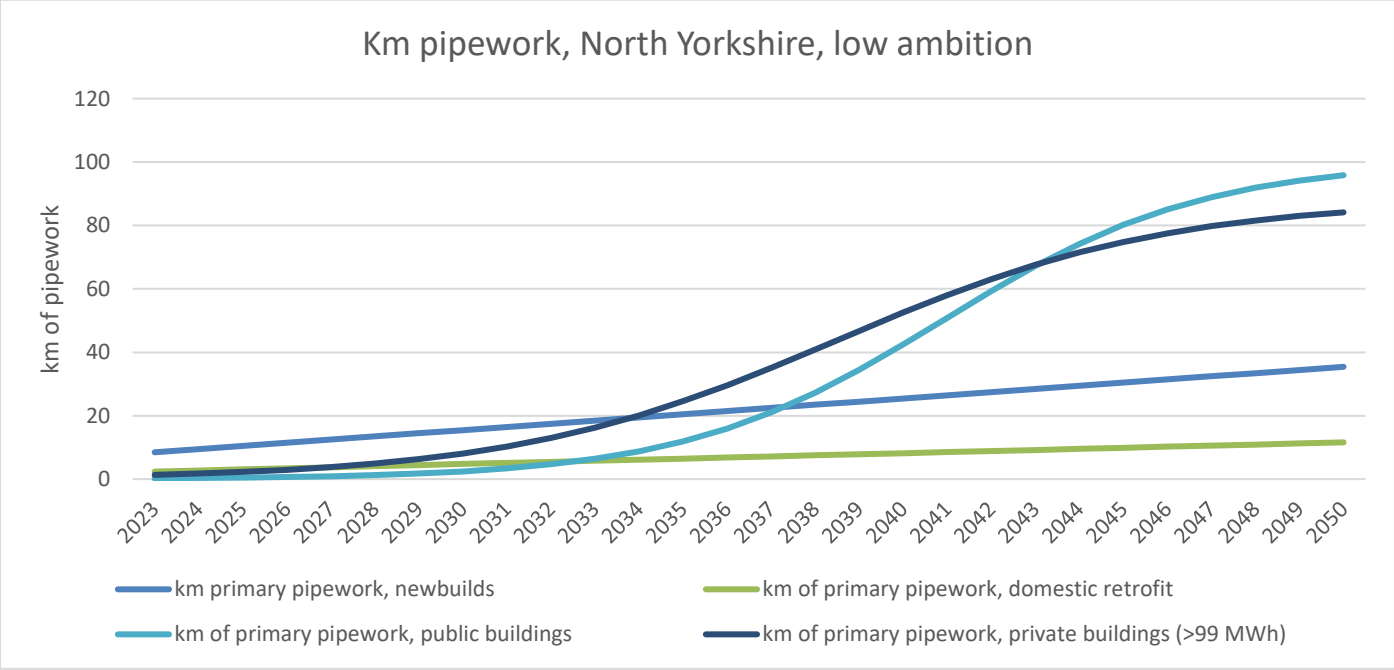
Table 21

Newbuild pipework capex (£m) by 2050	Domestic Retrofit pipework capex (£m) by 2050	Public buildings pipework capex (£m) by 2050	Private buildings with >74 MWh annual demand pipework capex (£m) by 2050
3.67	3.77	20.70	18.62

