

ADE Analysis: Heat Network Growth Curve & Supply Chain Modelling for the East Midlands Combined Authority

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ade

The Association for
Decentralised Energy

Combined Heat & Power
Demand Side Services
Energy Efficiency
Heat Networks

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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East Midlands Combined Authority: executive summary

The East Midlands has the potential to increase the heat it has from heat networks by 100x over the next 30 years and bring in more than £10bn 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, private non-domestic buildings account for the majority of heat demand that is currently met by heat networks across the East Midlands combined authority. According to EPC data, these buildings account for over half of the heat demand currently met by heat networks in the area: 66 GWh of the 114 GWh of heat we can estimate networks currently meet.

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 12 TWh of demand by 2050, with most of this demand added to networks in the mid-to-late 2020s. This falls to 10 TWh of demand in a low ambition scenario, in which most of the demand is added in the 2040s.
- The high ambition scenario predicts an estimated £12.8 Bn in capex, with investment peaking in 2026 and in 2027. Our low ambition scenario predicts a total capex of £11.2 Bn, but with investment peaking in 2039 and 2040.
- Our high ambition scenario would involve 2,593 km of primary pipework, compared to 1,640 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 2040s.
- Across all scenarios, heat demand – and therefore investment – is primarily driven by public buildings and large private non-domestic buildings.
- In our medium ambition scenario, in which large blocks of flats are connected to heat networks in the mid-2030s, domestic retrofit could add 658 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.

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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.

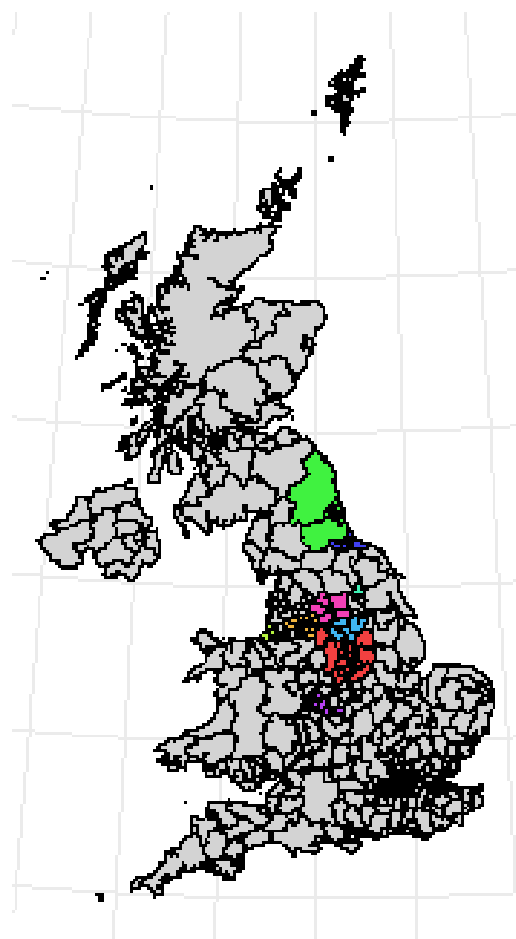
EPC data: baseline level of heat demand and projecting this forward

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 UKⁱ. 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.

Figure 1: 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

Table 1: Ambition scenarios for heat demand networks could meet

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

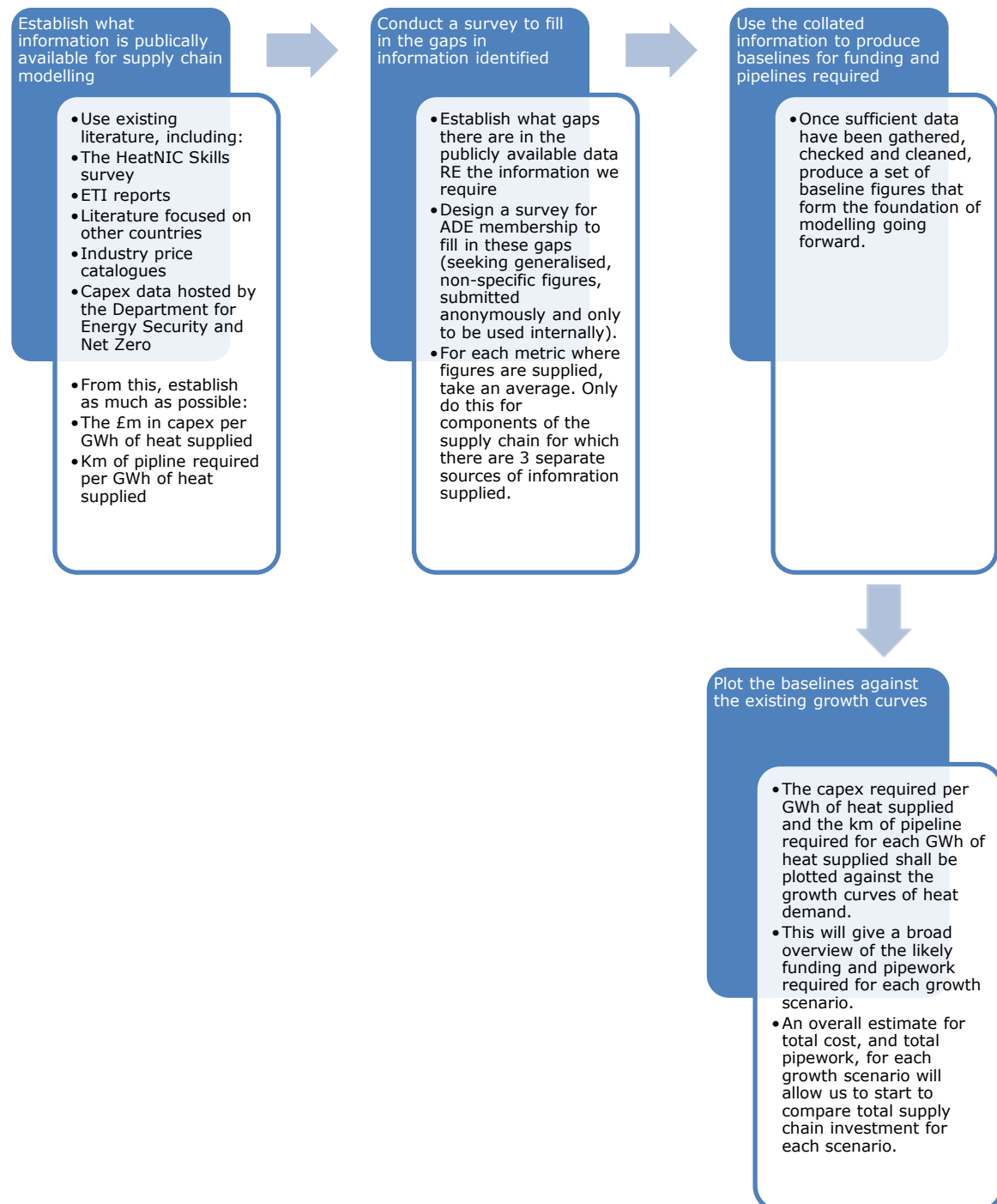
Market	Low Ambition Scenario	Medium Ambition Scenario	High Ambition Scenario
Newbuild	20% of newbuilds are added onto a heat network from 2024 onward	50% of newbuilds are added onto a heat network from 2024 onward	90% of newbuilds are added onto a heat network from 2024 onward

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.

Figure 2: process overview, obtaining capex data



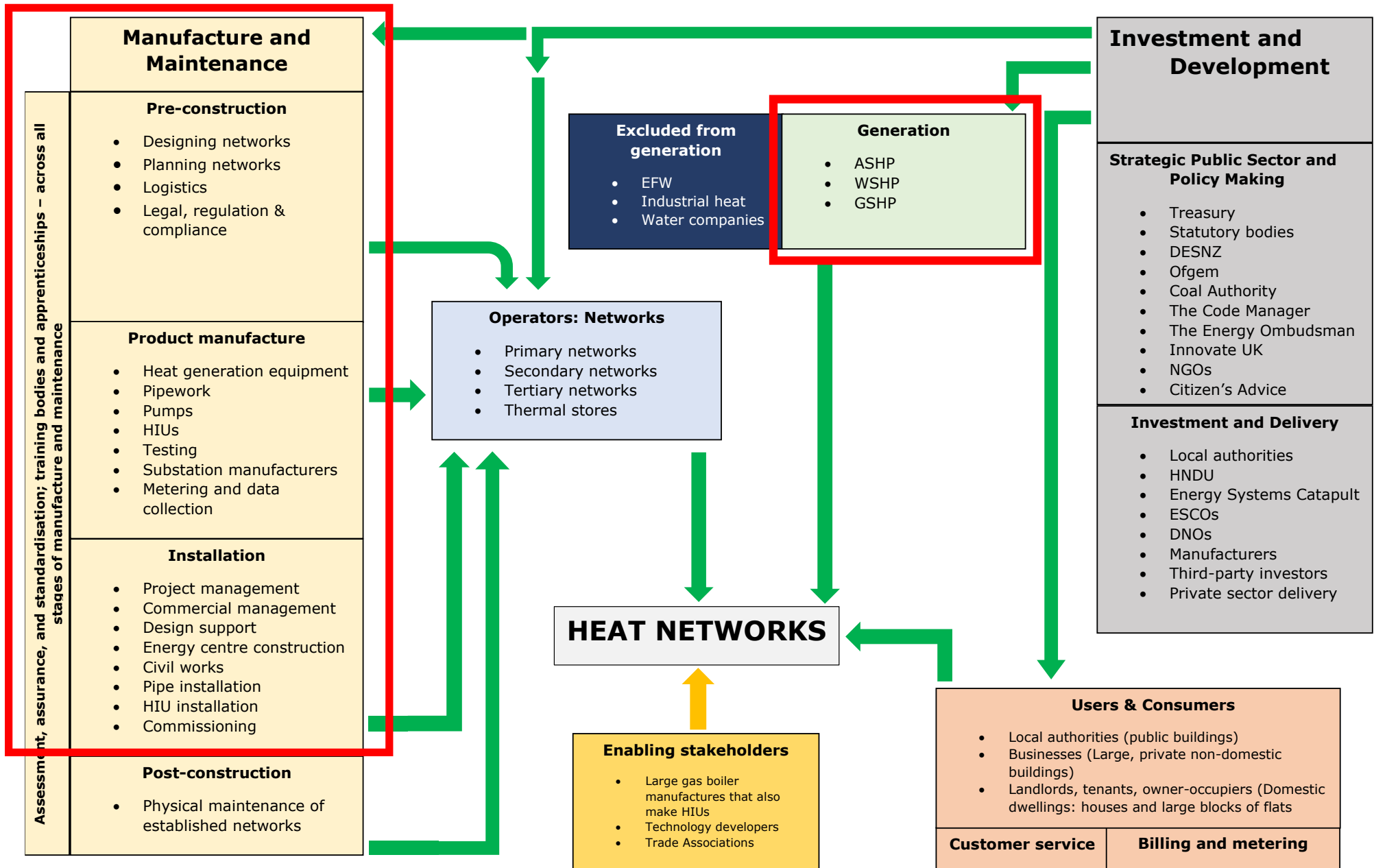
Overview of stakeholders identified

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, Figure 3

- 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)

Figure 3



Data from Heat Network Project Pipeline

Project pipeline data, hosted by the Department of Energy Security and Net Zeroⁱⁱⁱ 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.

