Decarbonising heat using secondary sources and Government policy - Waste Heat

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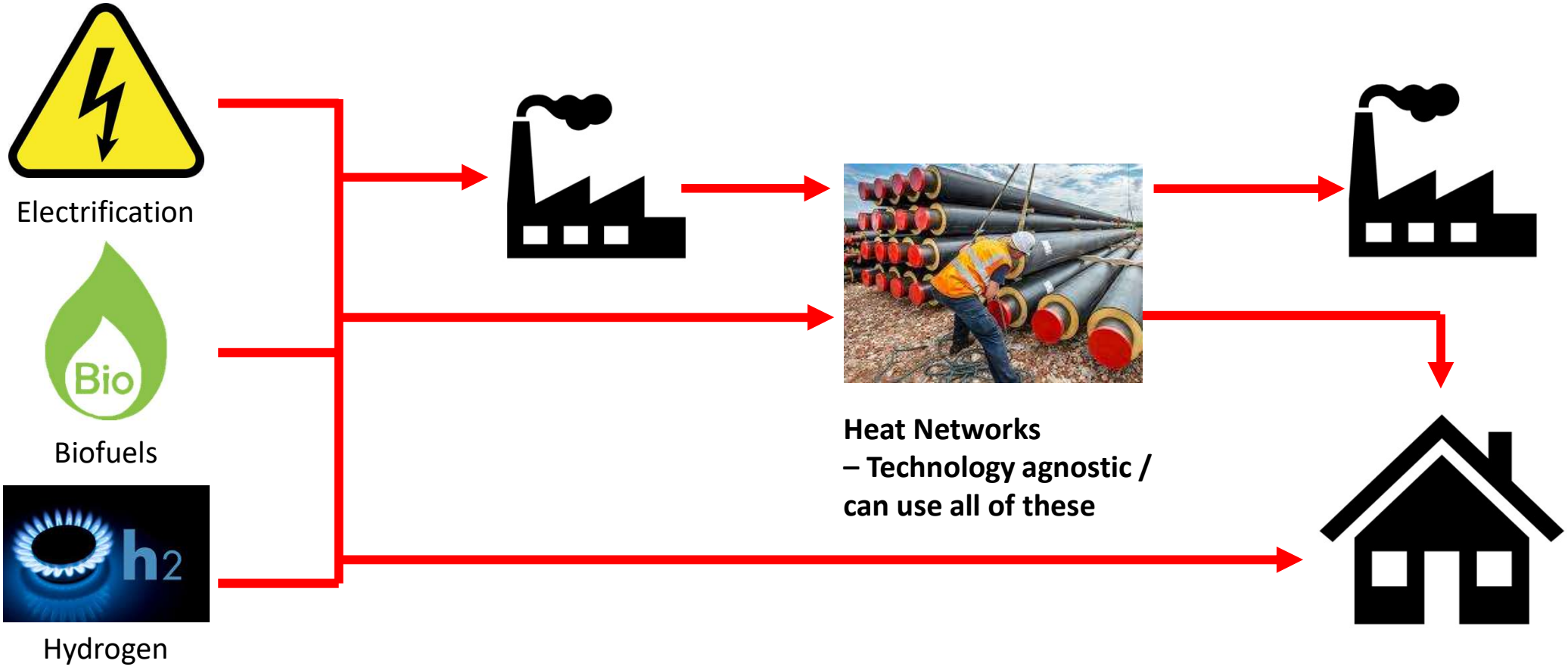
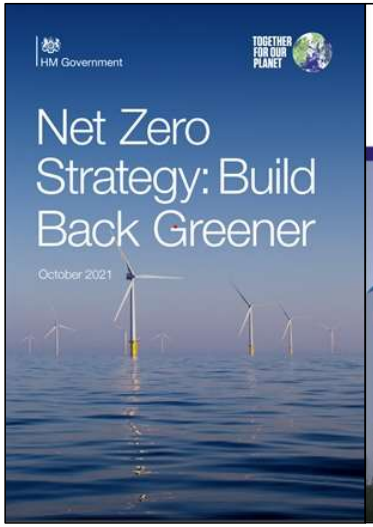
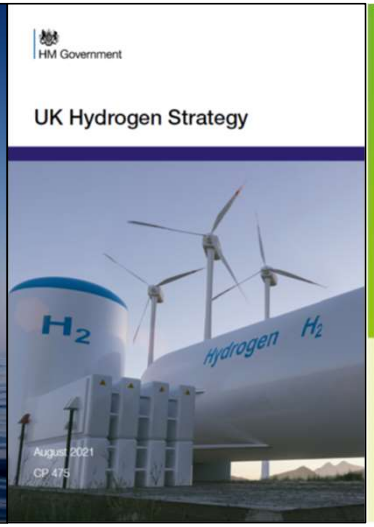
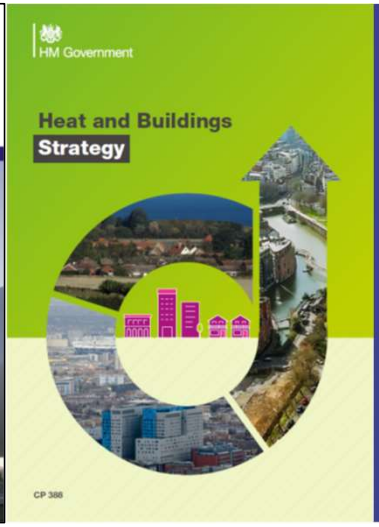
Heat decarbonisation options