North Yorkshire Region, low ambition, pipework requirements

Total Km of pipework, low ambition, North Yorkshire Region

Figure 19



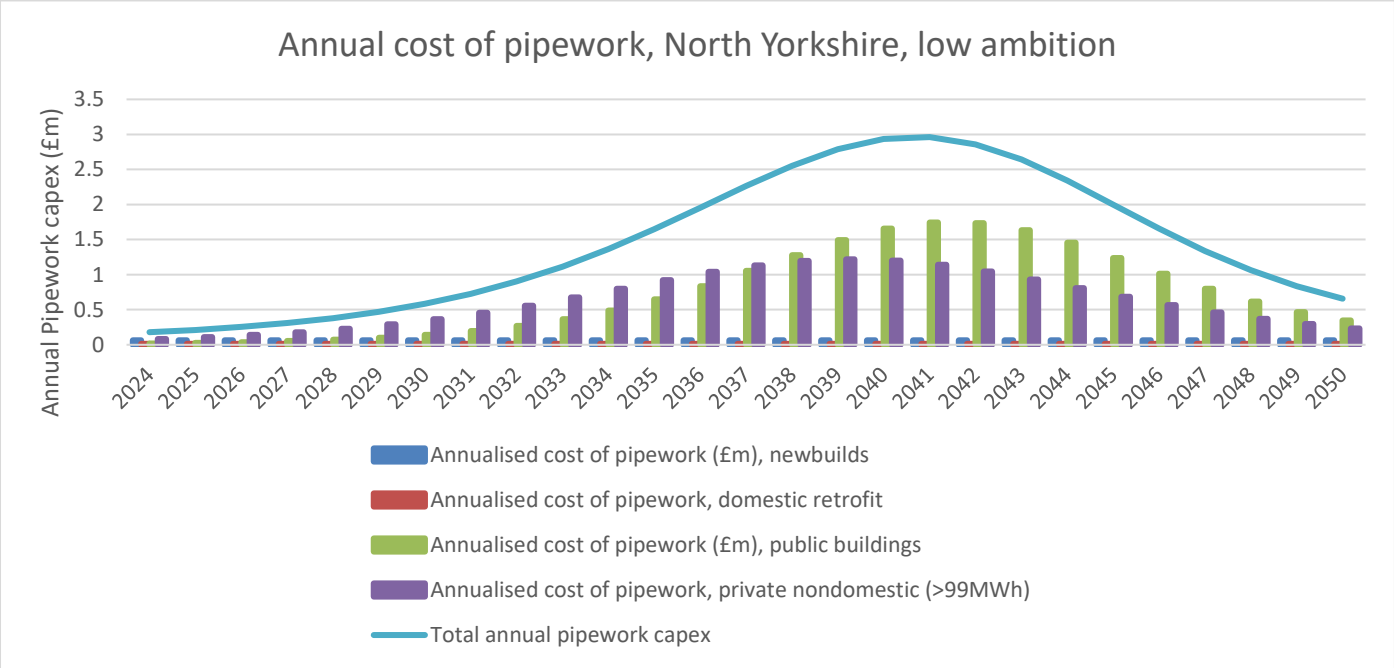
Total Km of pipework, low ambition, North Yorkshire Region

Table 22

Newbuild pipework (km) by 2050	Domestic Retrofit pipework (km) by 2050	Public buildings pipework (km) by 2050	Private buildings with >99 MWh annual demand, pipework (km) by 2050
35.43	11.59	95.85	84.14

Annual capex of pipework, low ambition, North Yorkshire Region

Figure 20



Total pipework capex, low ambition, North Yorkshire Region

Table 23

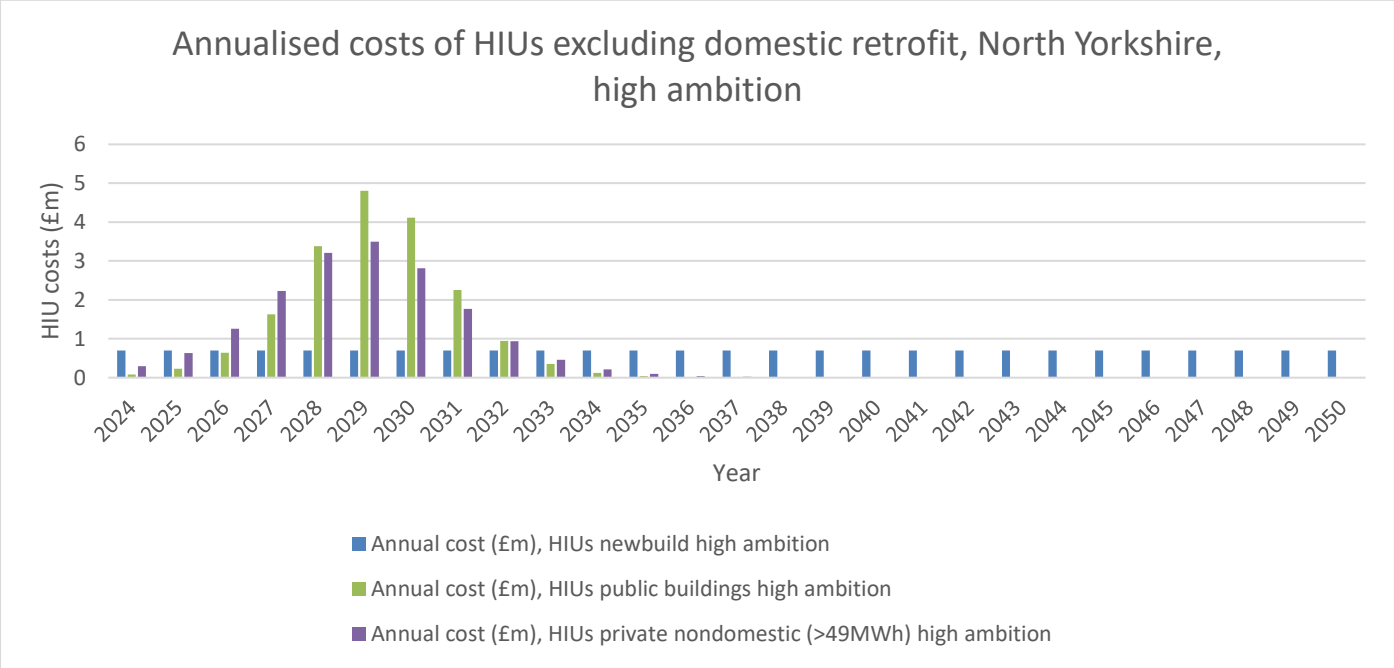
Newbuild pipework capex (£m) by 2050	Domestic Retrofit pipework capex (£m) by 2050	Public buildings pipework capex (£m) by 2050	Private buildings with >99 MWh annual demand pipework capex (£m) by 2050
1.71	0.36	19.79	17.14