Figure 4: relationship between heat demand and capex

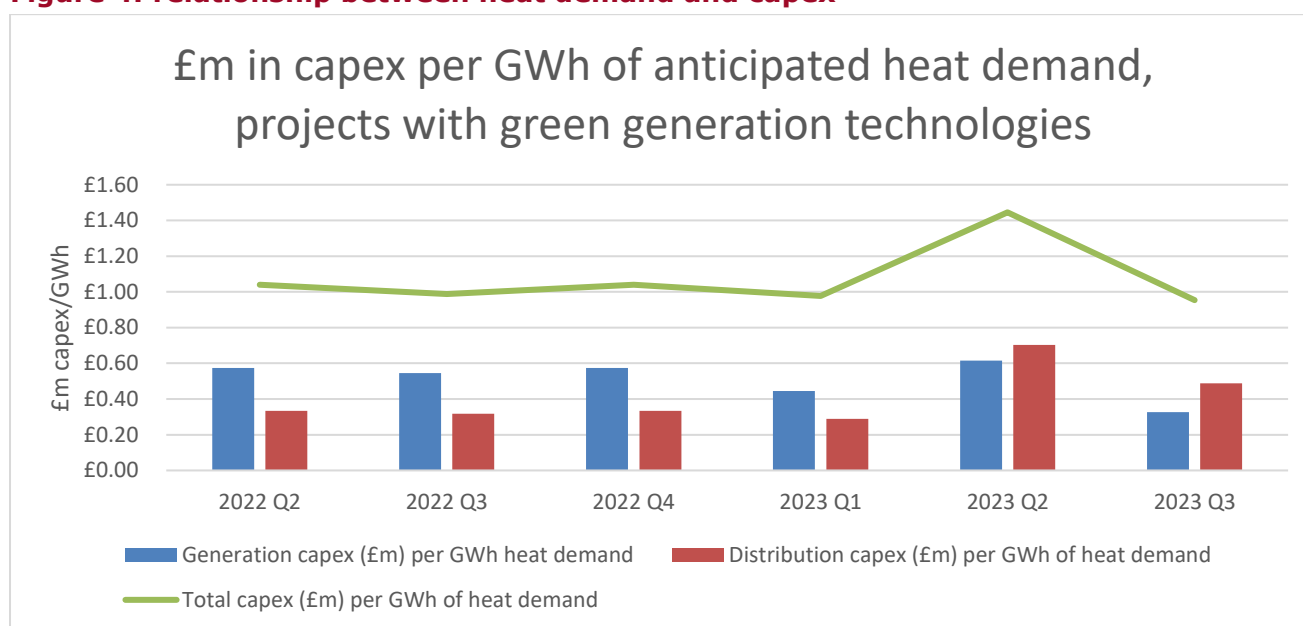


Table 2: average £m/GWh from project pipeline data

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.

Table 3: estimating MWh/m

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.

Table 4: proportions of pipework across sectors

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).

Table 5: average HIU unit costs across sectors

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 East Midlands could potentially meet in the area 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.

East Midlands baseline

Note 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.

Figure 5: baseline level of heat met by networks in the East Midlands

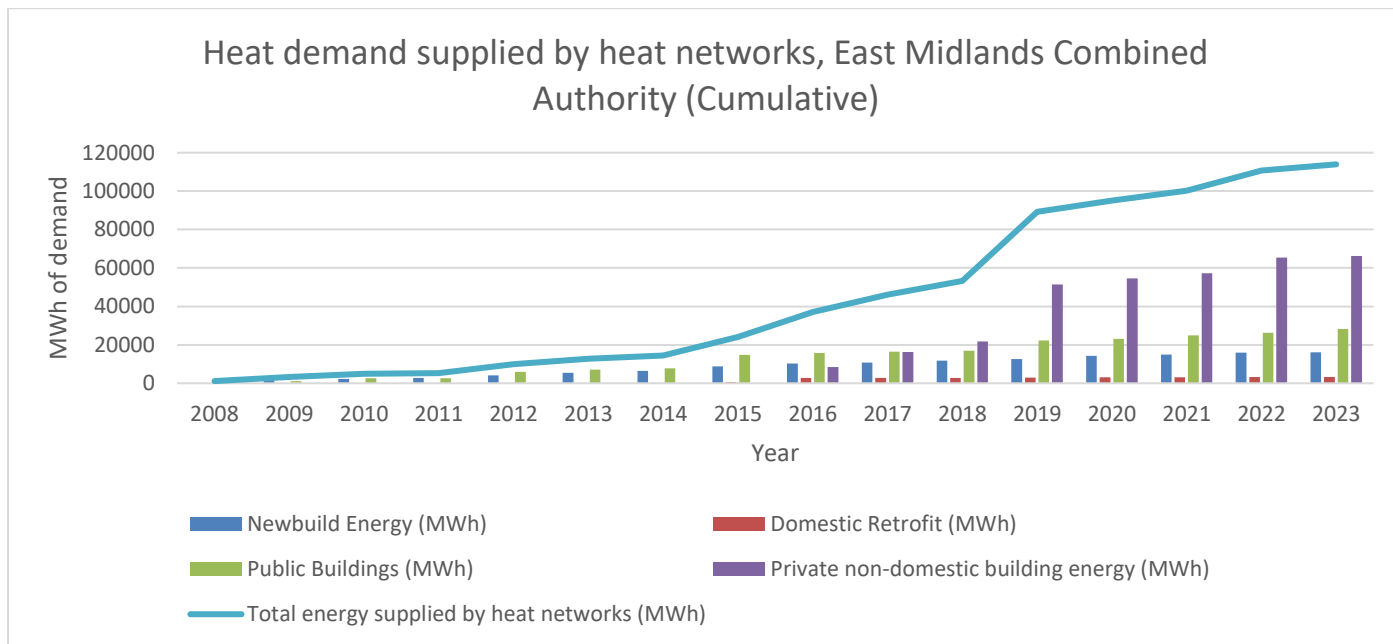


Table 6: baseline levels of heat met by heat networks for each sector, East Midlands

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)
16.19	3.23	28.23	66.30	113.94

East Midlands, projections of heat demand met by networks

East Midlands, high ambition, heat demand met by 2050

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

Figure 6: projected heat demand, high ambition, East Midlands

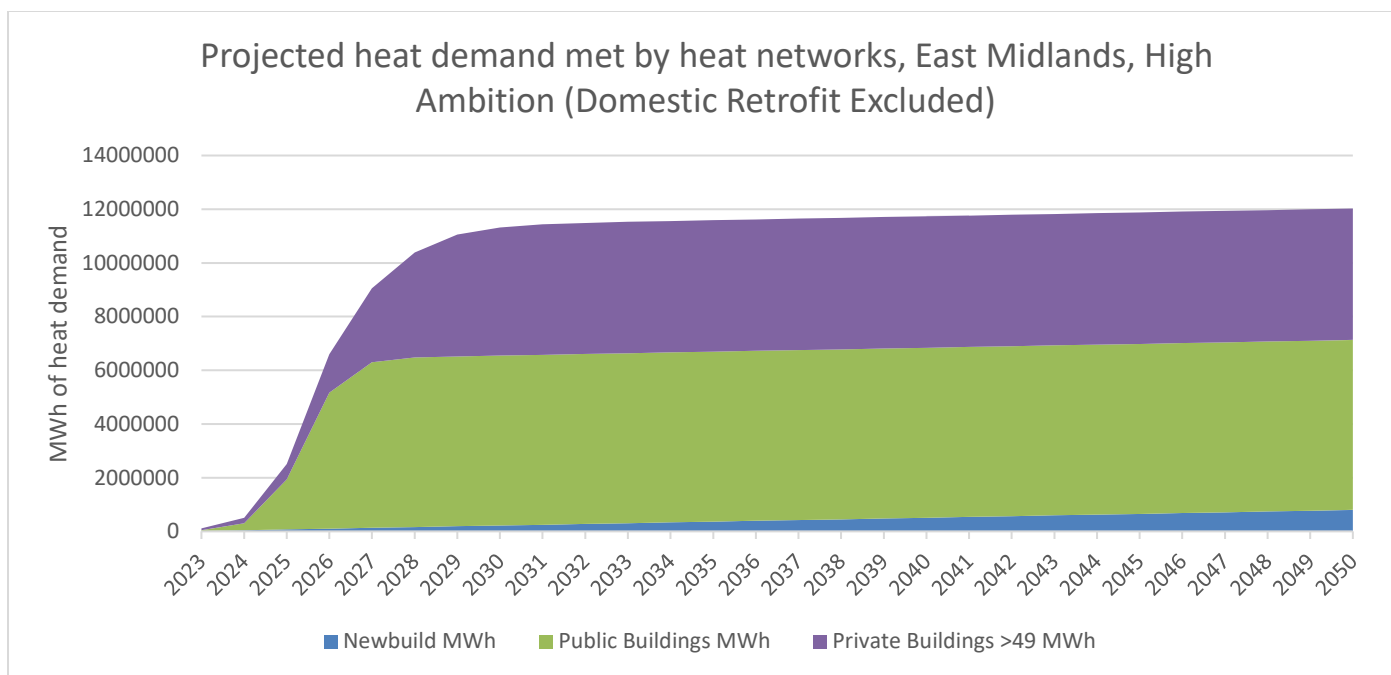


Table 7: projected total heat supplied by networks to each sector by 2050

Newbuild (GWh by 2050)	Public Buildings (GWh by 2050)	Private Buildings with >49MWh of annual demand (GWh by 2050)
797.90	6330.88	4895.65

