Heat Pump Driven Decentralised Energy Networks

A vision of an integrated low carbon energy system

Presented by: Ieman Barmaki – Director of Low Carbon Partnerships

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Heat Pumps | Contracting | Utilities

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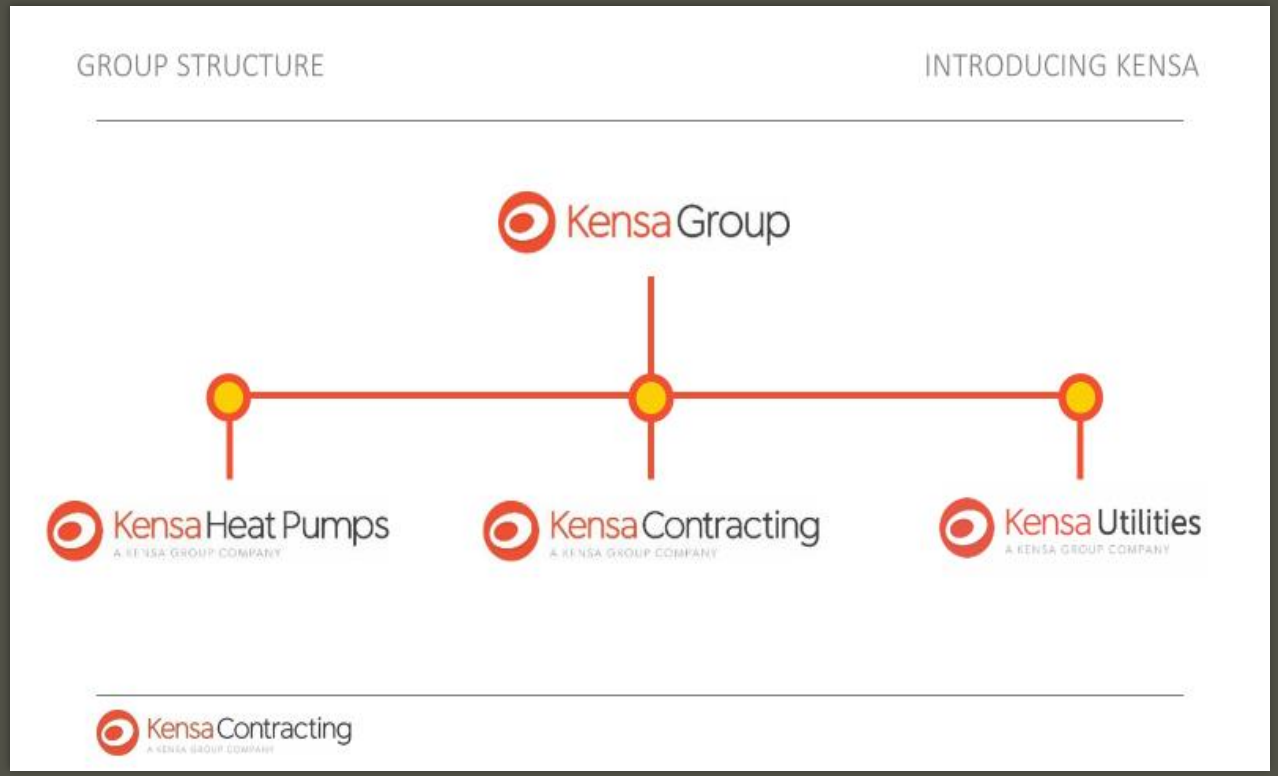
- UKs only manufacturer of GSHP for domestic applications
- Pioneers of the Shared Ground Loop Ambient systems in social housing
- Market Leader with 45% share in the UK
- Part owned by Legal & General PLC
- Production based in Truro – Cornwall
- National presence with offices in Exeter, Bradford, Glasgow and permanent exhibition at the Building Centre in London



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The Need to Decarbonise

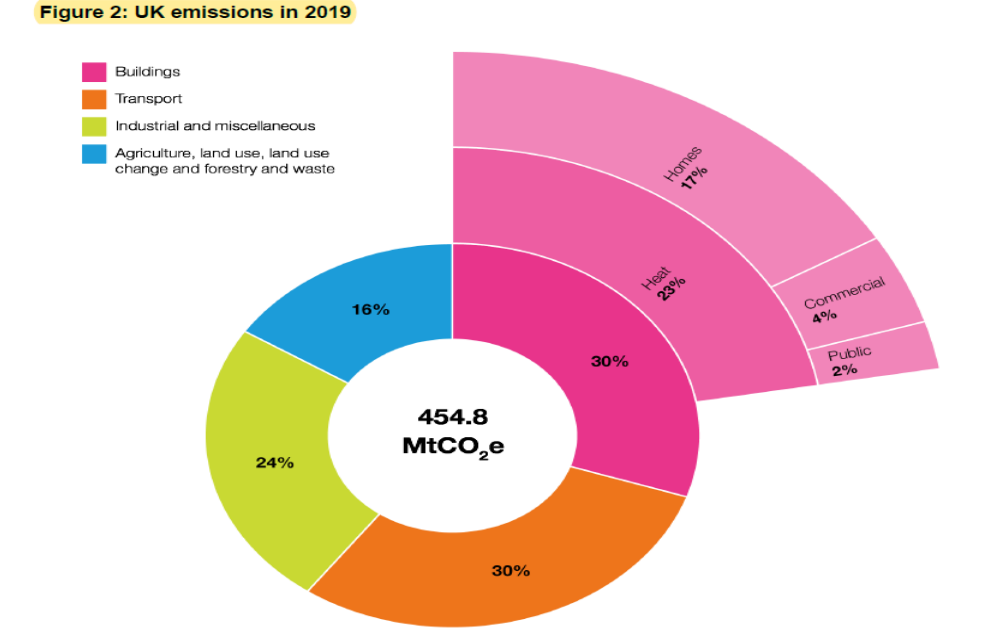

Figure 2 shows the proportion of emissions in 2019 from buildings to the nearest whole number; of the 454.8 mega tonnes of carbon dioxide equivalent ($MtCO_2e$) total emissions, 23% were due to heating buildings, with the largest proportion of this stemming from homes.[35]

Source: BEIS https://www.gov.uk/government/publications/heat-and-buildings-strategy

- 80% of existing homes use gas heating
- UK is the 3rd largest market for gas boilers behind South Korea and China
- 1.6M boilers sold in the UK every year
- 20K Heat Pumps!
- 6.2% of all heat in the UK is from Renewables
- 4.6% of that are from Heat Pumps
- Target of 600k heat pumps a year by 2028 - UK
- 1 million zero emission heating system by 2030 - Scotland

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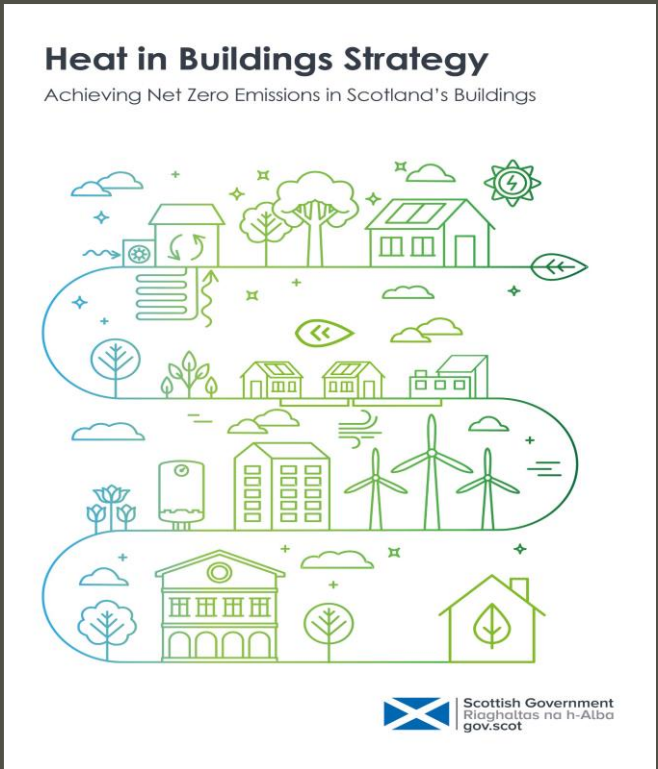
Heat In Buildings Strategy - Scotland



- All homes EPC band C by 2033
- Over 1 million homes with zero emission heat by 2030
- Customer protection and fuel poverty alleviation
- £1.8 billion for heat and energy efficiency projects
- £200 million Social Housing Net Zero Fund until 2026
  - Check Point 3 – application by 28th February 2022
- £200 million Green Scottish Public Sector Estates Scheme
- Green Heat Finance Task Force set up for innovative financing solutions
- £400 million large scale heat decarbonisation infrastructure
- 2024 zero emission heating in all new builds
- 2025 Gas boiler ban in off gas grid
- 2030 Gas boiler ban in other areas
- Development of Local Heat and Energy Efficiency Strategies
- **At least 22% of heat in building from renewable sources by 2030 including "ambient heat supplied heat pumps" Also Known as Ground/Water Source Heat Pumps**