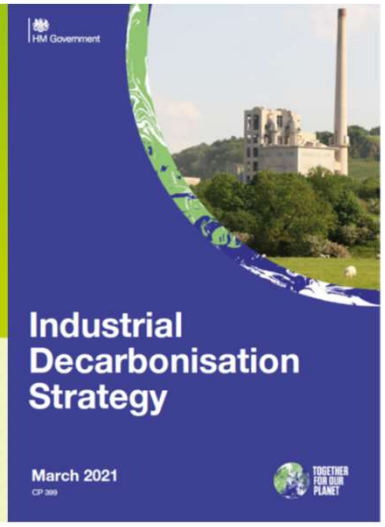


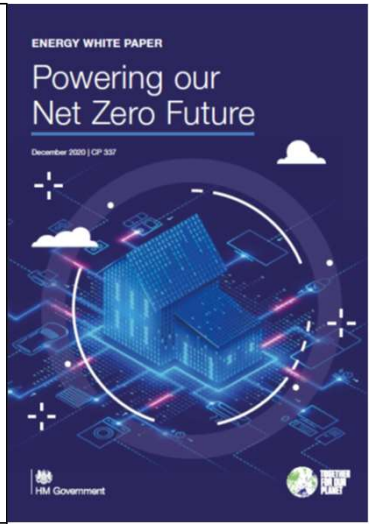
Publications and strategies











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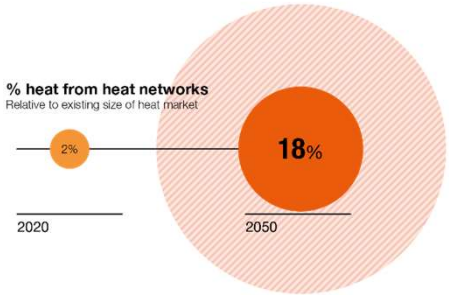
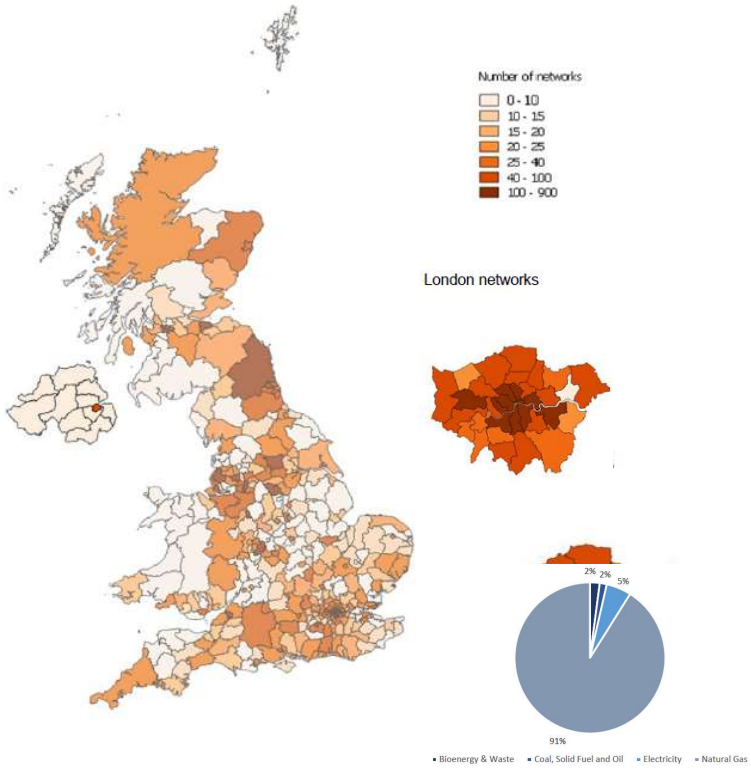
Importance of Heat Networks

- Today there are ~500,000 customers spread across 14,000 heat networks in the UK, of which ~2,000 are classed as district heating networks
- Heat networks **currently provide 3% of UK heat demand** and with Government support, they **could provide 20% of heat demand by 2050** in a least-cost pathway to meeting carbon targets. Our most recent research confirms this.
- Heat networks play a hugely important role in meeting carbon targets and reaching Net Zero.
- They can unlock otherwise inaccessible large-scale renewable and recovered heat sources such as **waste heat** from industry and heat from rivers and mines.



+10%

annual growth



BEIS (2018) Energy Trends: Experimental statistics on heat networks
(The experimental statistics may not wholly reflect the true position of the current heat network market due to networks not reporting or providing incorrect returns)