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

East Midlands, medium ambition, heat demand met by 2050

Figure 7: projected heat demand, medium ambition, East Midlands

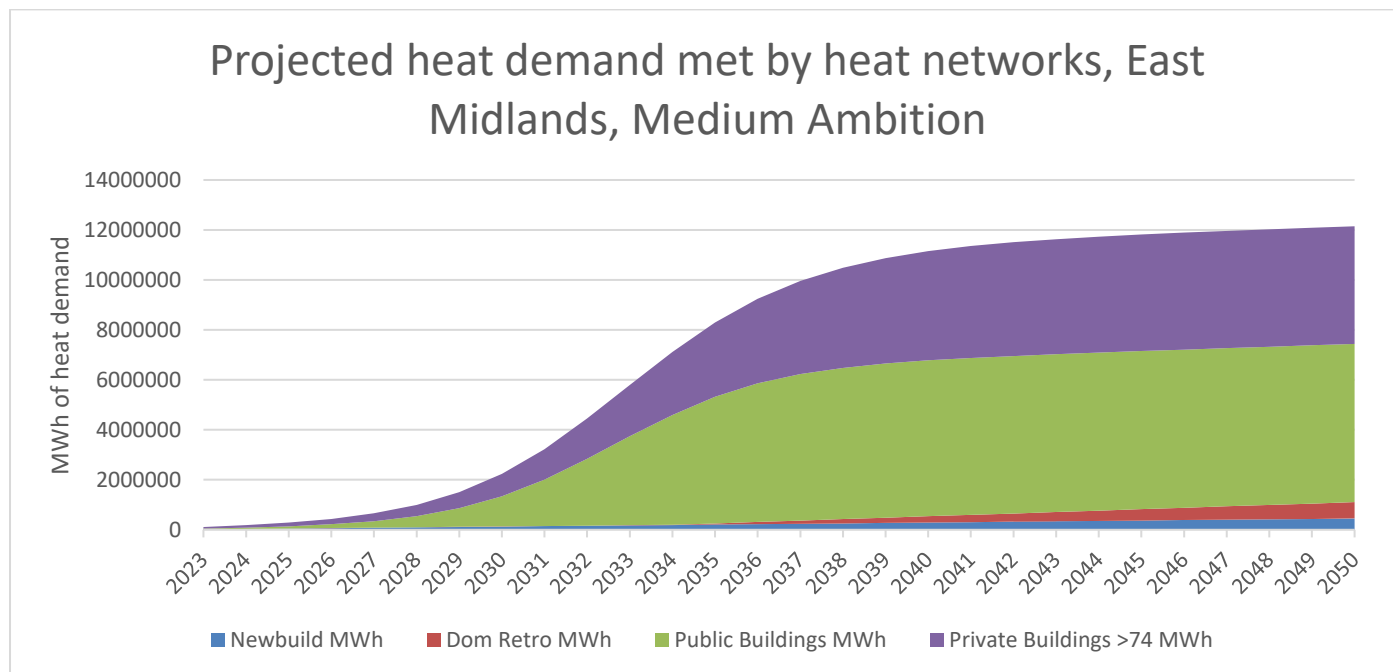


Table 8: projected total heat supplied by networks to each sector by 2050

Newbuild (GWh by 2050)	Domestic Retrofit (GWh by 2050)	Public buildings (GWh by 2050)	Private buildings with >74 MWh annual demand (GWh by 2050)
450.47	658.02	6330.55	4707.31

This assumes that all public buildings are connected by 2038, and that all private non-domestic buildings that have an annual heat demand of >74 MWh are connected by 2040

East Midlands, low ambition, heat demand met by 2050

Figure 8: projected heat demand, low ambition, East Midlands

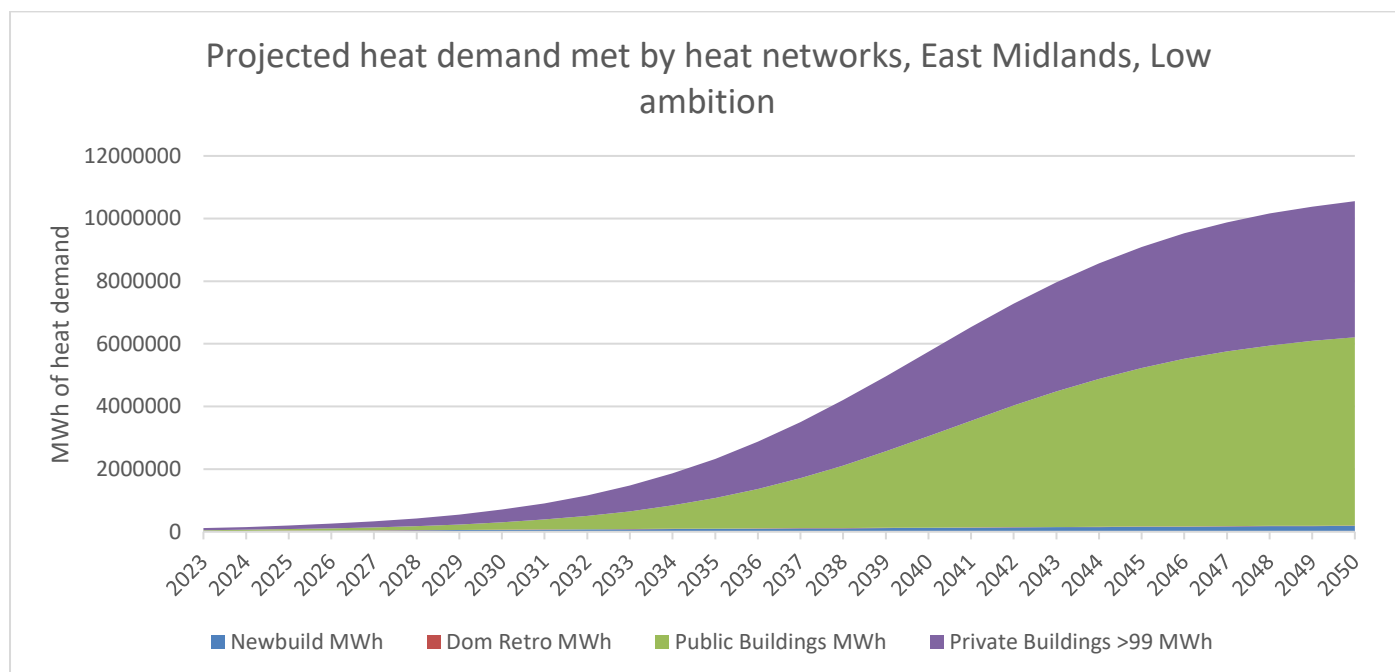


Table 9: total projected heat supplied by networks to each sector, 2050

Newbuild (GWh by 2050)	Domestic Retrofit (GWh by 2050)	Public buildings (GWh by 2050)	Private buildings with >99 MWh annual demand (GWh by 2050)
190	11.17	6010.12	4344.01

This assumes that all public buildings attempt to connect by 2050, and that all private non-domestic buildings that have an annual heat demand of >99 MWh attempt to connect by 2050