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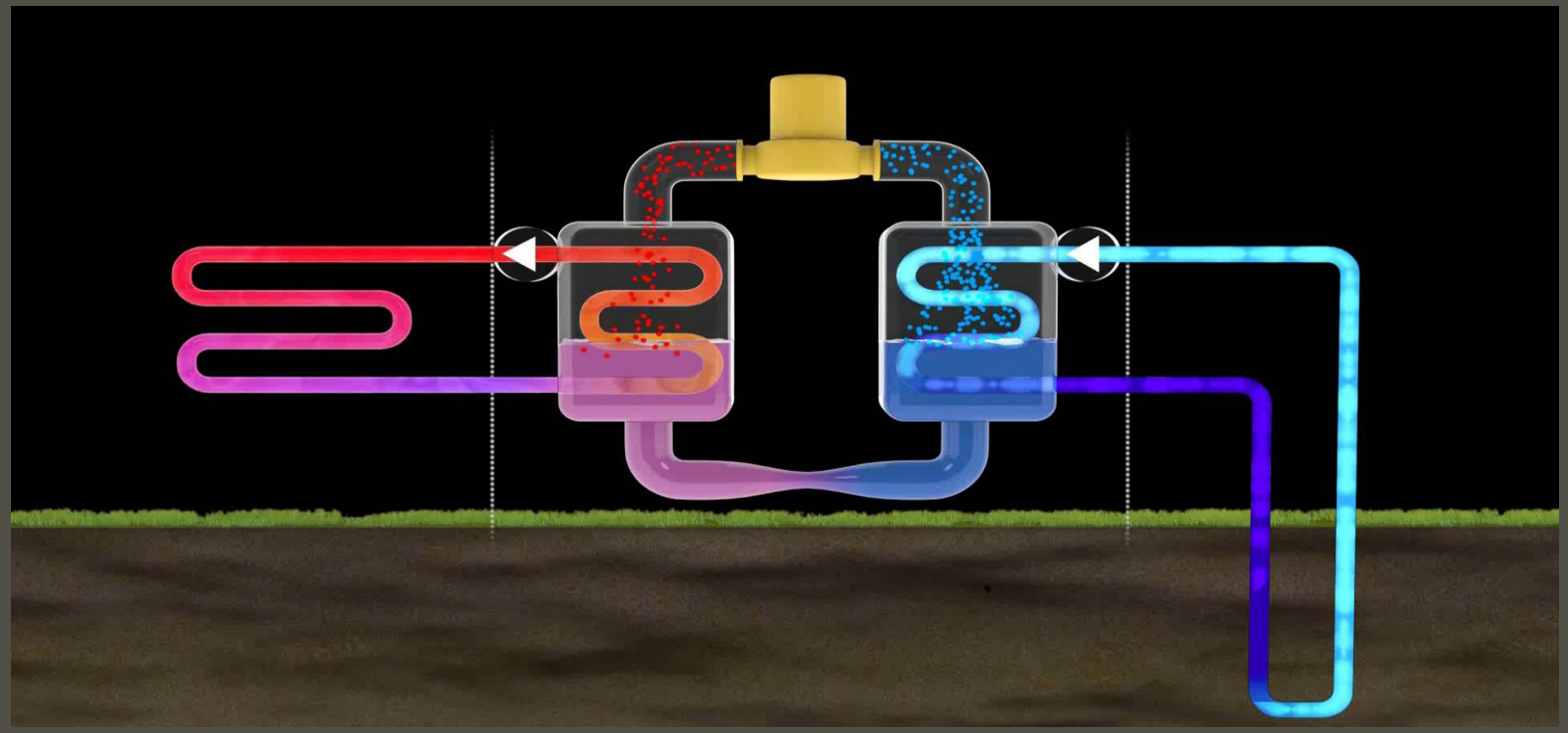
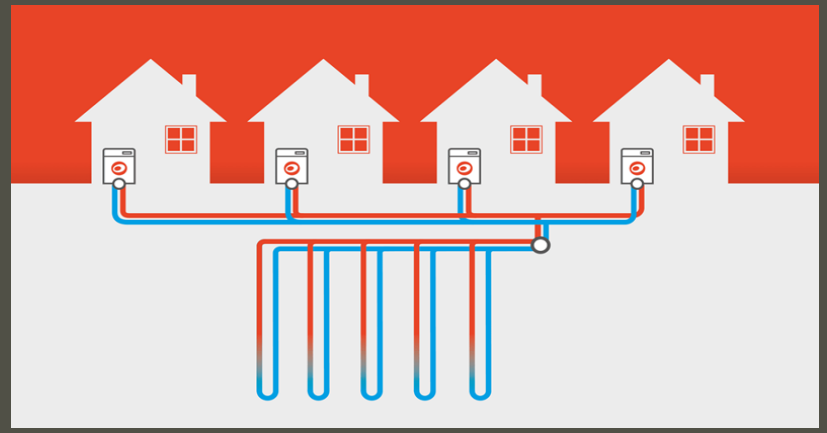
How Ground Source Heat Pumps Work



- Non combustion heating system
- 300% efficient
- Ground provides a highly efficient source of heat
- Unaffected by air temperature unlike ASHP
- Recharged by solar energy and rainfall
- Ground type (thermal conductivity) needs to be factored into sizing calculations
- Lowest running cost heating system



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Kensa's Shoebox Heat Pump

Tailored to social housing and new build

- 3kW and 6kW models
- Quiet operation: 47 dBA and 52 dBA
- Compact design: 530mm x 475mm x 370mm
- or 560mm x 605mm x 565mm (H x W x D)
- Integrated ground side circulation pump
- Heating and hot water (above 60°C)
- Fits in a cupboard or under a sink
- Compatible with all control systems

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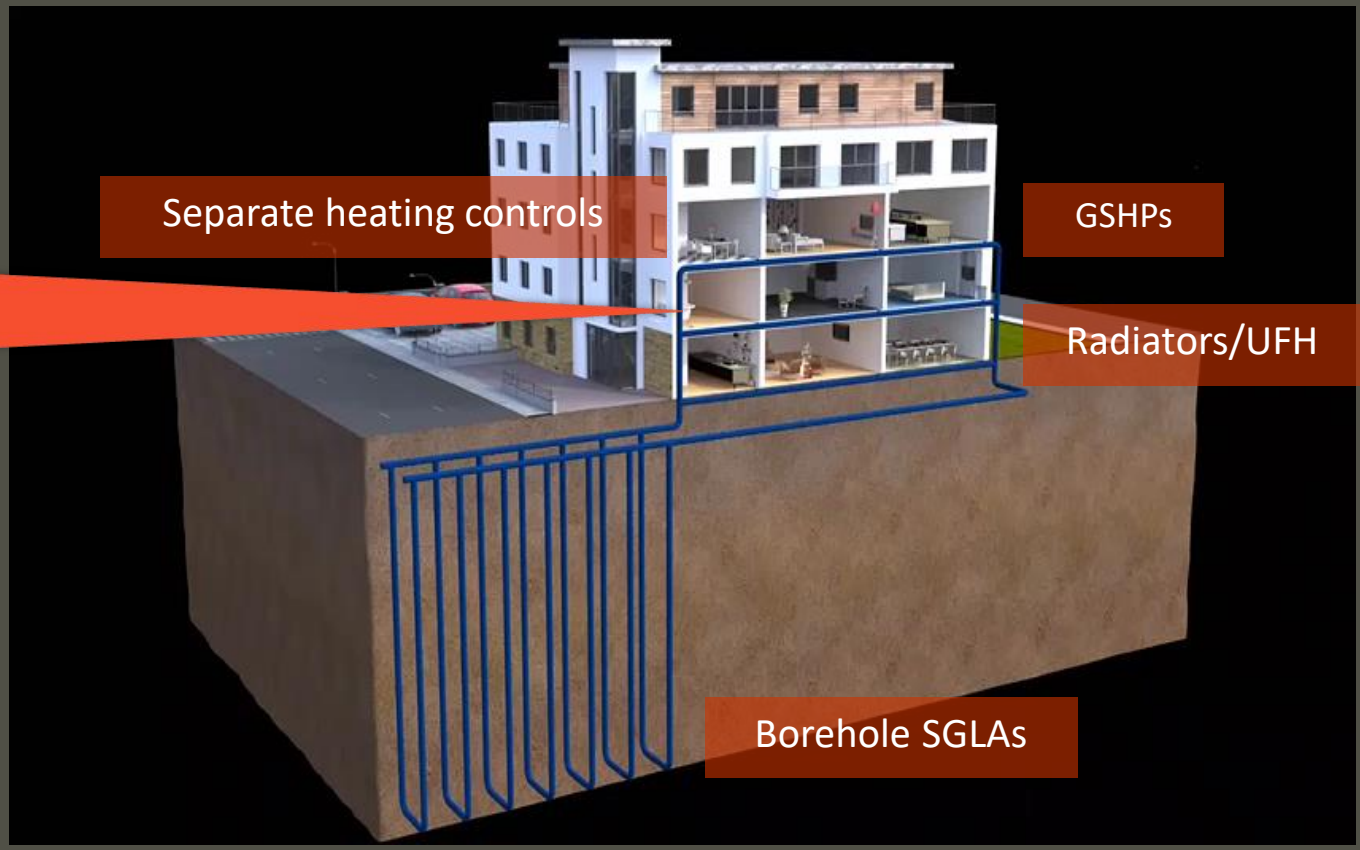
System Architecture With Ambient Heating

An individual Kensa heat pump inside each dwelling provides independently controllable heat and hot water for each property.