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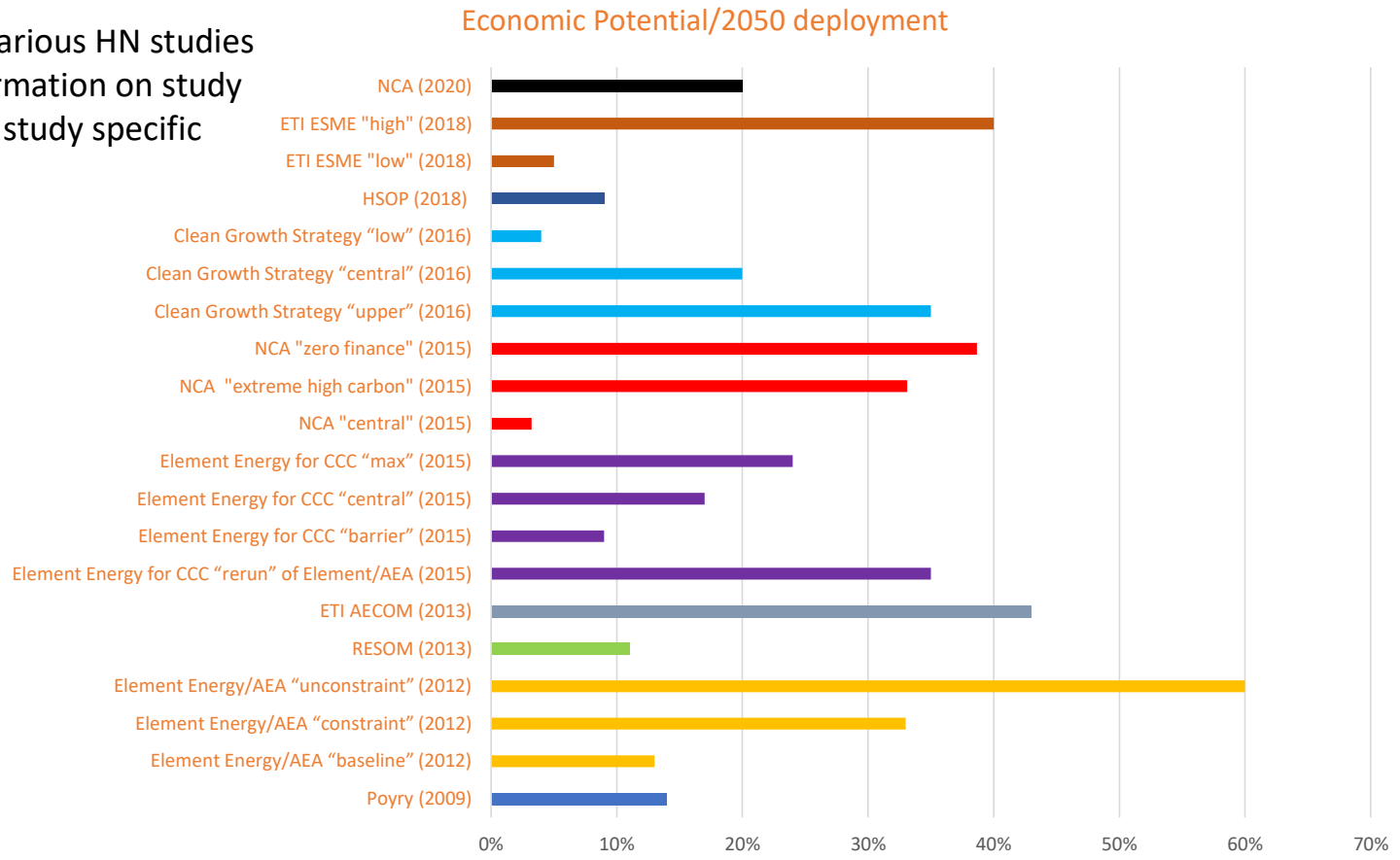
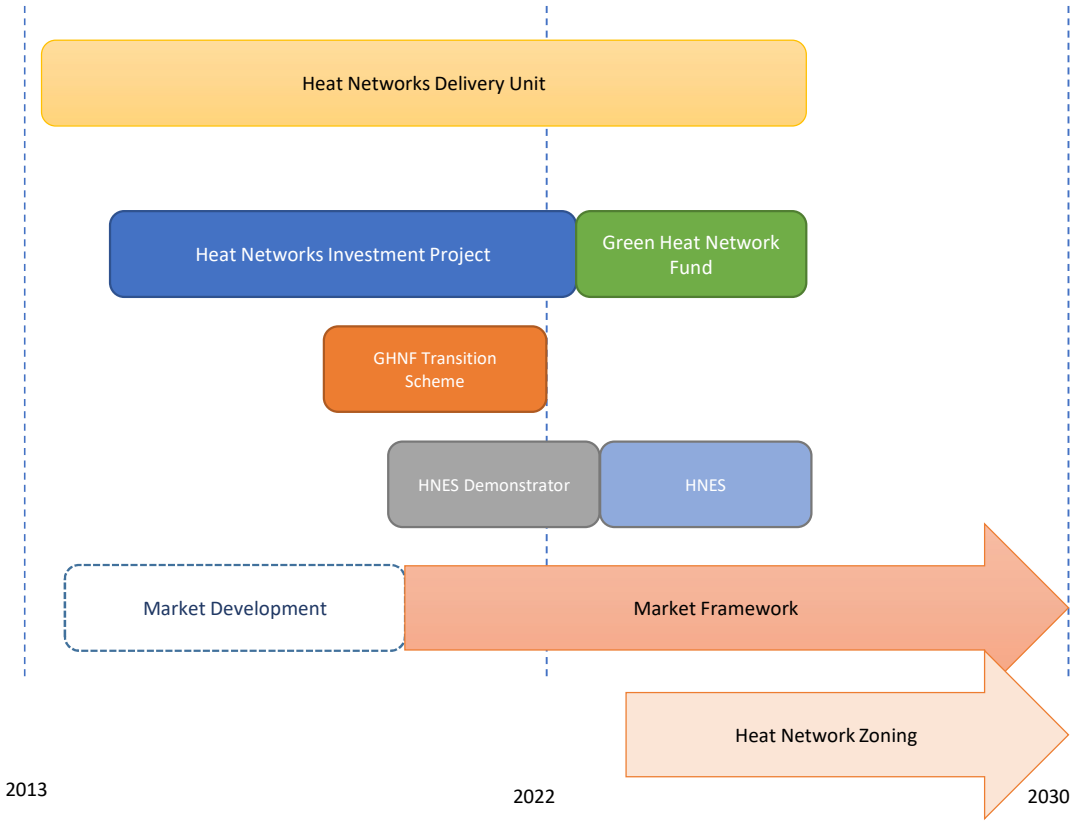
Positioning against other economic potentials

The Economic potentials from various HN studies are presented in the chart. Information on study approaches can be found in the study specific documentation.



HEAT NETWORKS TRANSFORMATION PROGRAMME

tackling climate change, driving the green economy, achieving net zero

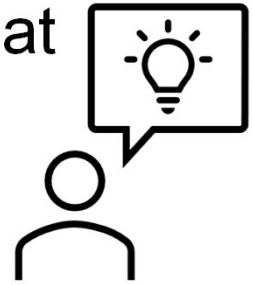


Initiative	Timeframe	Budget
Heat Networks Investment Project (HNIP)	16/17 to 21/22	£320m
Green Heat Networks Fund (GHNF)	22/23 to 24/25	£288m
Heat Networks Efficiency Scheme (HNES)	22/23 to 24/25	£30m
Heat Networks Skills Programme (HNSP)	22/23 to 24/25	
Heat Networks Regulation	21 onwards	Regulatory

Definition of Waste Heat

- Waste heat is thermal energy that is being rejected to ambient environment (e.g: air, rivers, sea or ground).
  - Note: we are interested in heat but it can also include coolth