East Midlands, projections of capex required to meet heat demand

East Midlands, high ambition, capex requirements

Figure 9: projected annual total capex, high ambition, East Midlands

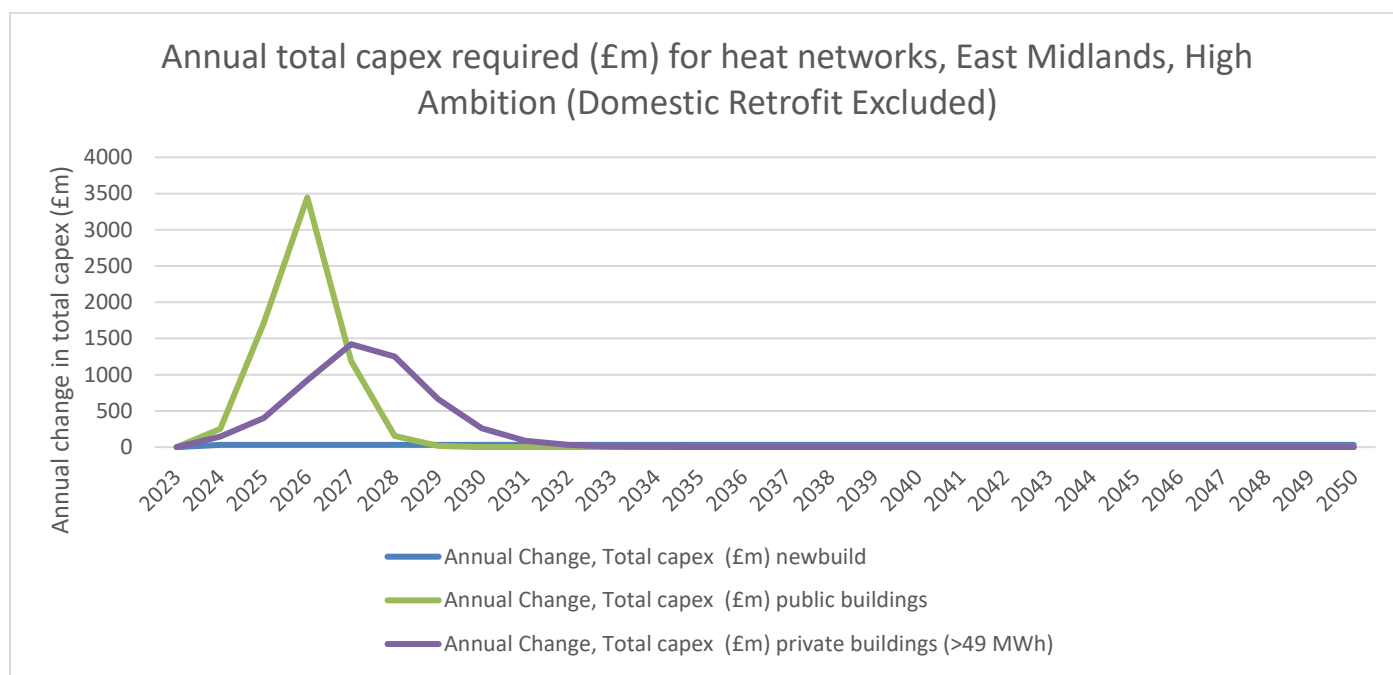


Table 10: projected total capex by 2050, East Midlands high ambition

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
839.82	6,771.08	5,188.29

Figure 10: projected annual generation capex, high ambition, East Midlands

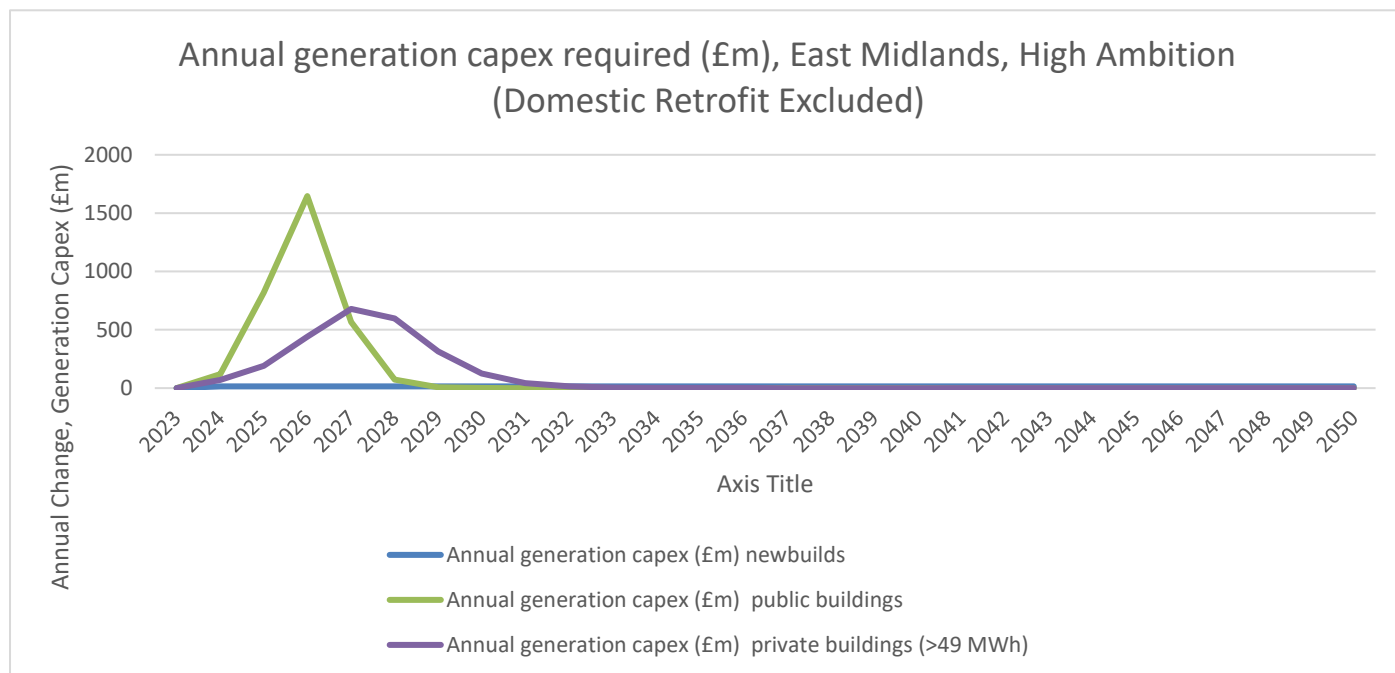


Table 11: projected total generation capex, high ambition, East Midlands

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
401.28	3,235.32	2,479

Figure 11: projected annual distribution capex, high ambition, East Midlands

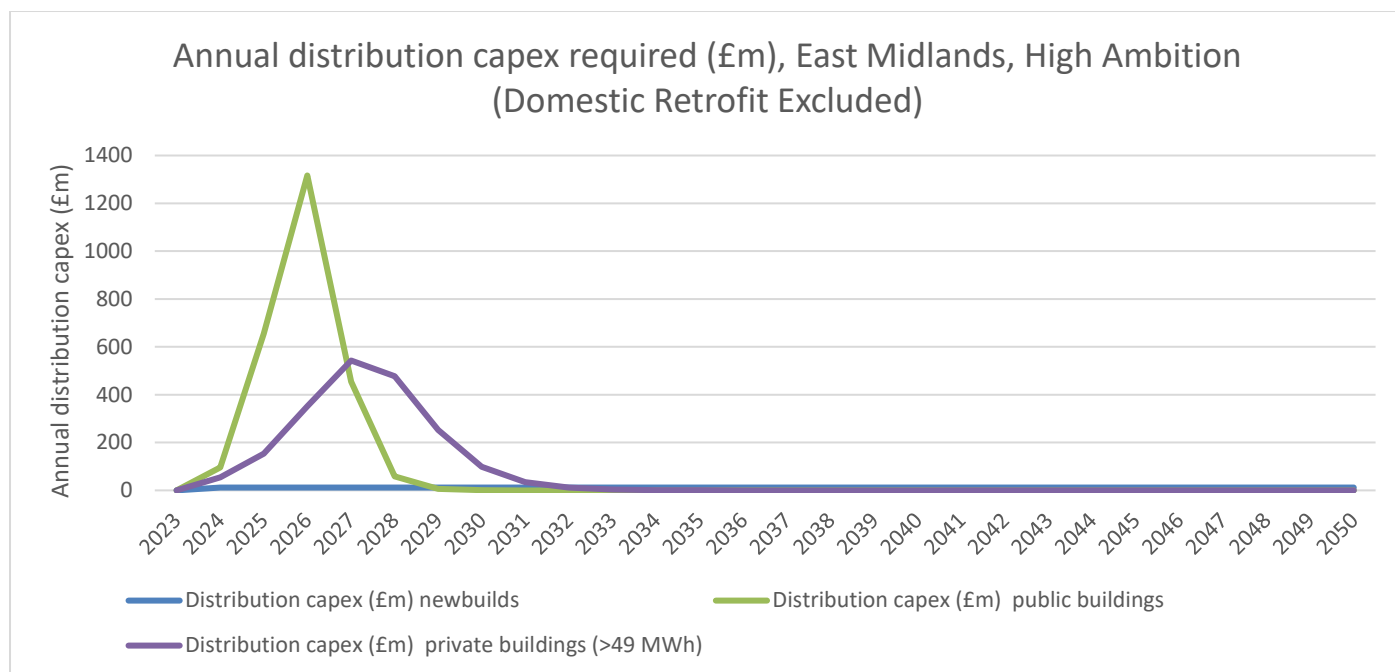


Table 12: projected total distribution capex, high ambition, East Midlands

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
320.95	2,587.70	1,982.81

East Midlands, medium ambition, capex requirements

Figure 12: projected total annual capex, medium ambition, East Midlands

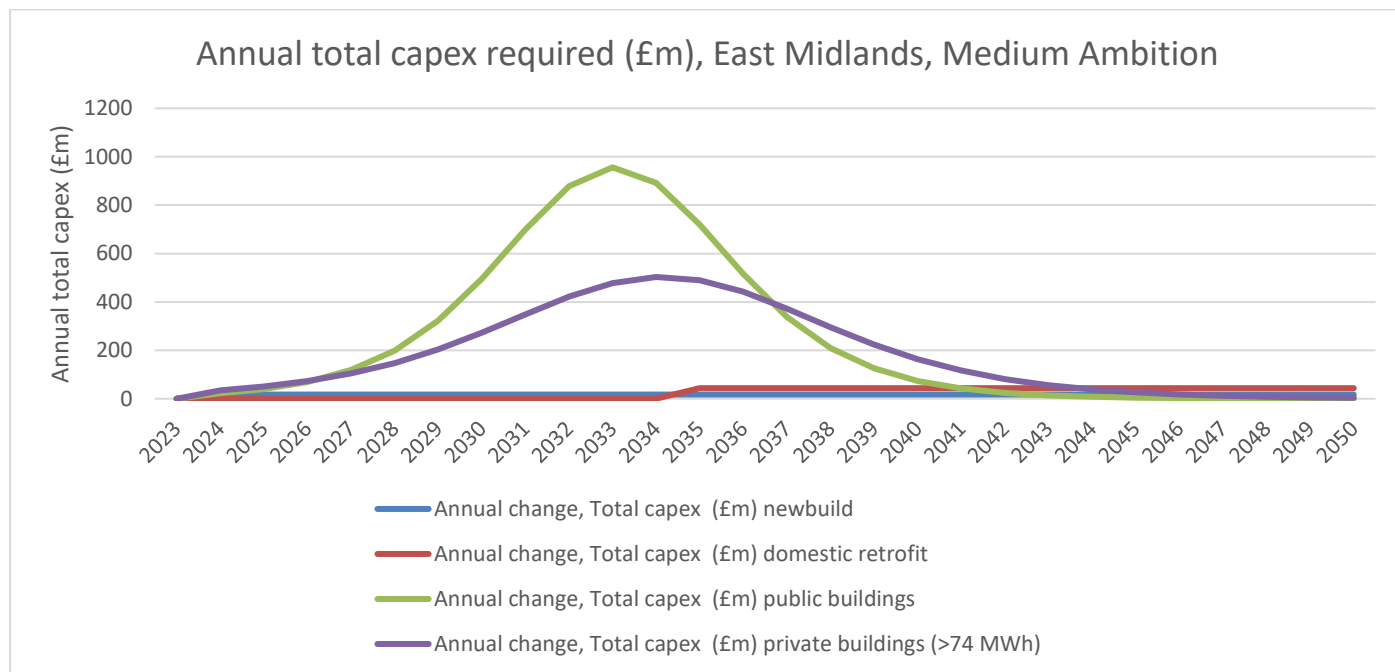


Table 13: projected total capex, high ambition, East Midlands

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
466.57	703.45	6,770.74	4,985.95

Figure 13: projected annual generation capex, medium ambition, East Midlands

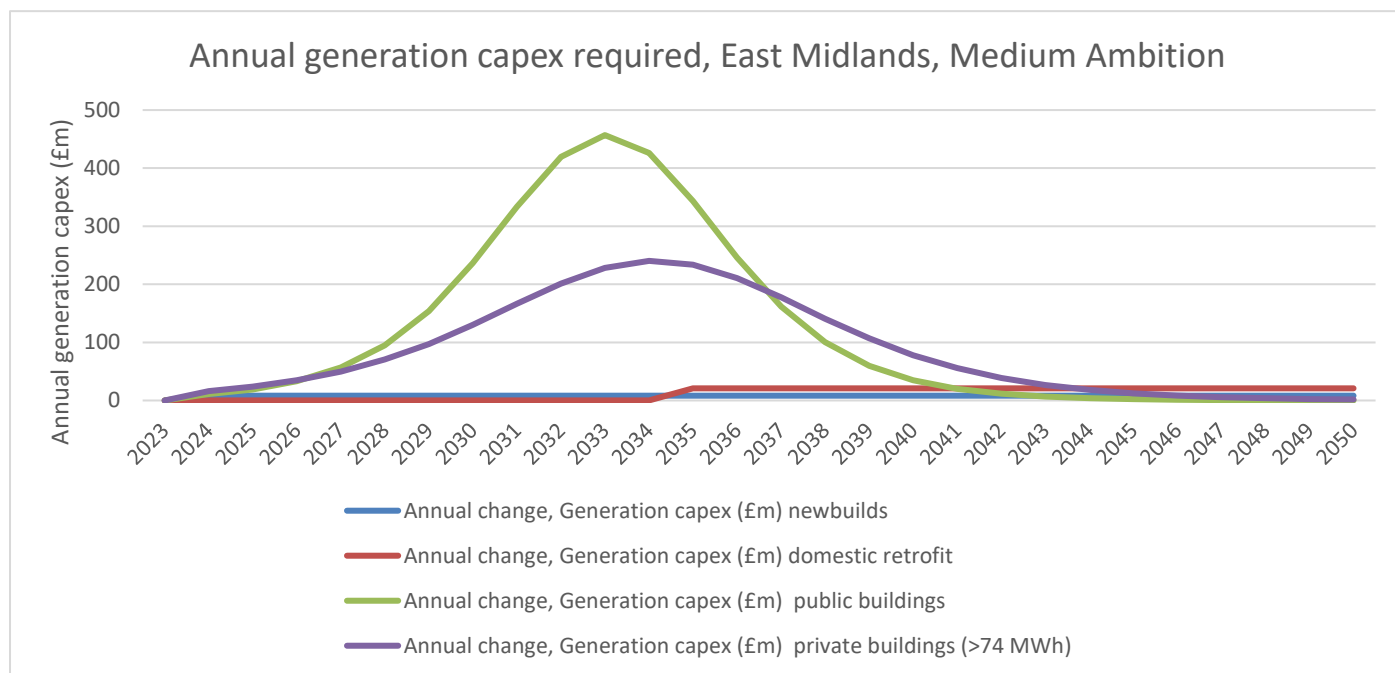


Table 14: projected total generation capex, medium ambition, East Midlands

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
222.93	336.12	3,235.16	2,382.36