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BOREHOLE INSTALLATION

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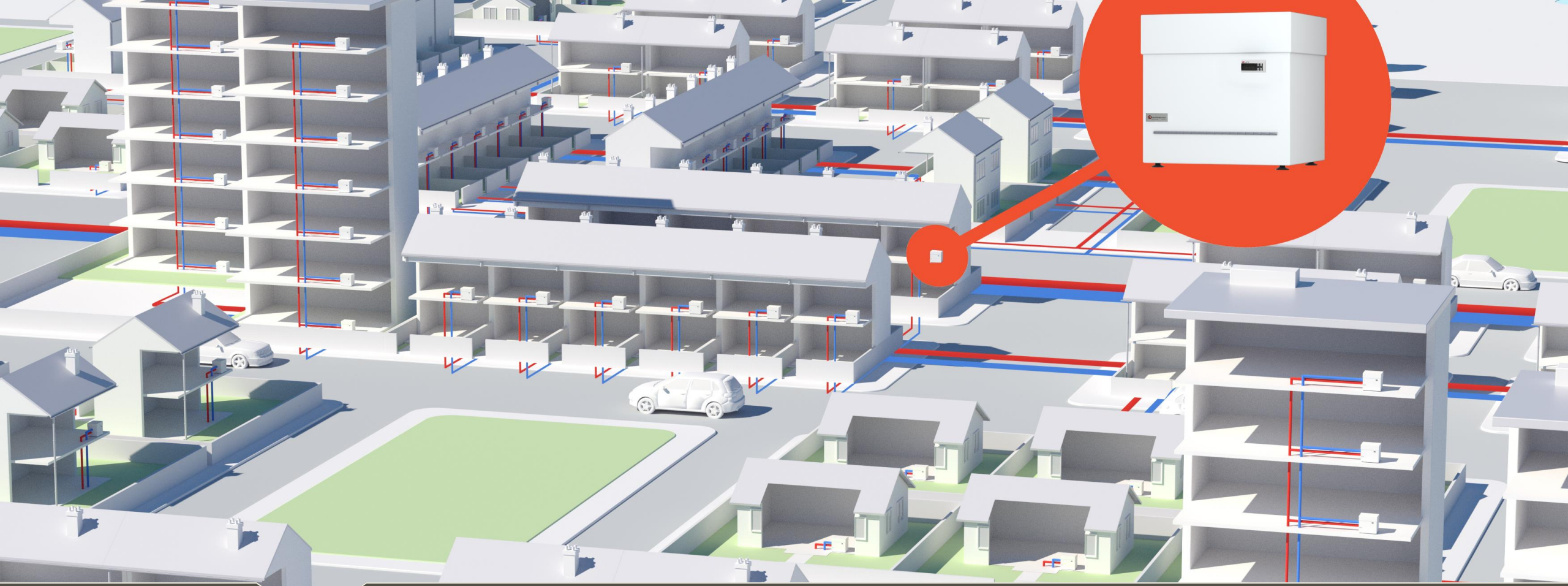
An ambient temperature district heating and cooling network



A network of pipes connecting every property

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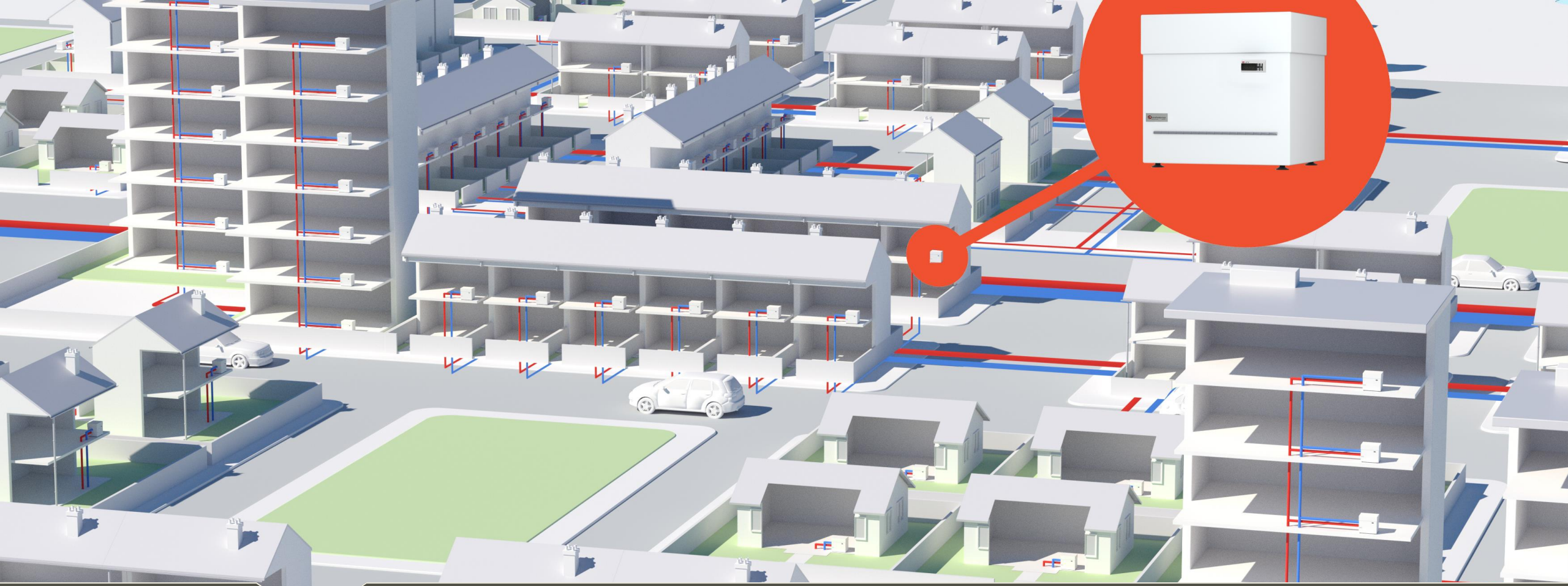

A network of pipes connecting every property
Temperatures range from 0 – 20°C

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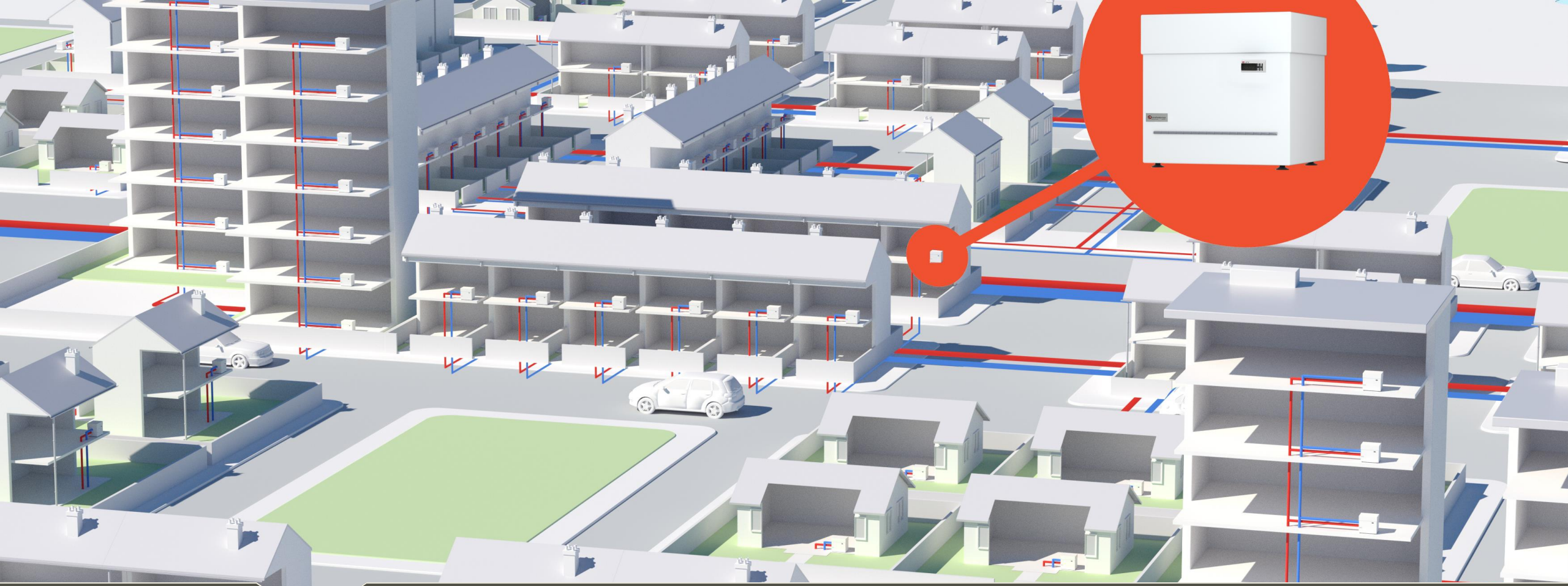