- We should be advocating that energy use is **optimised** and therefore **waste minimised** before trying to capture it for heat networks
  - Sustainable use of resources at the core of any waste heat work
  - Do not encourage wasteful practices

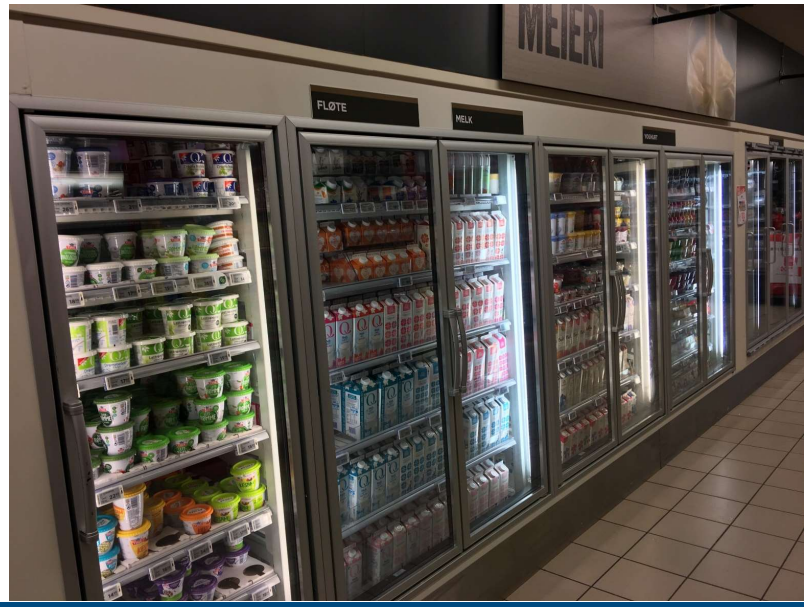


Waste Heat in Heat Networks

- Waste heat is a low / zero carbon energy source which must be utilised to create a sustainable future and achieve net zero carbon emissions
  - Reduces peak demand on grid
  - Encourages good resource utilisation
- Heat networks facilitate waste heat utilisation
  - *Allows heat to be moved from one place to another*

Sources of Waste Heat – Cooling

- *Where there is cooling there is waste heat!*
  - The process of cooling something is to remove heat from that thing and we want to do something with that heat
- Chillers (e.g. food storage)
- Forced air (e.g. fans)
- Forced liquid
- Cooling towers (water or air)
- Vents (e.g. commercial kitchens)
- Data centres
- Gas compression e.g. hydrogen transport
- Hydrogen Production



Other Sources of Waste Heat

- Sewage and waste water treatment
- Exhaust gases
- Underground railways
- Drying processes (e.g. paper)
- Electricity distribution
- Thermal power generation

Waste heat research

Aims

- To understand which sectors might have most potential in terms of scale, location and cost

Image: Petroac
https://renews.biz/66191/uk-project-explores-new-ways-to-recover-waste-heat/

Targeted sectors

Waste heat category (*)	Sub-sectors
Electricity Networks	Generation and Sub-stations
Industrial heat recovery	Cement, Chemical, Crematoria, Food and drink, Iron and steel, Lime, Other mineral industries, Paper and pulp
Commercial heat recovery	Cold stores, Data centres, Supermarkets, Underground railways
Waste water heat recovery	Treatment works (narrative discussion about in sewer heat offtake, but not mapped)

** Note that Energy from Waste had been covered by a separate study and is not included in the results shown here.*

Output #1: location, temp and scale

Source type	Medium	Number of locations mapped	Assumed source temperature (°C)	Primary water temperature (°C)	Total peak heat capacity across all sites (MW)	Average installed heat recovery per site (kW)	Total heat available across all sites (GWh/year)	Average waste heat available per site (MWh/year)
Cement	Hot flue gas	10	338	90	69	6,863	469	46,945
Iron and Steel	Hot flue gas	27	120	90	195	7,227	1,539	57,018
Lime	Hot flue gas	6	338	90	13	2,213	91	15,139
Crematoria	Hot flue gas	269	900	90	75	280	157	585
Substations	Oil	1,336	45	40	479	359	3,989	2,986
Data centres	**Water**	**264**	**35**	**30**	**1,940**	**7,347**	**16,153**	**61,187**
Other mineral industries	Water	169	35	30	65	387	504	2,984
Chemical	Water	125	32	27	94	751	703	5,628
Food and drink	Water	142	30	25	41	289	307	2,164
Paper and pulp	Water	10	30	25	11	1,121	80	7,980
Supermarkets	Refrigerant	4,853	23	18	1,439	296	7,981	1,645
Cold stores	Refrigerant	241	23	18	517	2,143	3,469	14,394
Underground railways	Air	65	22	14	39	595	322	4,953
Treatment works	Water	1,875	18	13	2,929	1,562	24,379	13,002
	TOTAL	**9,392**			**7,906**		**60,145**	

Output #2: typical cost of heat recovery

Source type	Primary water temperature (°C)	Average CAPEX benchmark (£/kW)	Average CAPEX per site (£'000)	Average OPEX per site (£'000/year)	Average LCOC (p/kWh)
Cement	90	238	1,514	178	0.55
Data centres	**30**	**168**	**987**	**320**	**0.62**
Treatment works	13	182	233	68	0.63
Other mineral industries	30	184	70	16	0.64
Chemical	27	183	127	30	0.65
Food and drink	25	184	53	11	0.65
Paper and pulp	25	184	196	42	0.65
Iron and Steel	90	568	1,516	211	0.78
Lime	90	495	1,066	66	0.78
Cold stores	18	634	976	58	0.85
Substations	40	828	285	10	0.90
Underground railways	14	834	483	24	0.95
Supermarkets	18	757	218	8	1.14
Crematoria	90	614	172	5	2.15

Although cost of capture may be low, some of these sources will need to be upgraded if they are to be used in a conventional heat network.