Figure 14: projected annual distribution capex, medium ambition, East Midlands

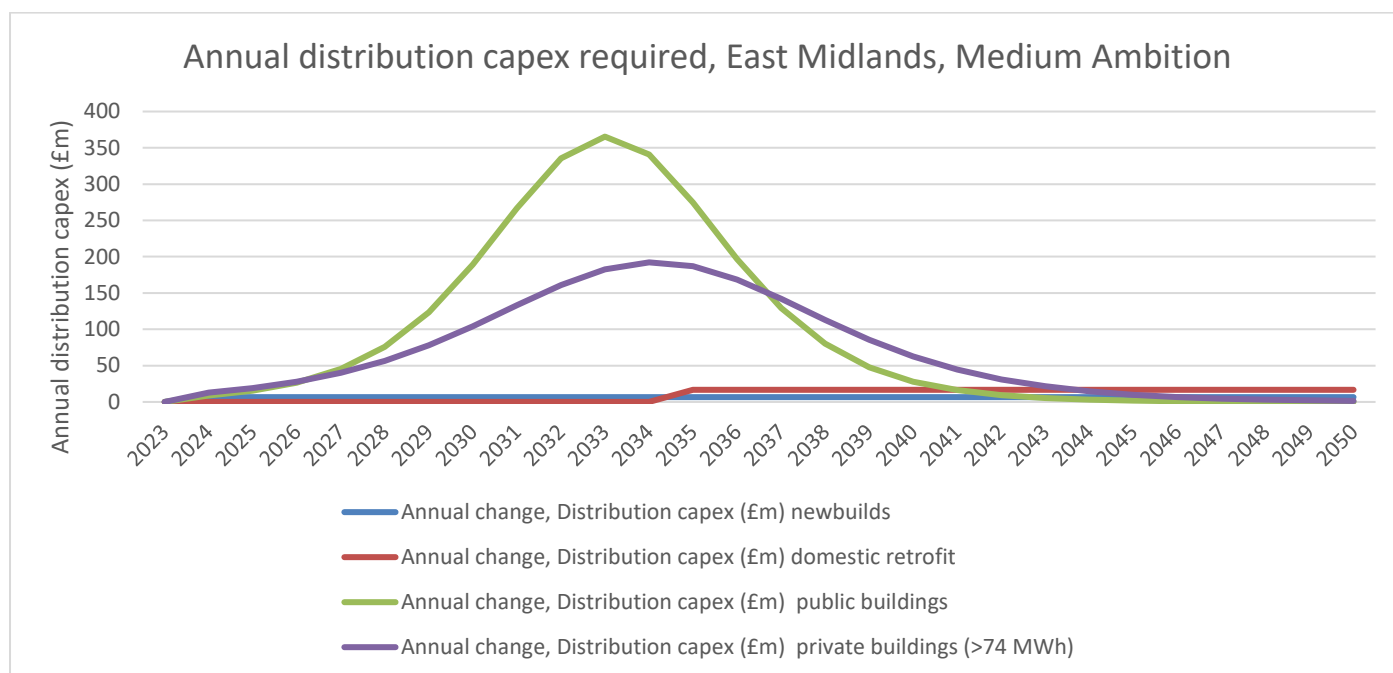


Table 15: projected total distribution capex, medium ambition, East Midlands

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
178.31	268.84	2,587.57	1,905.48

East Midlands, low ambition, capex requirements

Figure 15: projected total annual capex, low ambition, East Midlands

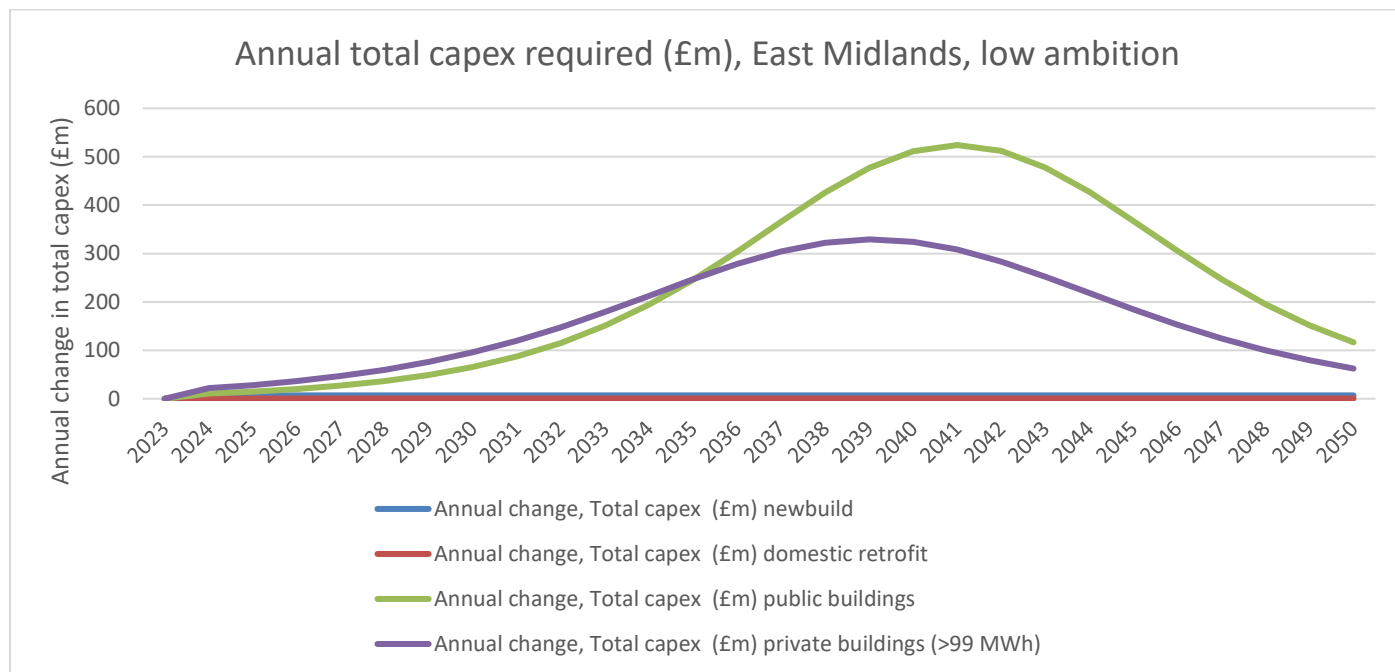


Table 16: projected total capex, low ambition, East Midlands

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
186.62	8.53	6,426.49	4,595.65

Figure 16: projected annual generation capex, low ambition, East Midlands

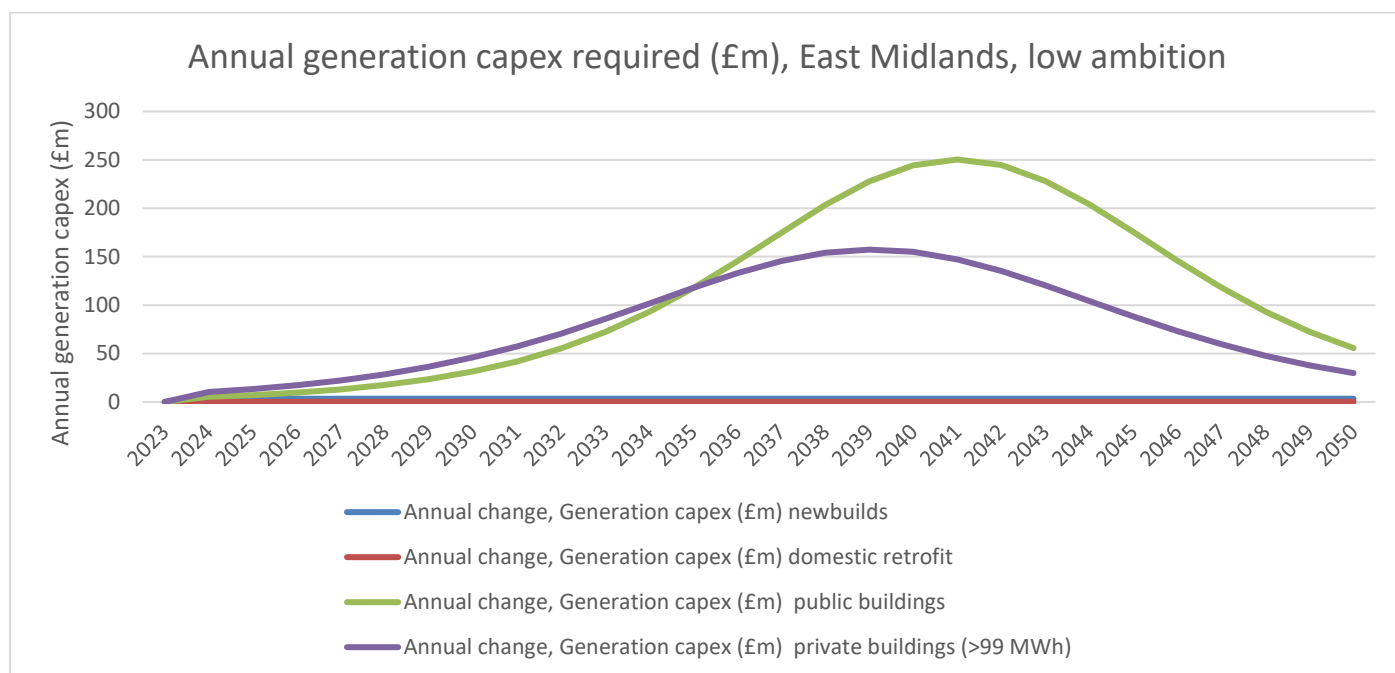


Table 17: projected total generation capex, low ambition, East Midlands

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
89.17	4.08	3,070.67	2,195.87