A network of pipes connecting every property
Temperatures range from 0 – 20°C
Individual heat pumps in each property to produce space heating and DHW

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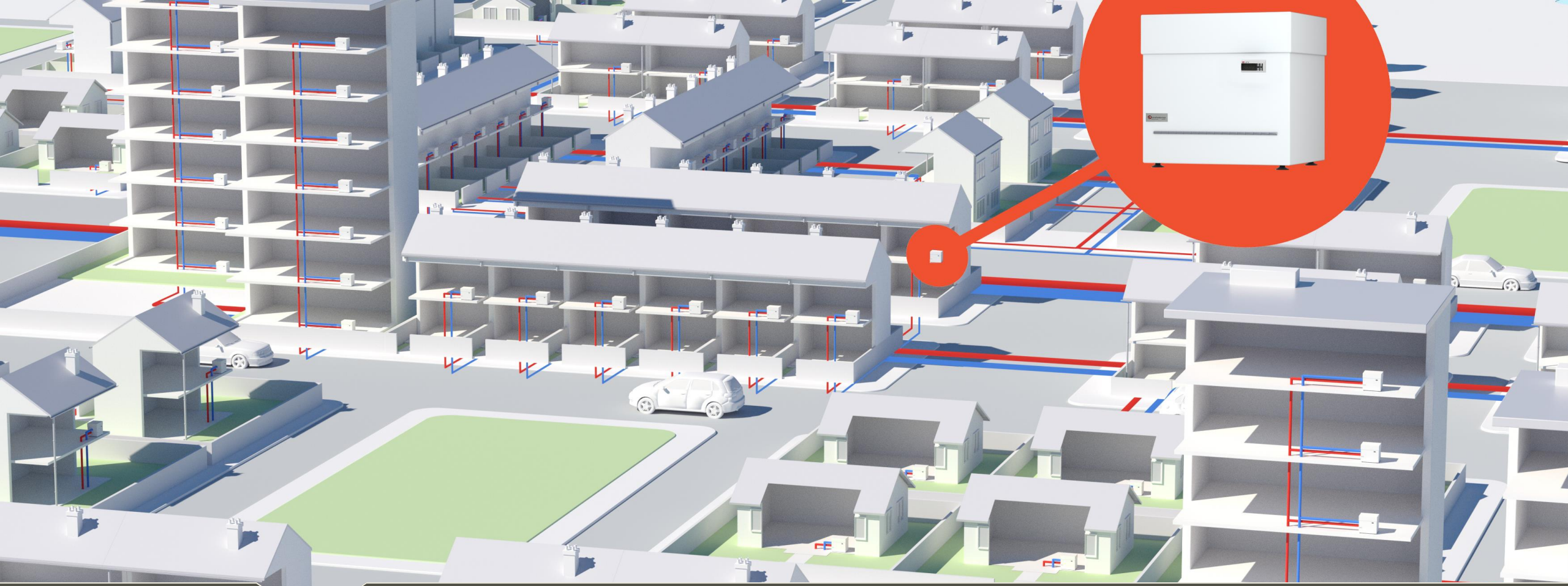

A network of pipes connecting every property
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Passive and active cooling from the same network

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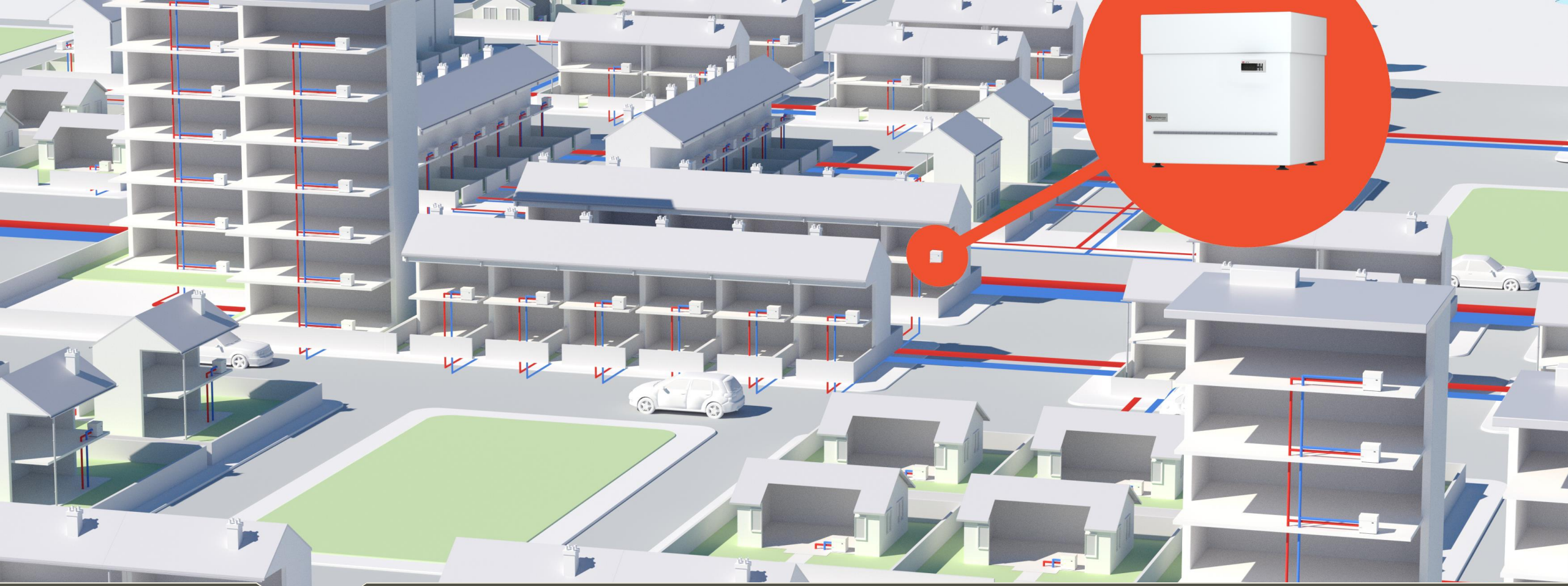

A network of pipes connecting every property
Temperatures range from 0 – 20°C
Individual heat pumps in each property to produce space heating and DHW
Passive and active cooling from the same network
Waste heat and cold is recycled into the network

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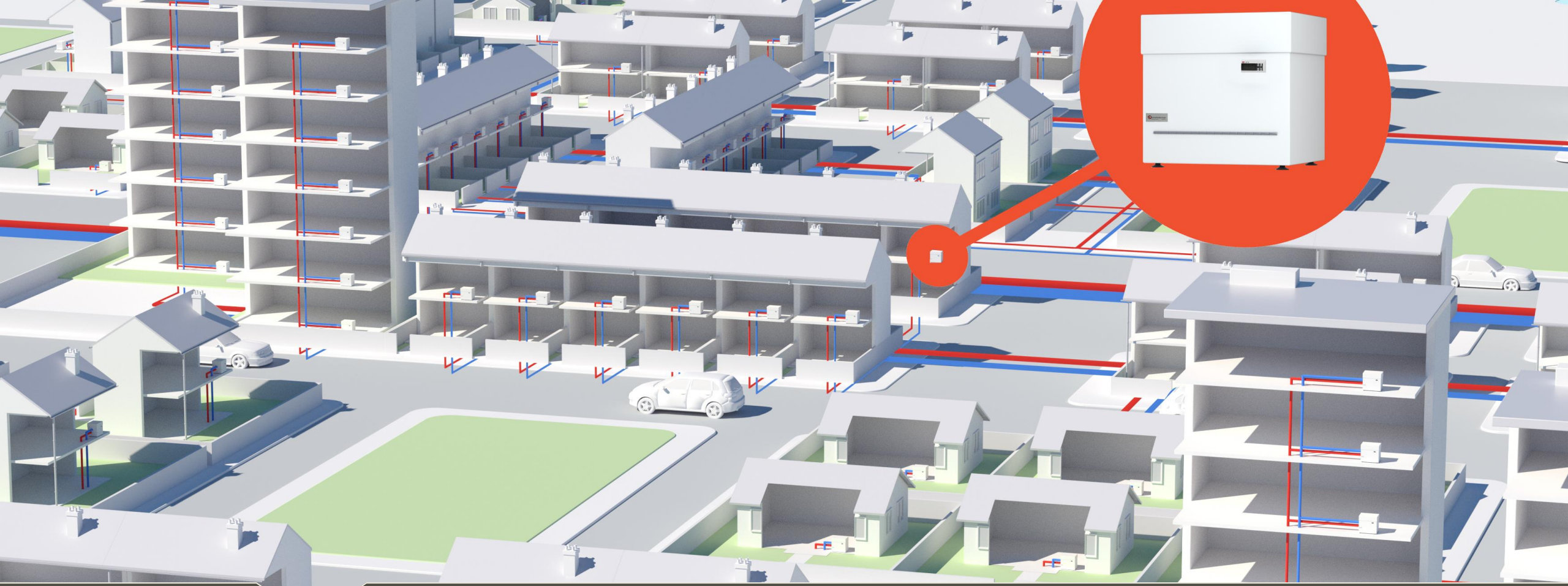