Combining Waste Heat Datasets

Various other data sets exists which provide insight to waste heat these include:

- Thermal power stations
- Incinerators (e.g. energy from waste)

Annual recoverable heat by sector (GWh/year) - **Total 282 TWh/year**

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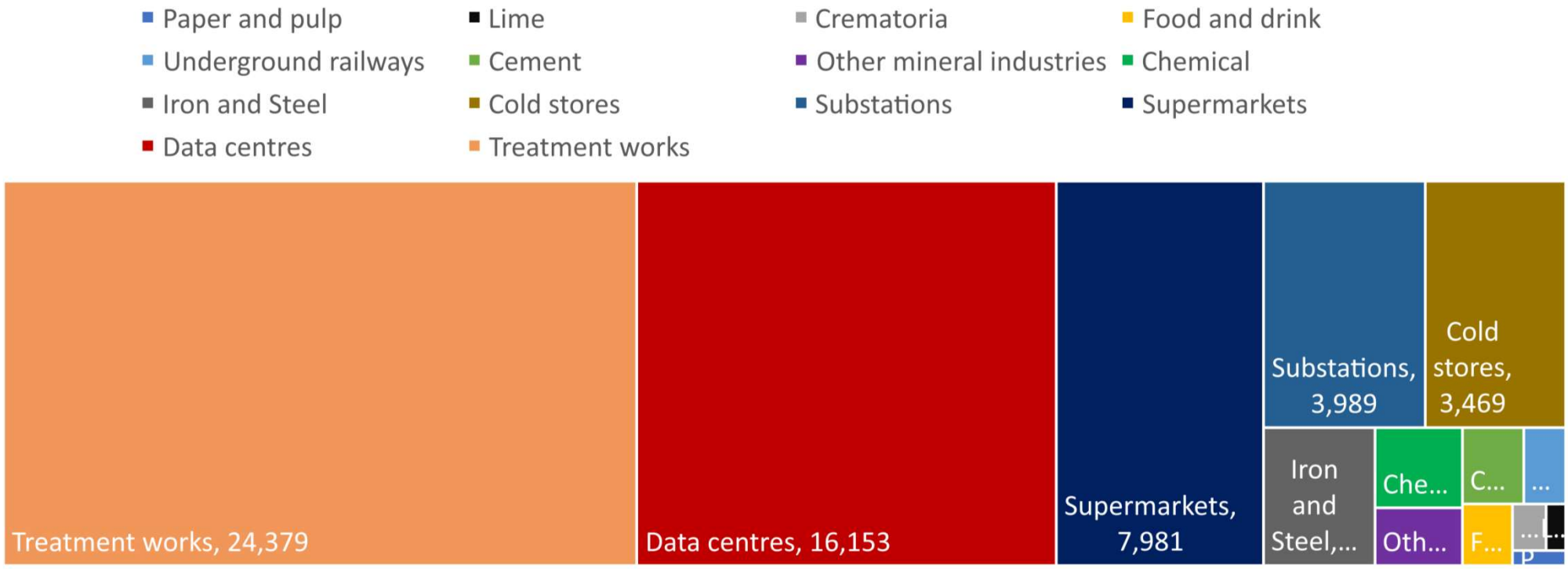
Annual recoverable heat by sector (GWh/year) – *removed power stations and incinerators*



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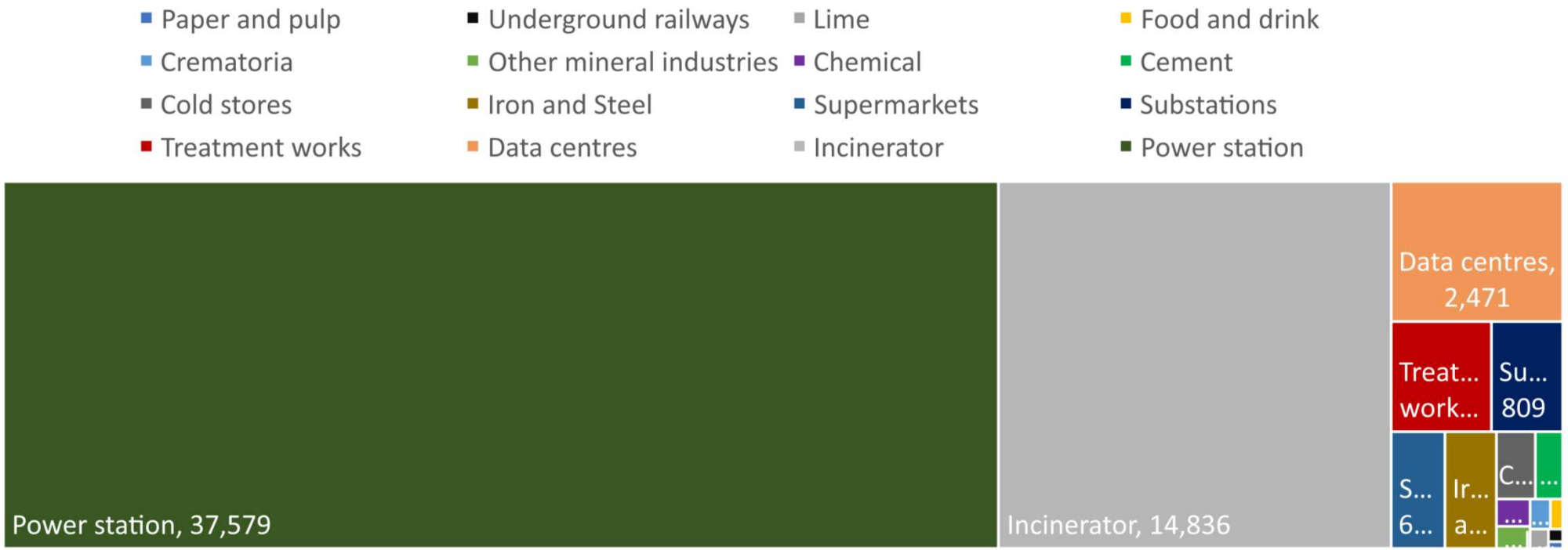
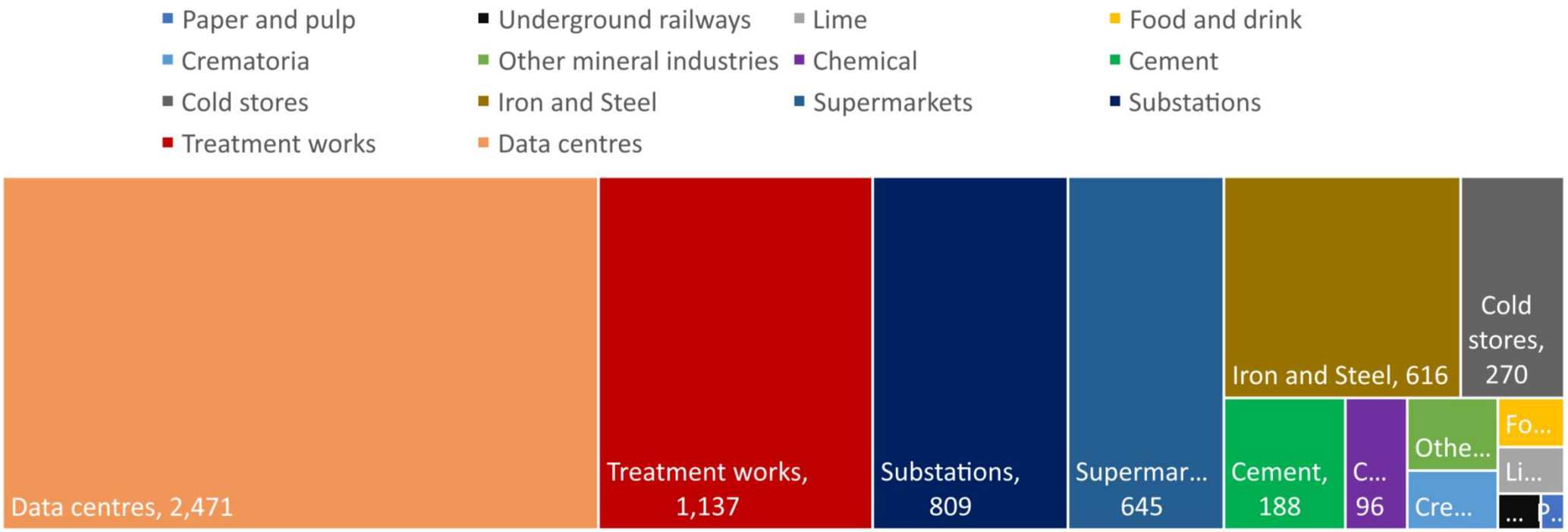
Evaluating the Energy Benefits