Figure 17: projected annual distribution capex, low ambition, East Midlands

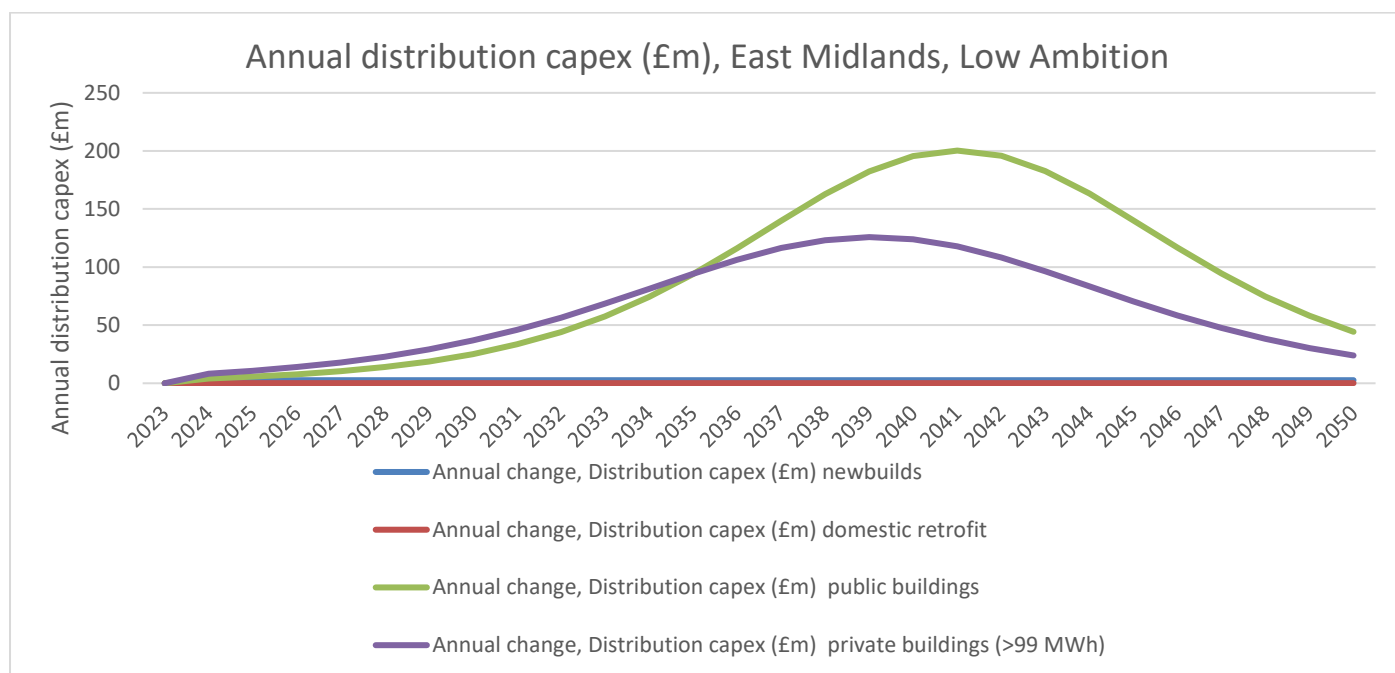


Table 18: projected total distribution capex, low ambition, East Midlands

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
71.32	3.26	2,456.01	1,756.32

East Midlands, projections of pipework required to meet heat demand

East Midlands, high ambition, pipework requirements

Figure 18: total Km of pipework, high ambition, East Midlands

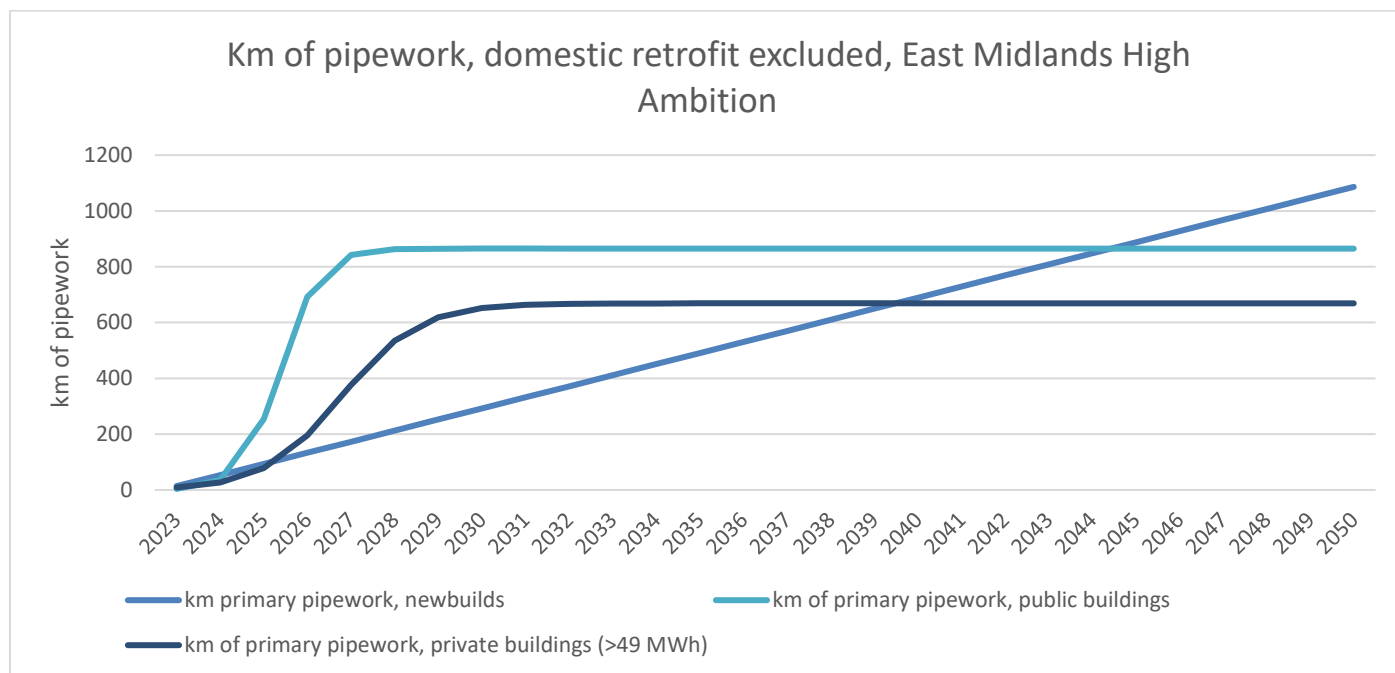


Table 19: total km of pipework, high ambition, East Midlands

Newbuild pipework (km) by 2050	Public Buildings pipework (km) by 2050	Private Buildings with >49MWh of annual demand, km (km) by 2050
1,072.16	861.02	659.75