A network of pipes connecting every property
Temperatures range from 0 – 20°C
Individual heat pumps in each property to produce space heating and DHW
Passive and active cooling from the same network
Waste heat and cold is recycled into the network
User pays for their energy via their electricity bill

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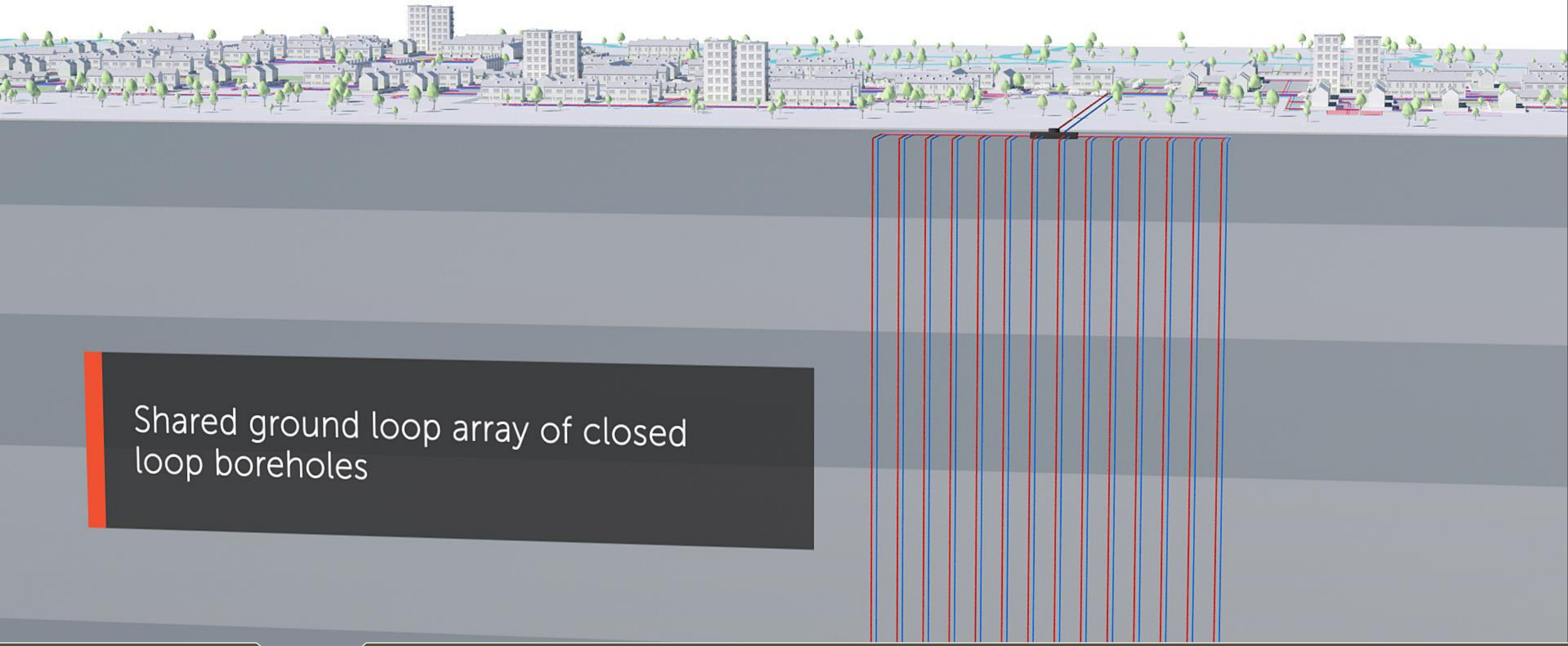

Shared ground loop array of closed loop boreholes

Multiple sources to bring the loop back to ambient.

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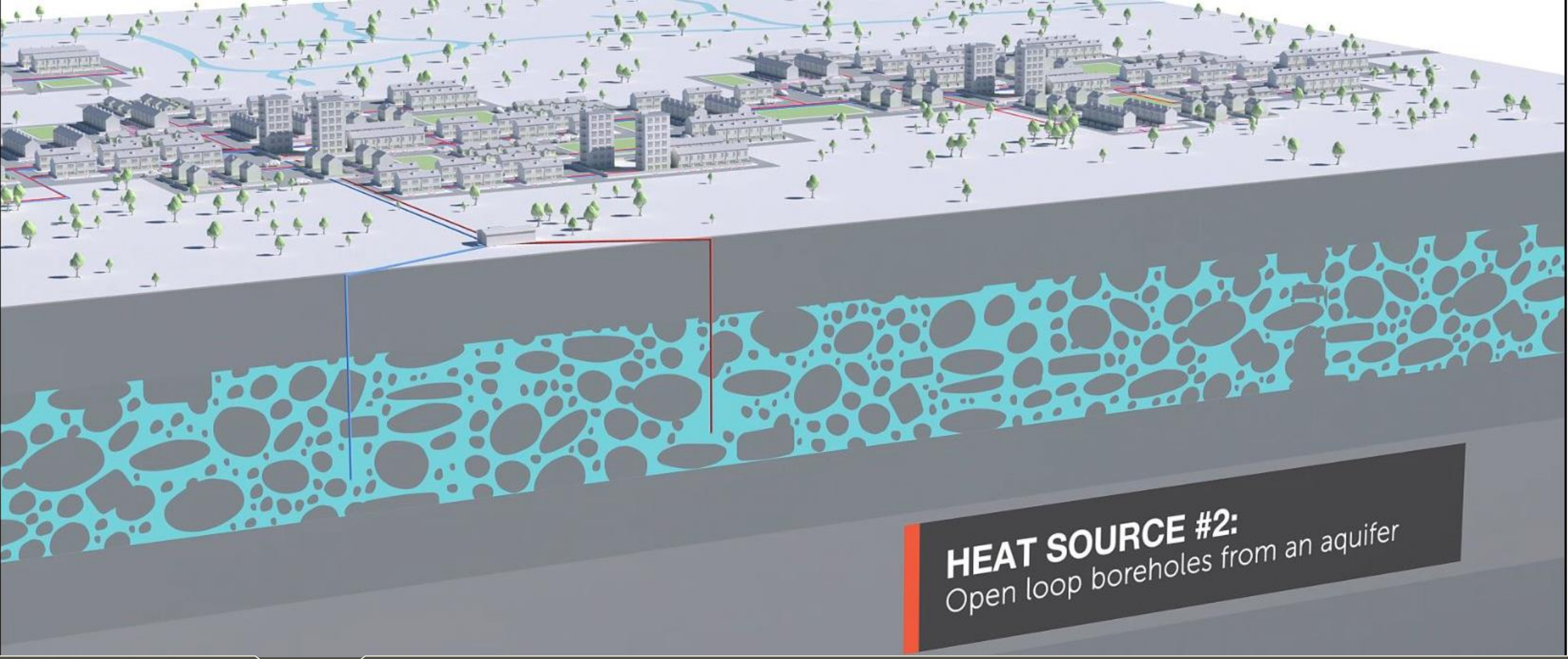