- What would the **electrical savings** be if we assume an **air source heat pump** was delivering the same amount of heat at 70°C
- Waste heat sources are used directly if above 70°C or indirectly with heat pump to upgrade the temperature to 70°C
- Assumed temperatures of sources taken from Opportunity areas for district heating networks in the UK
- Generic CoP curves used for calculation purposes
- **Theoretical** exercise does not consider the proximity of the demand and supply
- Provides insight into maximum **theoretical** potential benefit

Annual estimated electricity savings compared to ASHP (GWh/year) – **Total 59 TWh/year**



Annual estimated electricity savings compared to ASHP (GWh/year) – *removed power stations and incinerators*



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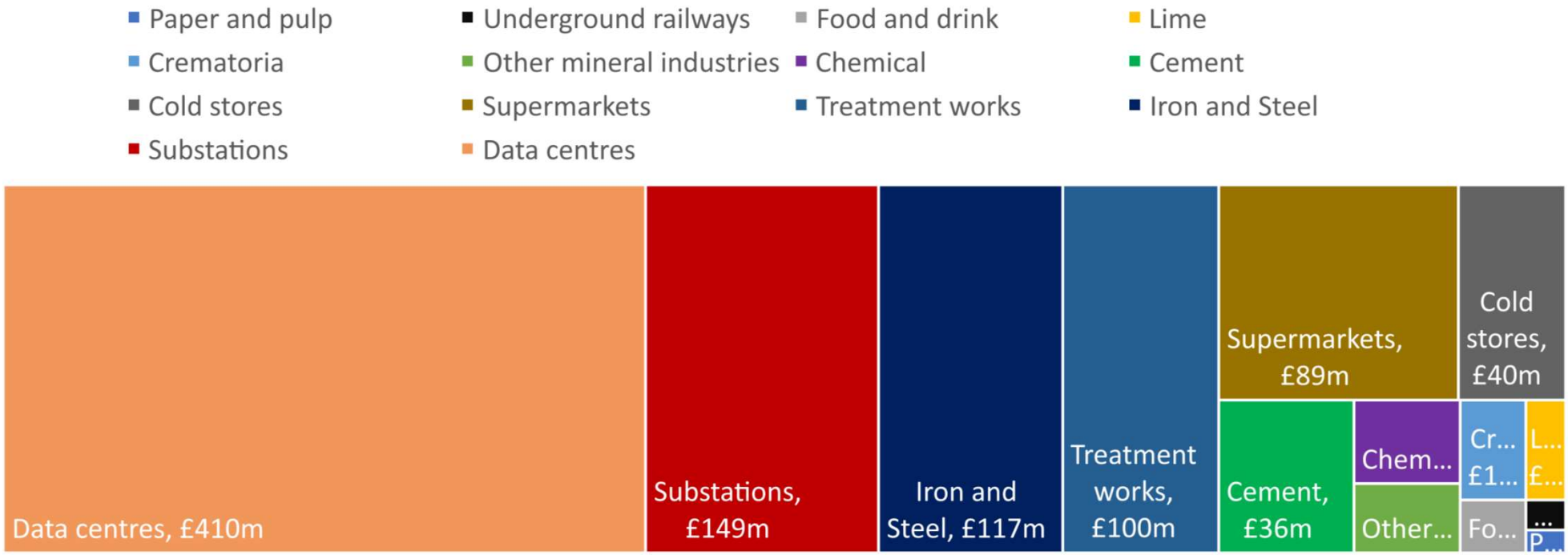
Evaluating the Financial Benefits