Figure 19: projected annual pipework capex, high ambition, East Midlands

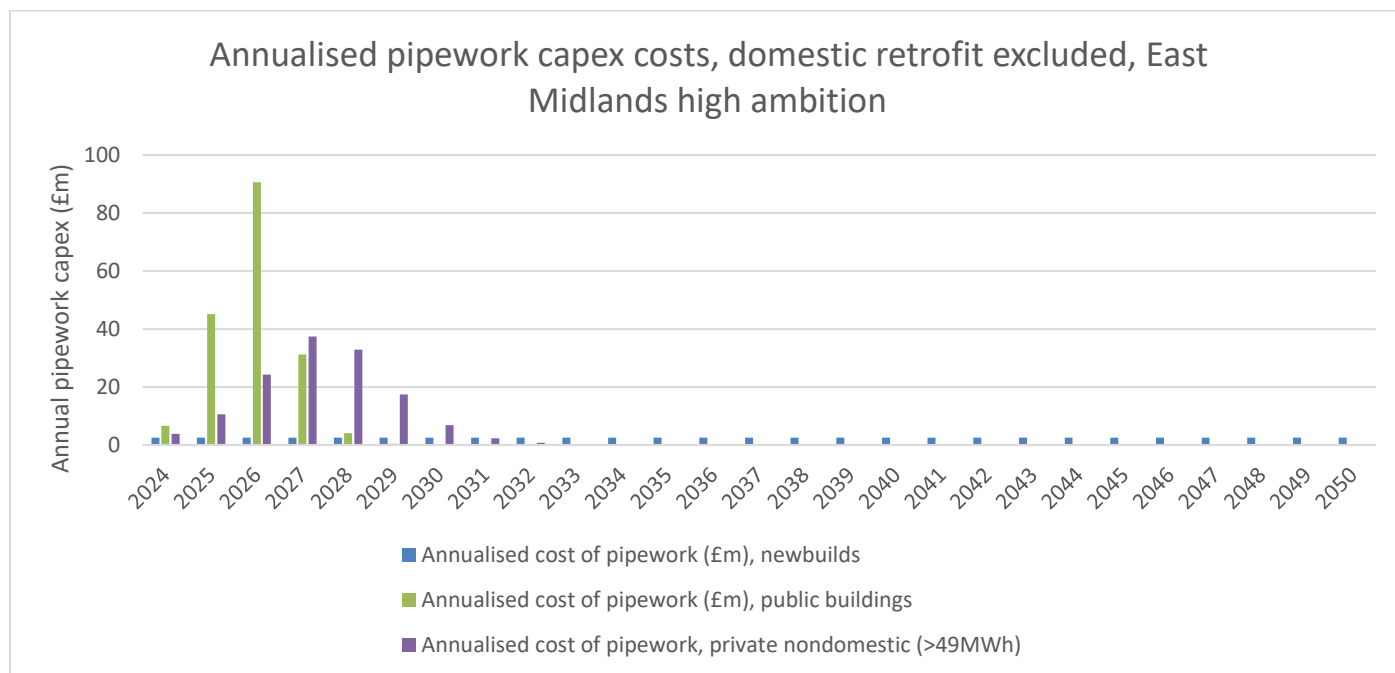


Table 20: projected total pipework capex, high ambition, East Midlands

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
68.06	178.20	136.54

East Midlands, medium ambition, pipework requirements

Figure 20: total Km of pipework, medium ambition, East Midlands

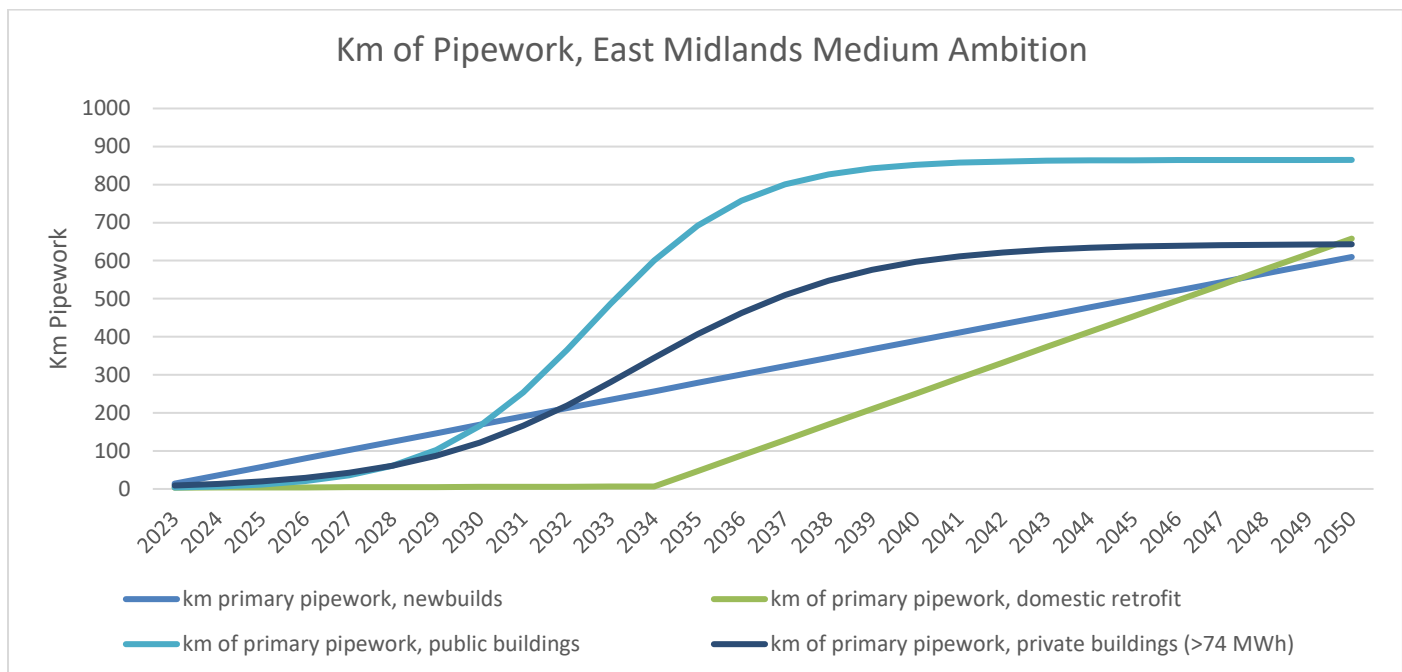


Table 21: projected total km of pipework, medium ambition, East Midlands

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
595.64	654.75	860.97	634.02