North Yorkshire Region, projections of HIUs required to meet heat demand

North Yorkshire Region, high ambition, HIU requirements

Annual HIU capex, high ambition, North Yorkshire Region

Figure 21



Total HIU capex, high ambition, North Yorkshire Region

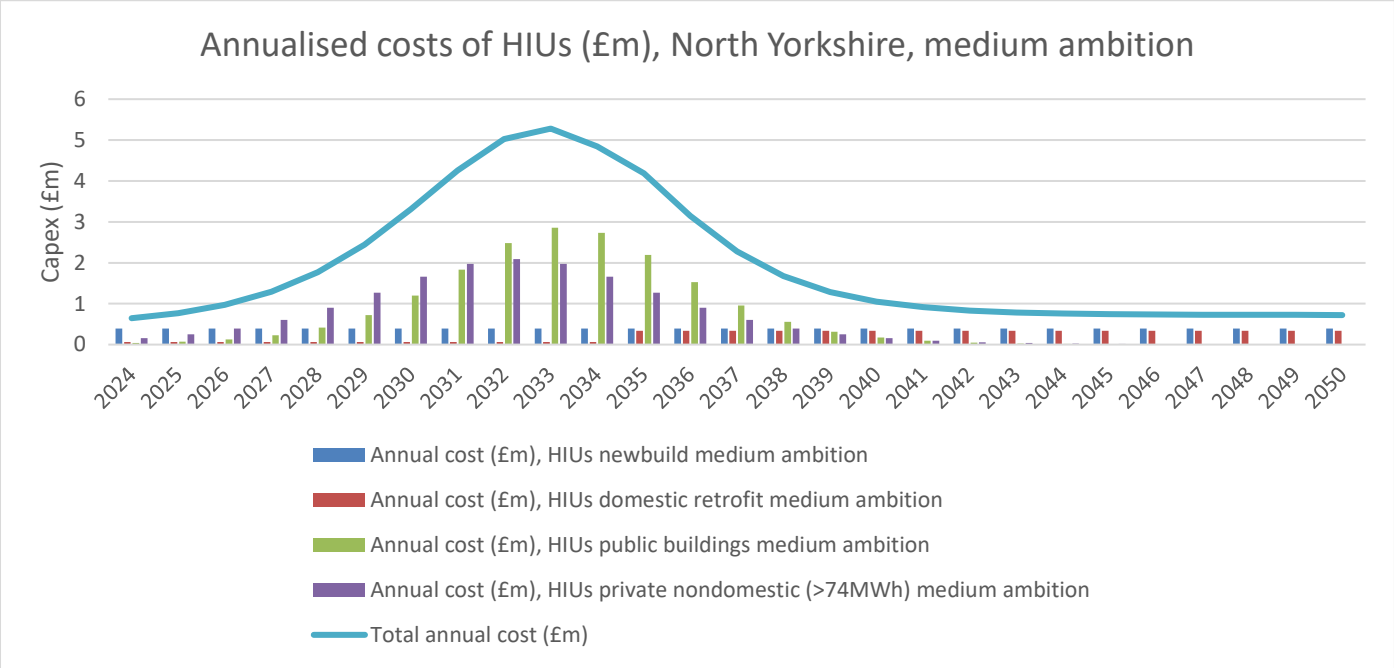
Table 24

Newbuild HIU capex (£m) by 2050	Public Buildings HIU capex (£m) by 2050	Private Buildings with >49MWh of annual demand, HIU capex (£m) by 2050
18.93	18.62	17.50