- Assume electricity tariff is £0.20 per kWh
- Using the previous analysis and taking into account a high level calculated OPEX for the heat recovery equipment
- Financial Saving = Electricity Saving x Electricity Tariff - OPEX

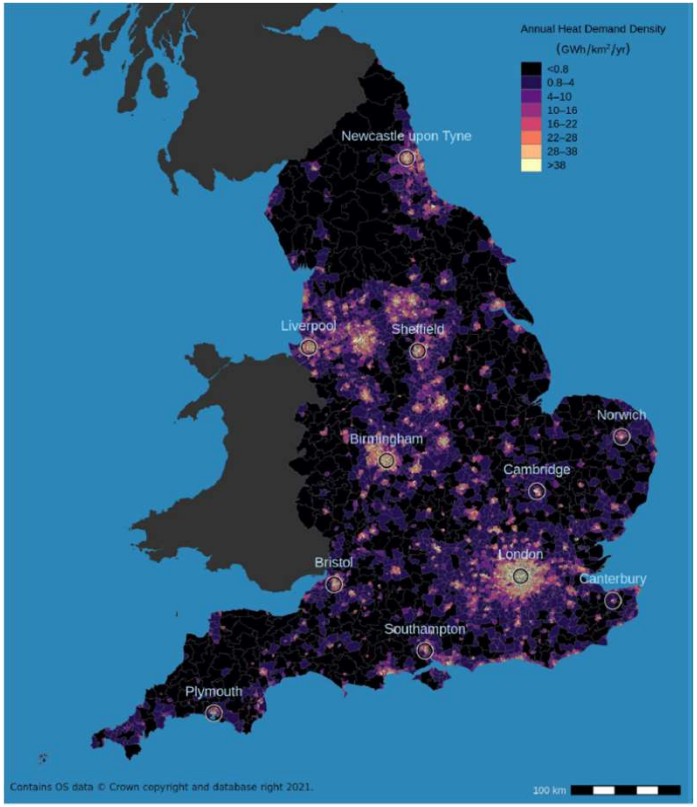
Annual estimated financial savings compared to ASHP (£m) – **Total £11.4bn**

Annual estimated financial savings compared to ASHP (£m) – *removed power stations and incinerators*