Figure 21: projected annual pipework capex, medium ambition, East Midlands

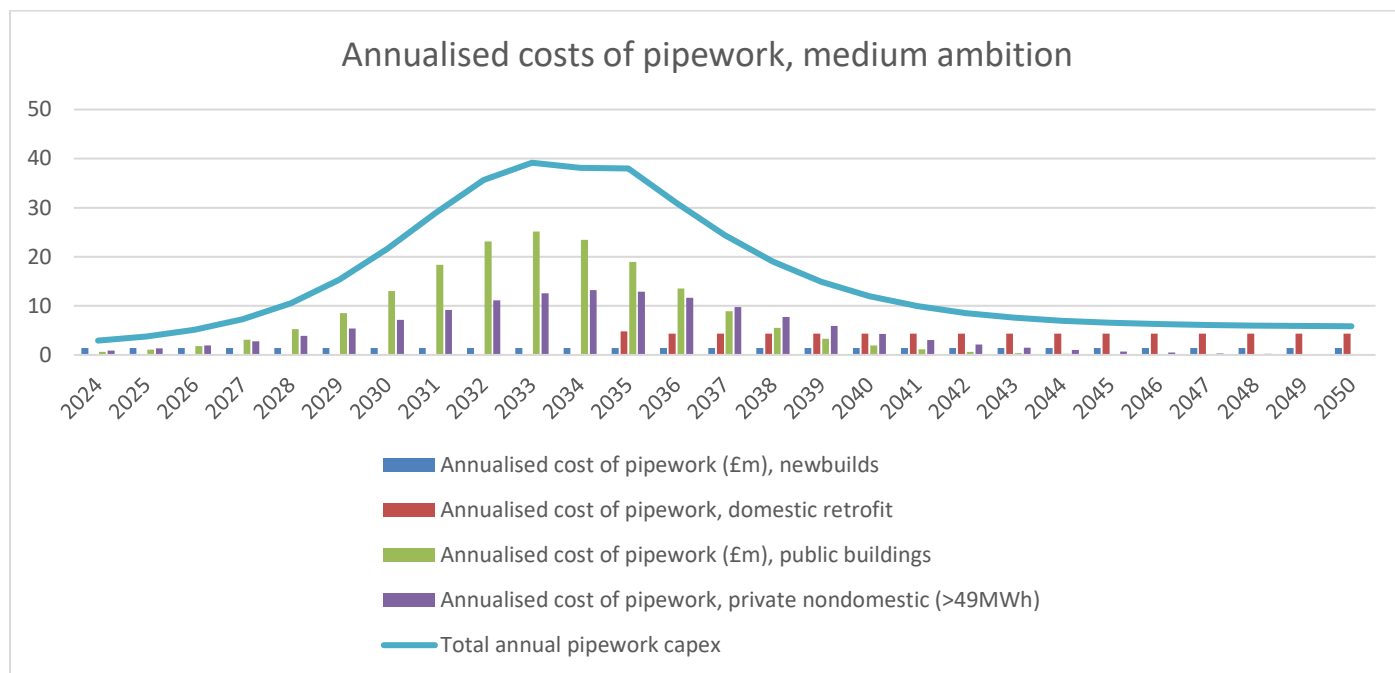


Table 22: projected annual pipework capex, medium ambition, East Midlands

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
37.81	70.12	178.18	131.22

East Midlands, low ambition, pipework requirements

Figure 22: total Km of pipework, low ambition, East Midlands

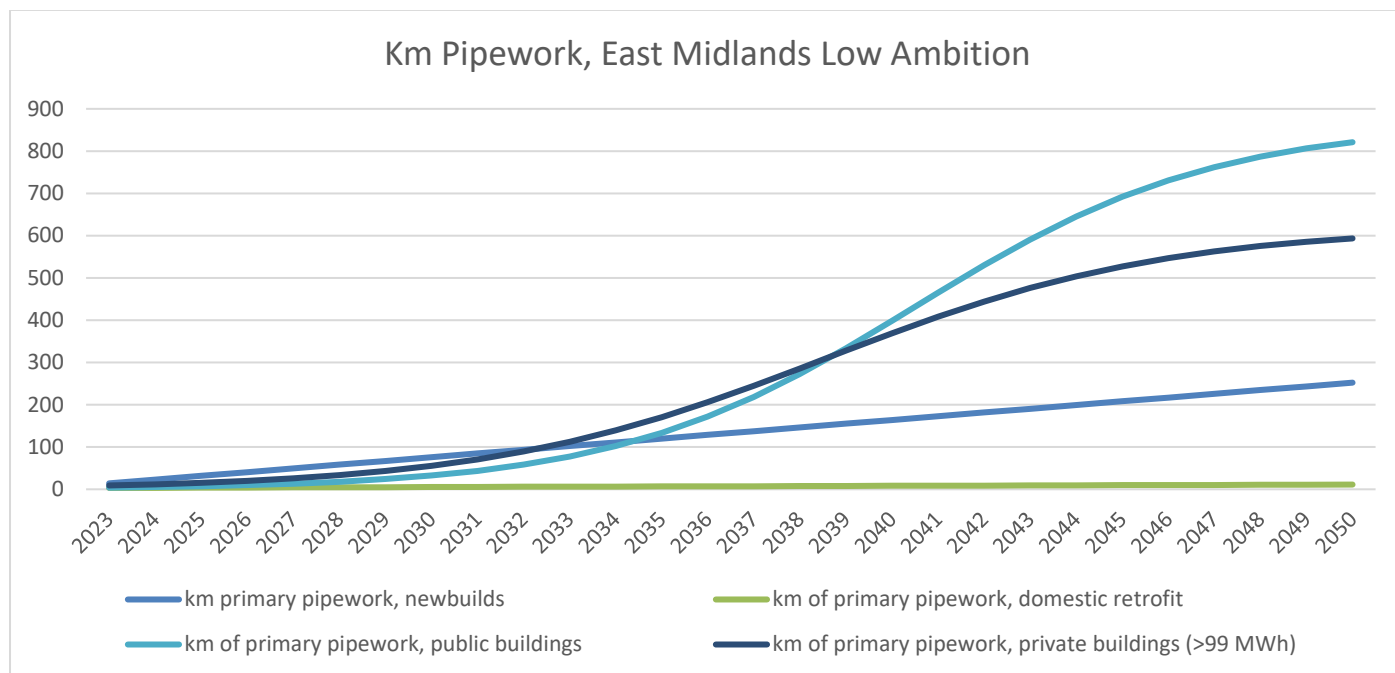


Table 23: total Km of pipework, low ambition, East Midlands

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
238.26	7.93	817.20	584.39

Figure 23: annual capex of pipework, low ambition, East Midlands

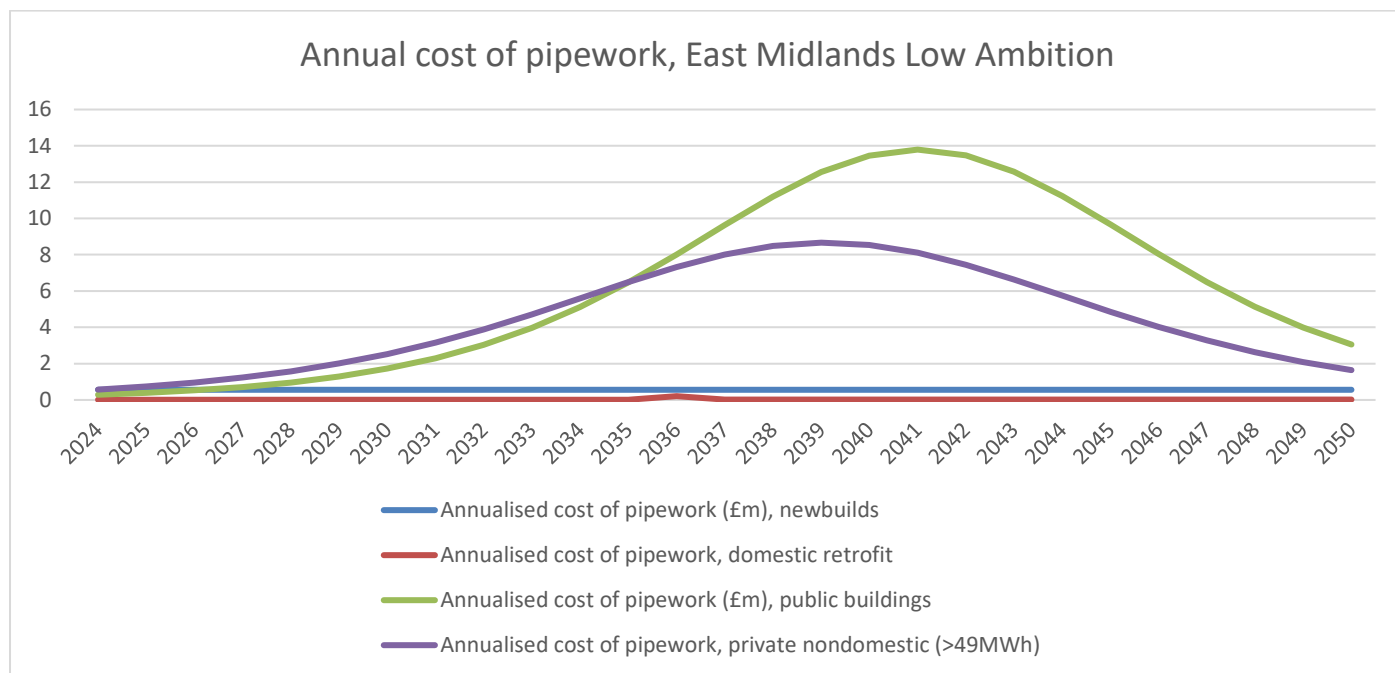


Table 24: total pipework capex, low ambition, East Midlands

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
15.12	0.60	169.13	120.94

East Midlands, projections of HIUs required to meet heat demand

East Midlands, high ambition, HIU requirements

Figure 24: annual HIU capex, high ambition, East Midlands

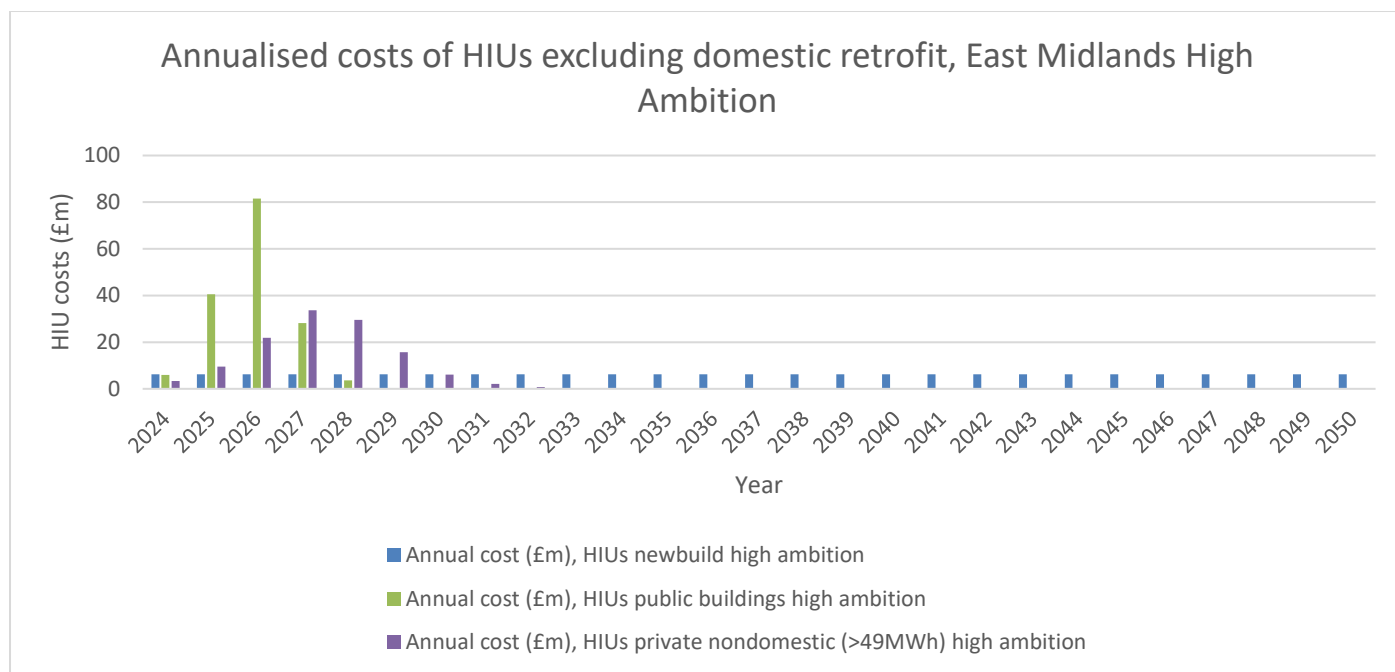


Table 25: total HIU capex, high ambition, East Midlands

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
167.29	160.29	122.82

East Midlands, medium ambition, HIU requirements

Figure 25: annual HIU capex, medium ambition, East Midlands

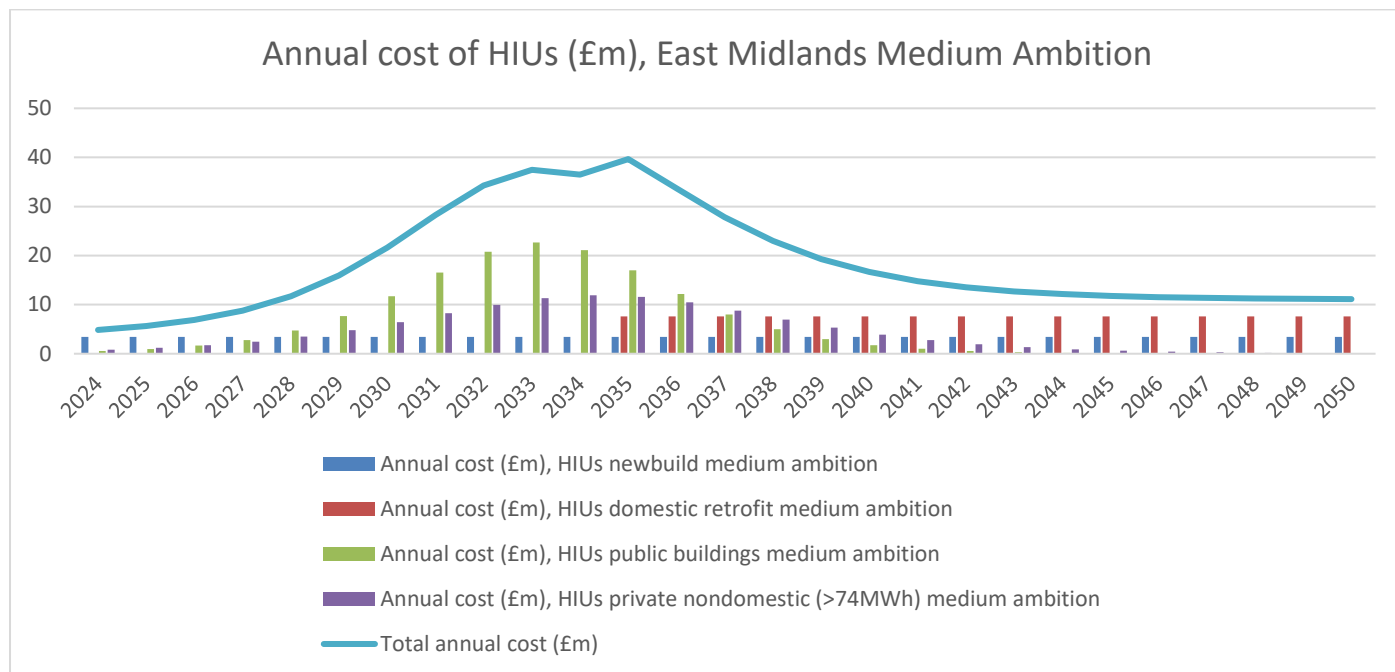


Table 26: total HIU capex, medium ambition, East Midlands

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
92.94	122.22	160.28	118.03

East Midlands, low ambition, HIU requirements

Figure 26: annual HIU, low ambition, East Midlands

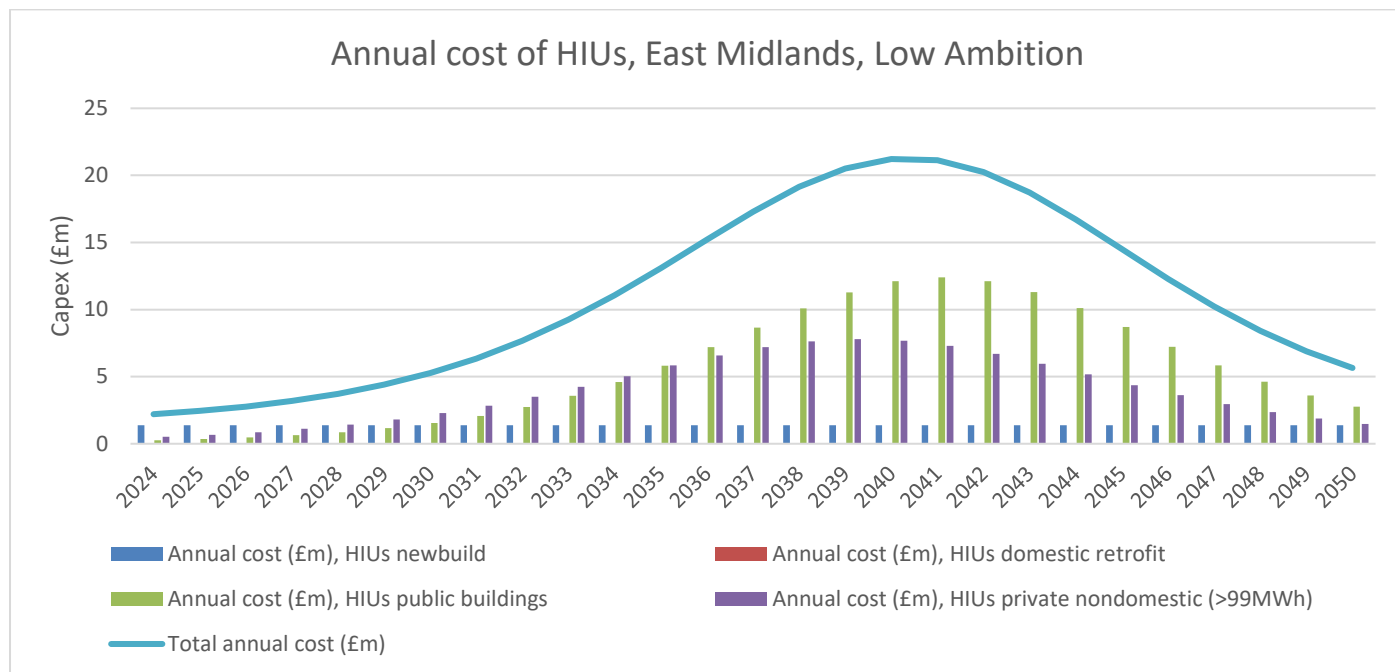


Table 27: total HIU capex, low ambition, East Midlands

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
37.17	1.48	152.13	108.79

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- ^v Non-domestic National Energy Efficiency Data Framework (ND-NEED), 2021, Department of Business, Energy and Industrial Strategy, [Non-domestic National Energy Efficiency Data Framework \(ND-NEED\), 2021 - GOV.UK \(www.gov.uk\)](#), p.39
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- ^{vii} Non-domestic National Energy Efficiency Data Framework (ND-NEED), 2021, Department of Business, Energy and Industrial Strategy, [Non-domestic National Energy Efficiency Data Framework \(ND-NEED\), 2021 - GOV.UK \(www.gov.uk\)](#), p.39
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