North Yorkshire Region, medium ambition, HIU requirements

Annual HIU capex, medium ambition, North Yorkshire Region

Figure 22



Total HIU capex, medium ambition, North Yorkshire Region

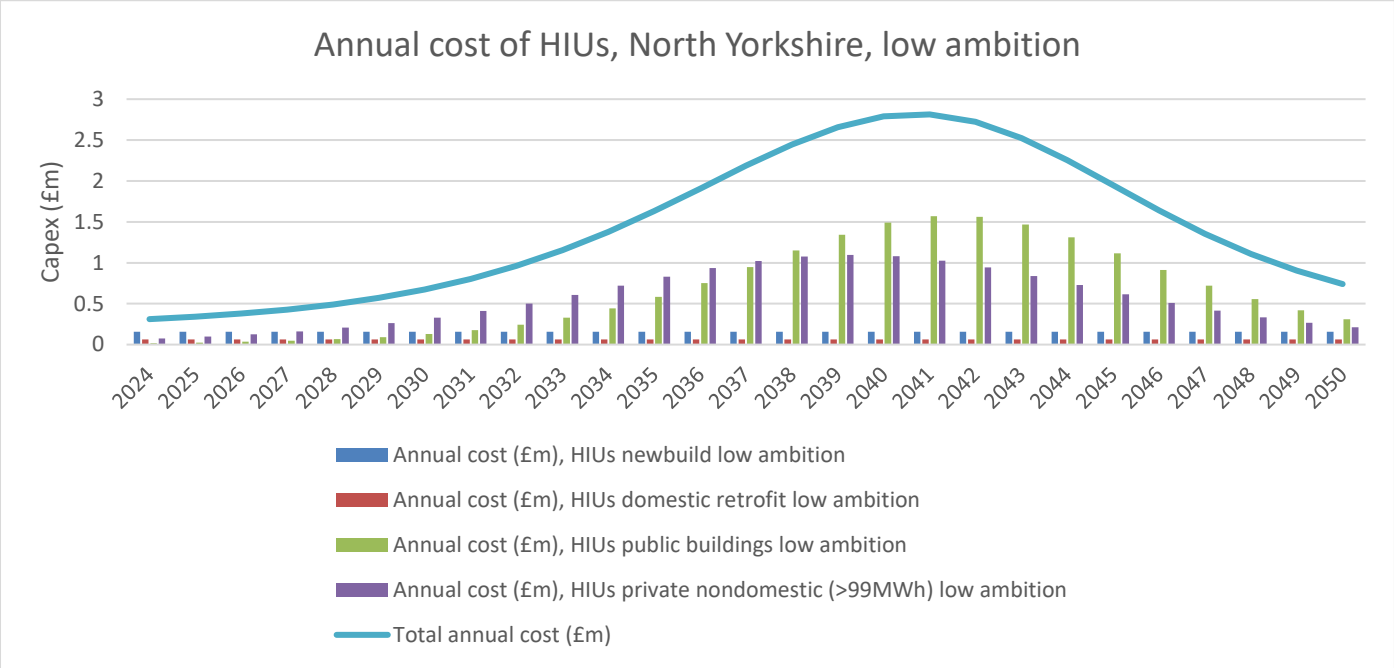
Table 25

Newbuild HIU capex (£m) by 2050	Domestic Retrofit HIU capex (£m) by 2050	Public buildings HIU capex (£m) by 2050	Private buildings with >74 MWh annual demand HIU capex (£m) by 2050
10.51	6.02	18.62	16.75

North Yorkshire Region, low ambition, HIU requirements

Annual HIU, low ambition, North Yorkshire Region

Figure 23



Total HIU capex, low ambition, North Yorkshire Region

Table 26

Newbuild HIU capex (£m) by 2050	Domestic Retrofit HIU capex (£m) by 2050	Public buildings HIU capex (£m) by 2050	Private buildings with >99 MWh annual demand HIU capex (£m) by 2050
4.21	1.70	17.80	15.41

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