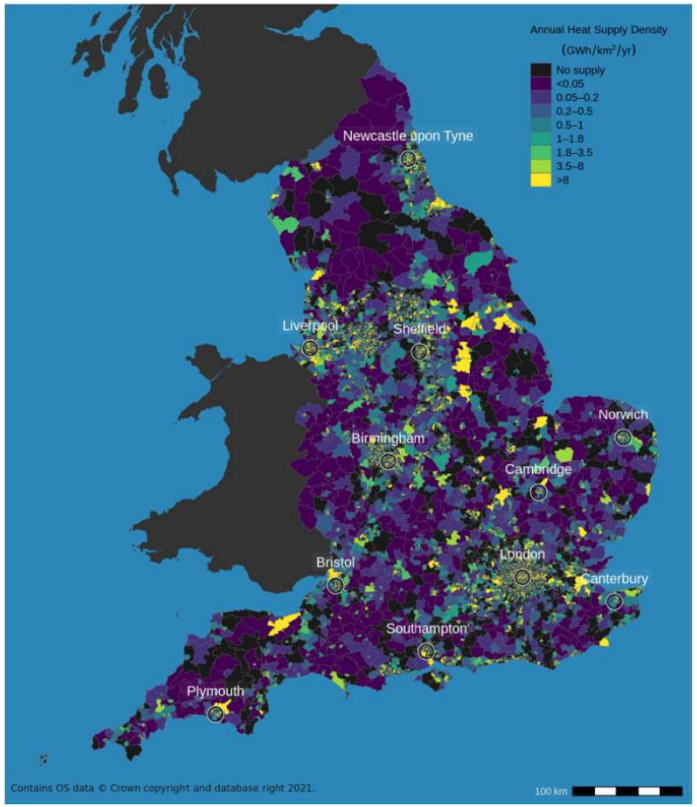


Heat Demand Density

Source: BEIS – Opportunity Areas for District Heating Networks in the UK

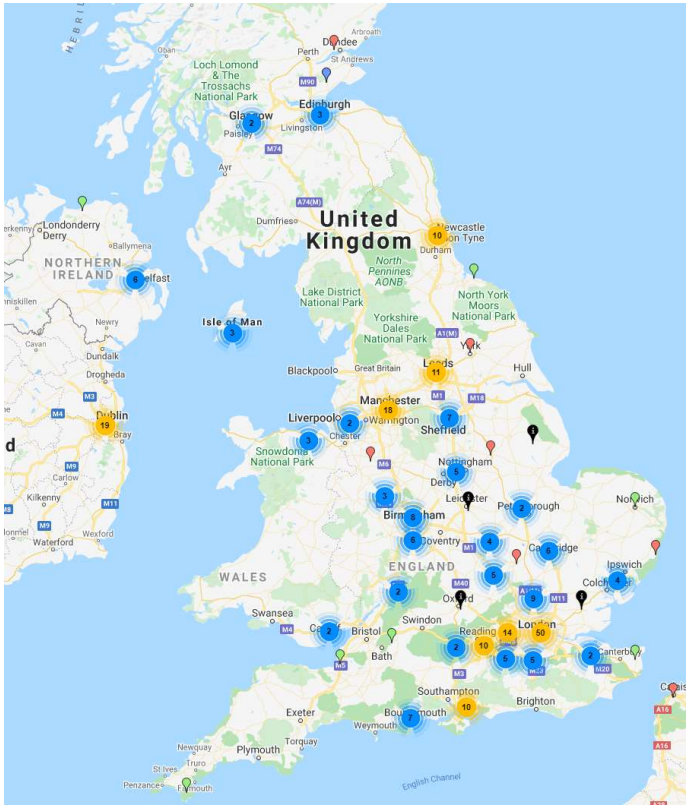


Heat Supply Density



Data Centre Locations

Source: https://www.datacentermap.com/



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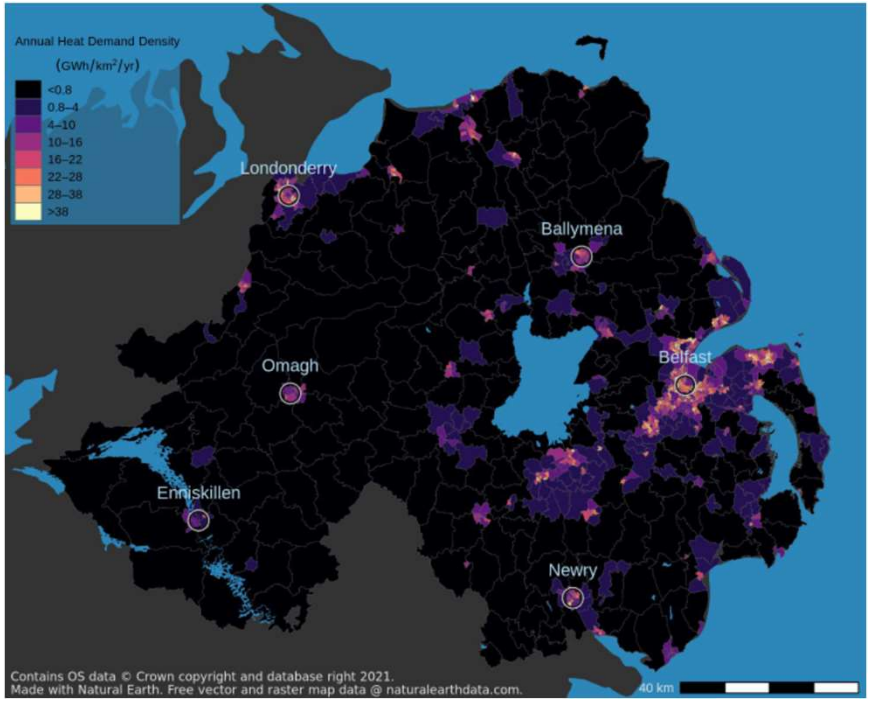
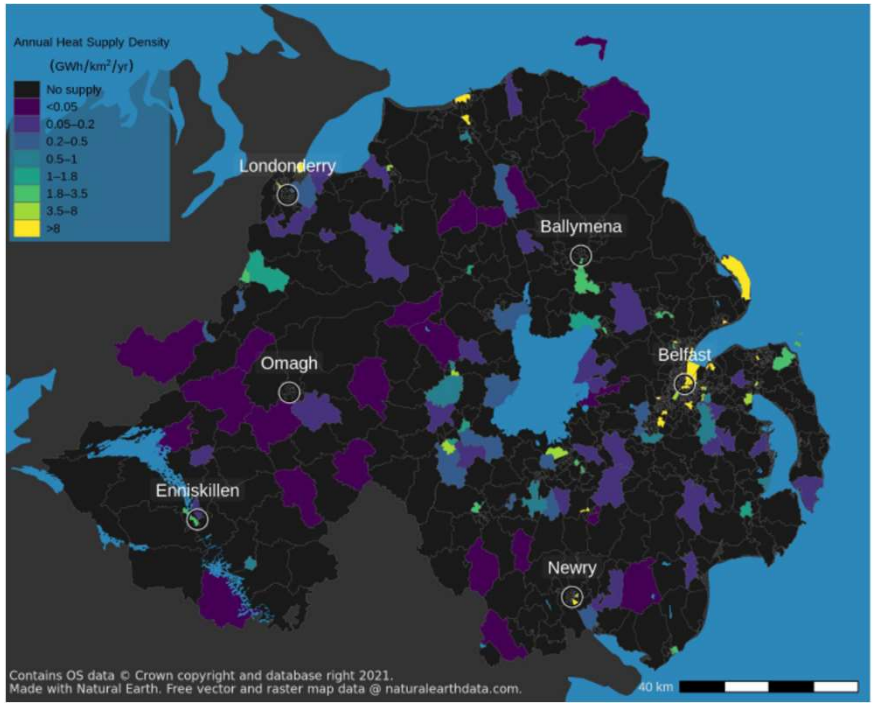
Northern Ireland
Heat Demand Density Heat Supply Density

Source: BEIS – Opportunity Areas for District Heating Networks in the UK





Waste Heat Research Summary

- There is currently a lot of waste heat generated across the UK

- Different sectors have different characteristics in terms of:
  - The temperature of the heat
  - The technology required to capture it
  - Their location

- As a consequence the cost of heat recovery from different sectors is different.

- The geographic spread of heat across the UK does not align with that of demand everywhere but there are significant areas of overlap.

- **The potential is huge!**

Sustainable Resource Usage

- Reduce
  - Reduce the energy demand through energy efficiency
- Reuse
  - Reuse the energy in the process where possible
- Recycle
  - Use a heat network to take the waste heat to use it elsewhere

Complementary Workstreams

- Opportunity areas for district heating networks in the UK: second National Comprehensive Assessment
- Energy from Waste (EfW) study
- Waste heat from Water Sector
- Heat Network Optimisation Opportunities (HNOO) scheme
- Heat Network Transformation Programme
  - Green Heat Network Fund (GHNF), Market Framework, Heat Network Efficiency Scheme (HNES), Heat Network Investment Project (HNIP)
- City DEEP Decarbonisation Projects (CDDP)
- Greening Existing Networks (GEN)
- Industrial Heat Recovery Support Programme (IHRS)
- Industrial Energy Transformation Fund (IETF)
- Waste Heat Recovery from Hydrogen Production by Embassy of Denmark

Thank you

To SIRACH, IOR and other speakers