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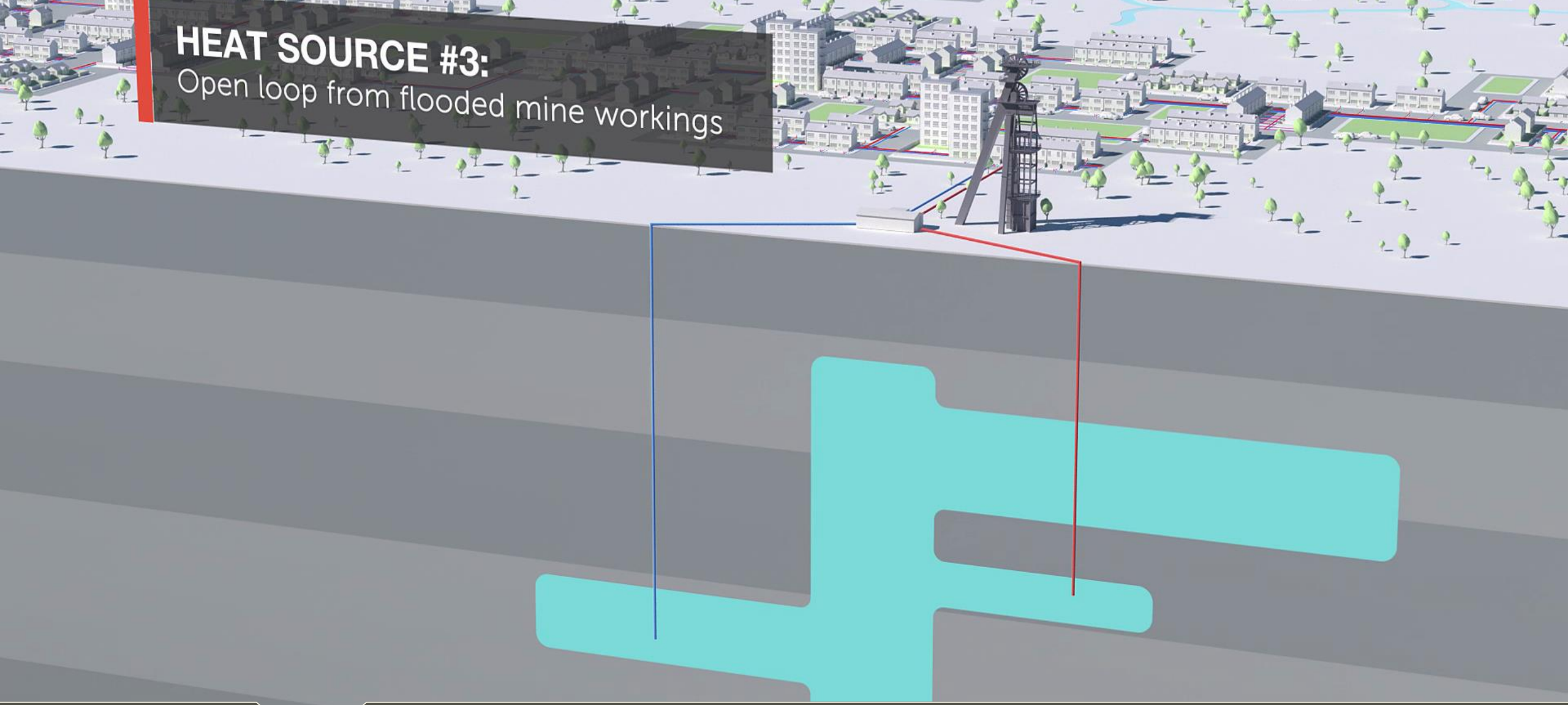

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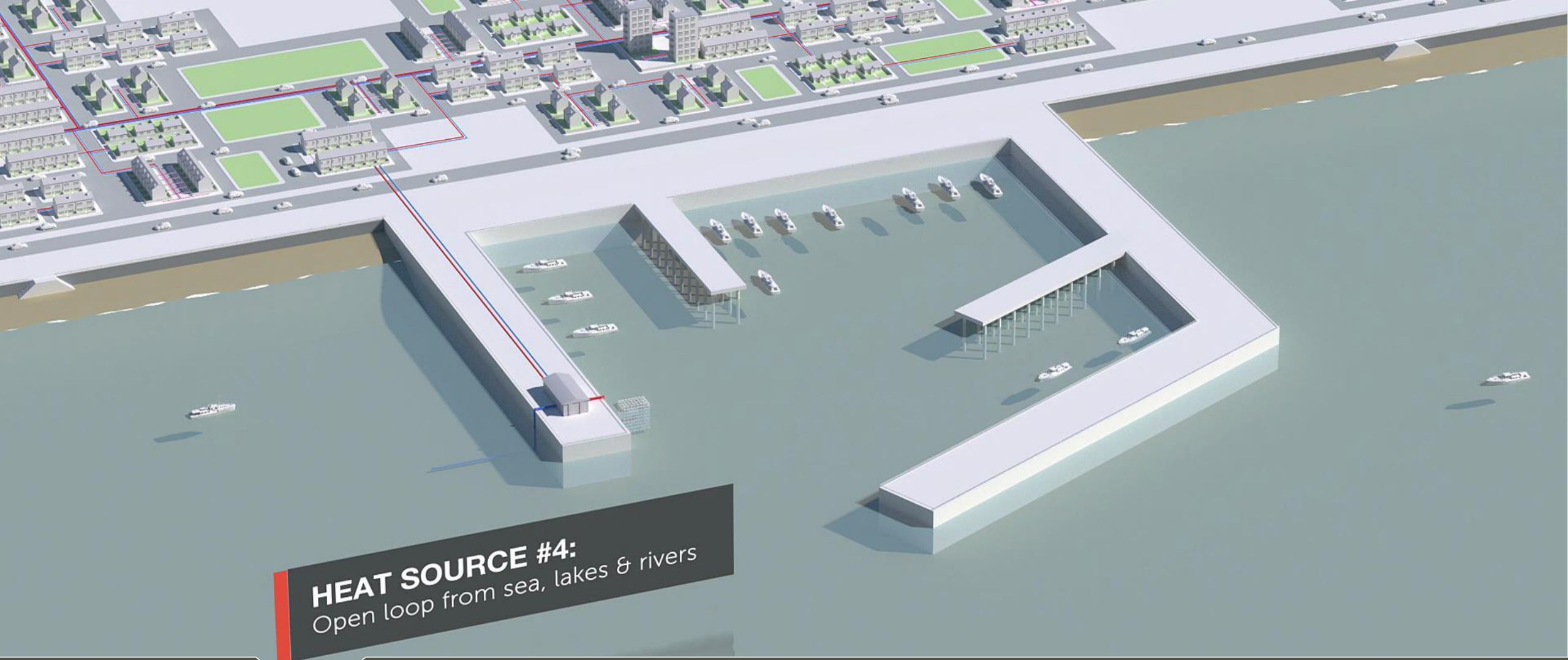

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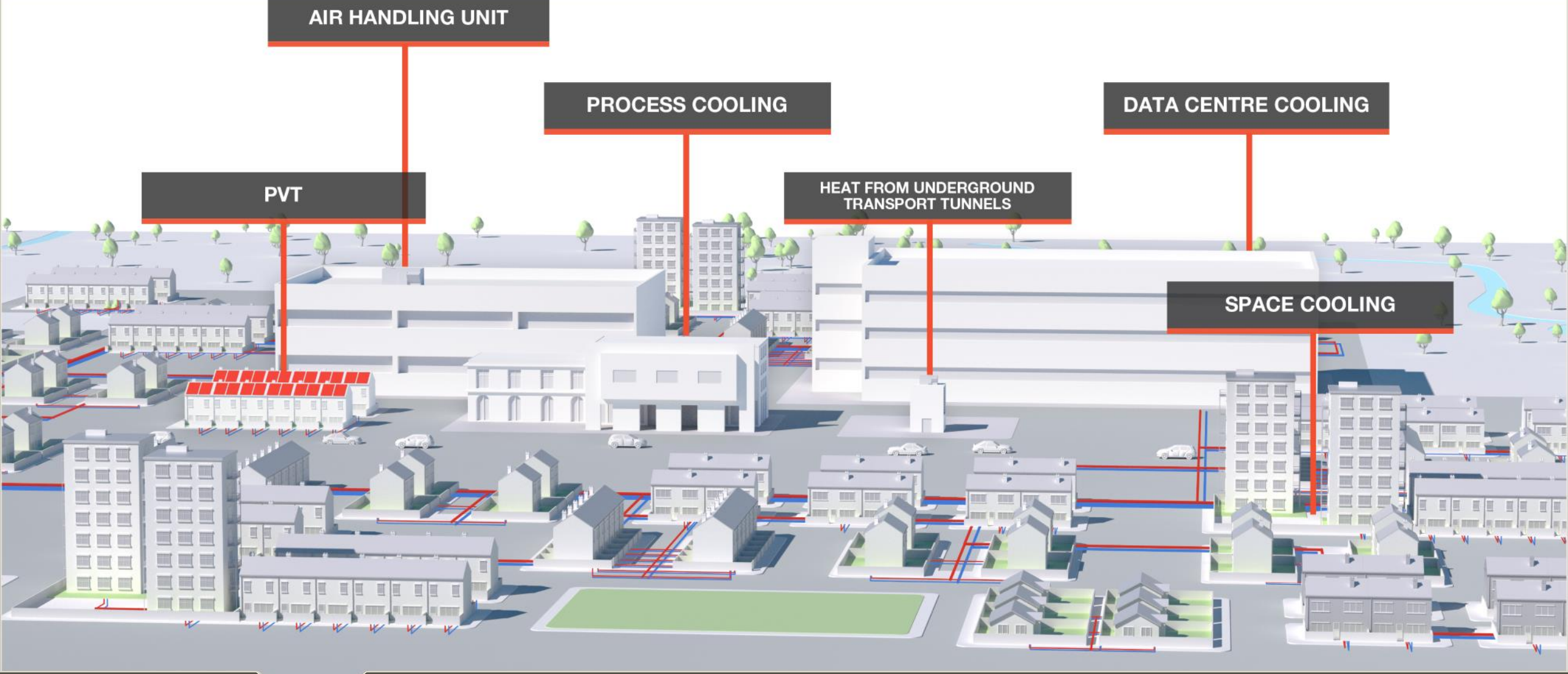

Multiple sources to bring the loop back to ambient.

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GROUND SOURCE HEAT PUMP- BENEFITS

Benefits	Ground source	Air source
More efficient	✓	×
Lower carbon emissions	✓	×
Lower running costs	✓	×
Increased opportunity for night-time operation & load-shifting	✓	×
Lower maintenance costs	✓	×
Straightforward planning permission	✓	×
No noise impact	✓	×
Completely unobtrusive	✓	×
Ability to cool	✓	×

THE APPEAL OF HEAT PUMPS

- Contributes towards lowest cost compliance strategy
- System architecture is scalable and can be installed as and when required
- No planning permission required
- Installation does not impact the appearance of the property
- Mimics traditional gas boiler arrangements – appliance producing hot water, cylinder, controls

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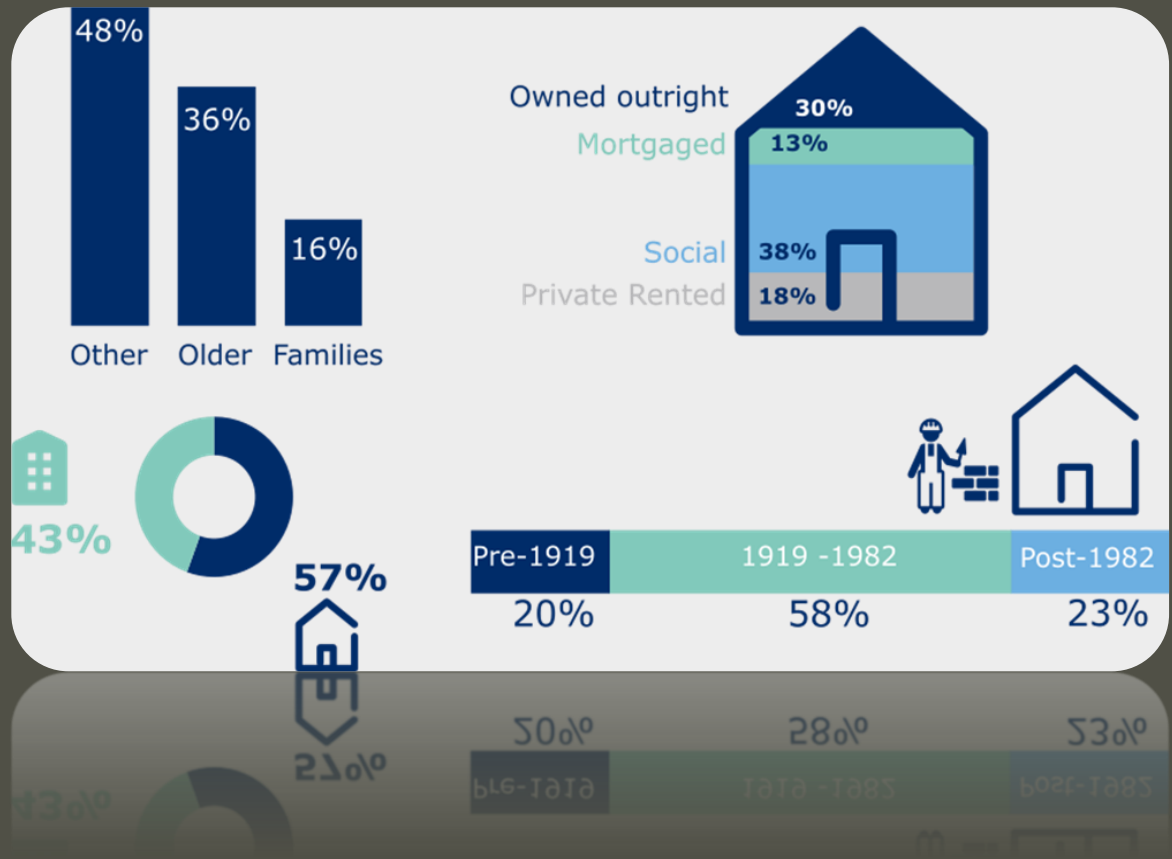
Why is Social Housing Retrofit Important?

- Social rented sector – 607,929
- 46,530 flats in tower blocks with majority heated with electric storage heaters
  - Running costs in excess of £1100 pa – Potential lowest regret retrofit opportunity
- 50% of social housing tenants have incomes of between £10K-£15K
- Majority with a weekly income of between £192 to £288
- Average rents of £83.70
- 38% of those in fuel poverty live in social housing
- 43% of those in fuel poverty live in flats
- Huge opportunity for social impact and decarbonisation

Composition of Fuel Poor Households by Selected Household and Dwelling Characteristics



2019 Scottish Housing Condition Survey

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Housing Data

Table 6: Primary Heating Fuel by Age and Type of Dwelling, 2019

Dwelling Type	Dwelling Age	Primary Heating Fuel			Sample
		Gas	Electric	Other	size
All Dwelling types	**All age bands**	81%	11%	9%	*2,997*
	pre-1919	72%	10%	18%	*546*
	1919-1982	85%	9%	6%	*1652*
	post-1982	79%	13%	8%	*799*
Detached	**All age bands**	71%	6%	23%	*852*
	pre-1919	39%	8%	52%	*186*
	1919-1982	80%	4%	16%	*316*
	post-1982	79%	5%	15%	*350*
Semi	**All age bands**	87%	6%	7%	*685*
	pre-1919	71%	8%	21%	*74*
	1919-1982	88%	6%	6%	*446*
	post-1982	89%	8%	3%	*165*
Terraced	**All age bands**	89%	8%	3%	*589*
	pre-1919	81%	12%	7%	*74*
	1919-1982	90%	7%	3%	*438*
	post-1982	88%	*	*	*77*
Flat	**All age bands**	79%	17%	4%	*871*
	pre-1919	87%	11%	2%	*212*
	1919-1982	80%	15%	5%	*452*
	post-1982	69%	28%	4%	*207*

Table 5: Primary Heating Fuel, Households (000s) and %, for All Stock and by Sector, 2019

	All Stock		Owner Occupied		Private Rented		Social	
Primary Heating Fuel	**000s**	**%**	**000s**	**%**	**000s**	**%**	**000s**	**%**
Mains gas	2,016	81%	1,277	82%	230	74%	509	80%
Electricity	262	11%	121	8%	53	17%	88	14%
Oil	129	5%	111	7%	15	5%	2	0%
Communal Heating	34	1%	*	*	*	*	28	4%
LPG bulk or bottled	18	1%	*	*	*	*	-	-
Solid mineral fuel	20	1%	10	1%	4	1%	6	1%
Biomass	16	1%	11	1%	4	1%	-	-
Sample size		*2,997*		*1,965*		*317*		*715*

- 88,000 social properties with Electric Heating
- Best opportunity to retrofit with 300% efficient heating systems
- Saving residents up to 66% on heating and hot water cost
- Lowest regret option

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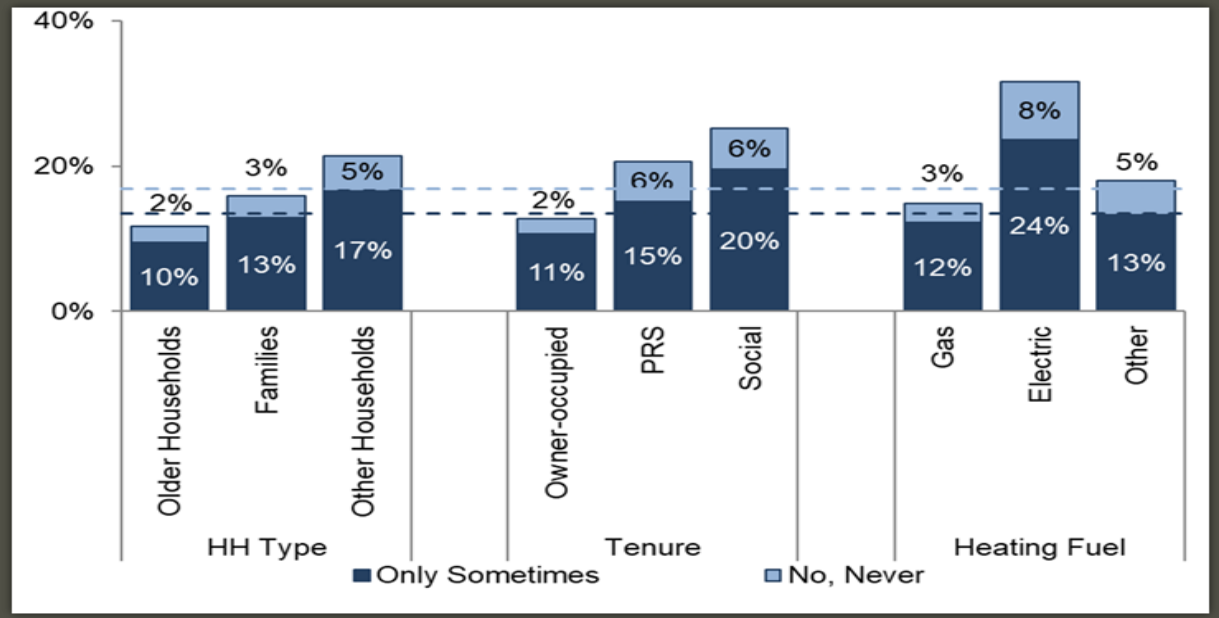
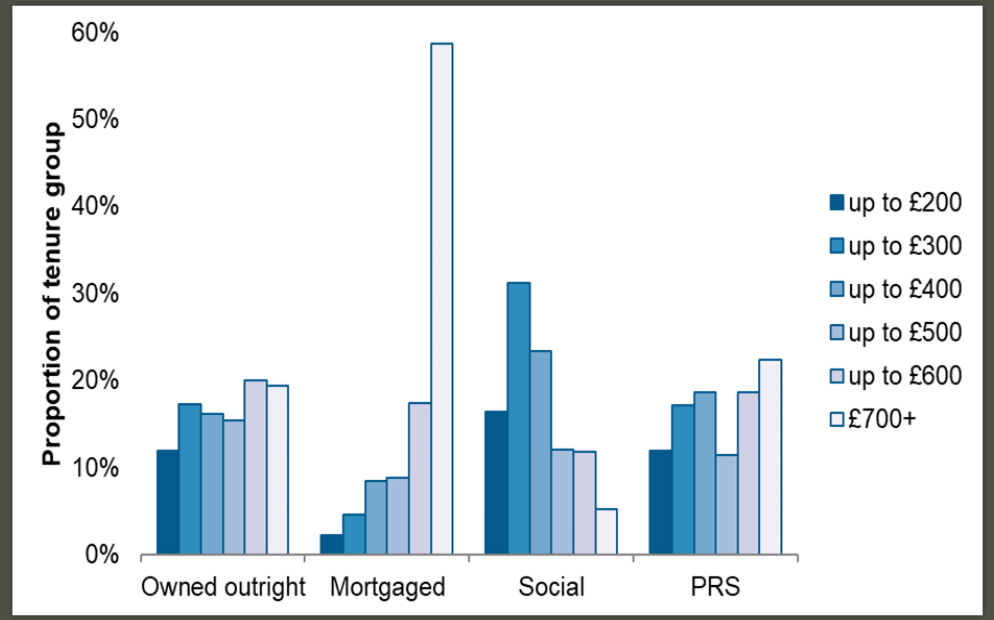
Housing Data

"Does Your Heating Keep You Warm Enough in the Winter?" by Household Type, Tenure and Primary Heating Fuel; SHCS 2019



Proportion of Households in Each Tenure Group by Weekly Household Income Band, 2019



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Drivers for Investment in Social Housing

A tried and tested solution to meet all the drivers listed below

Fuel Poverty

- **Lowest running cost**
- Average 50% savings when replacing NSH
- Load shifting
- Time of use tariffs
- Protection against gas levy
- Less rent arrears

Social Impact

- **Financial inclusion**
- Local Economic Improvement
- Reduced burden on NHS
- Better mental health
- Behaviour change
- Local greening projects

Net Zero Carbon

- **Lowest CO2**
- Renewable Energy
- No NOx/SOx emissions
- Able to meet 2030 targets
- Could be funded through S106 Carbon offset funds
- Able to benefit from electricity grid decarbonisation

Good Asset Management

- **Lowest Life-Cycle costs**
- Longest appliance life
- Lowest maintenance cost
- No compliance cost (CP12)
- Lowest RepEx cost
- Long life of asset infrastructure buried under ground -100years
- Possible to apply a standing charge-similar to gas
- Future proof – can connect to batteries and other renewable sources of electricity

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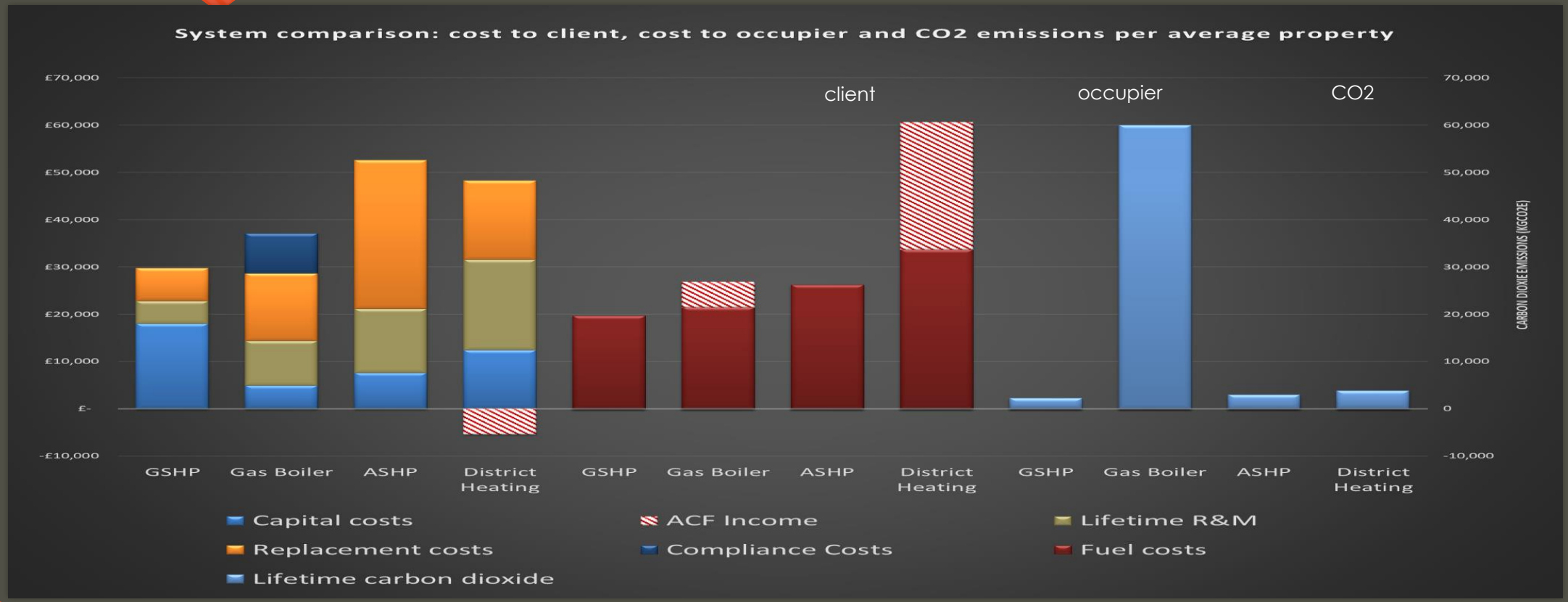
Life Cycle Analysis: GSHP has lowest lifecycle cost!

Potential to reduce capital cost by a further 50% through Social Housing Net Zero Fund



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Support with Building the "GREEN" Business Case

HM Treasury: The Green Book – Central Government Guidance on Appraisals and Evaluation- The Five Case Model

Strategic Case	•Is there a clear case for change and will it meet aims & objectives? •Net Zero 2030, Climate Emergency, local and national policy drivers
Economic Case	•Is it value for money? •Social value, fuel poverty alleviation, NHS savings, well being of residents
Commercial Case	•Is it viable? •In line with 30+year HRA business plans, making use of open spaces and parks, funding, commercial returns
Financial Case	•Is it affordable over the life of the asset? •Financial modelling, divested pension funds, best possible NPVs, better affordability of rents, S106, PWLB
Management Case	•Is it achievable and are we capable? •Robust project management in house, asset management skills, large scale deployment, asset infrastructure ownership models

Enfield Council

Case Study

5th generation district heating in action

Project Overview

- Client: Enfield Council
- Principal Contractor: ENGIE
- Specialist subcontractor: Kensa
- England's largest shared loop district GSHP system
- Eight tower blocks – 402 individual flats
- Expected 30-50% savings on residents' heating bills
- Significant CO_2 emissions reductions
- Generates 20 year RHI income for Enfield
- Enfield Council benefits from ECO funding
- Commenced: November 2017
- Completed: October 2018

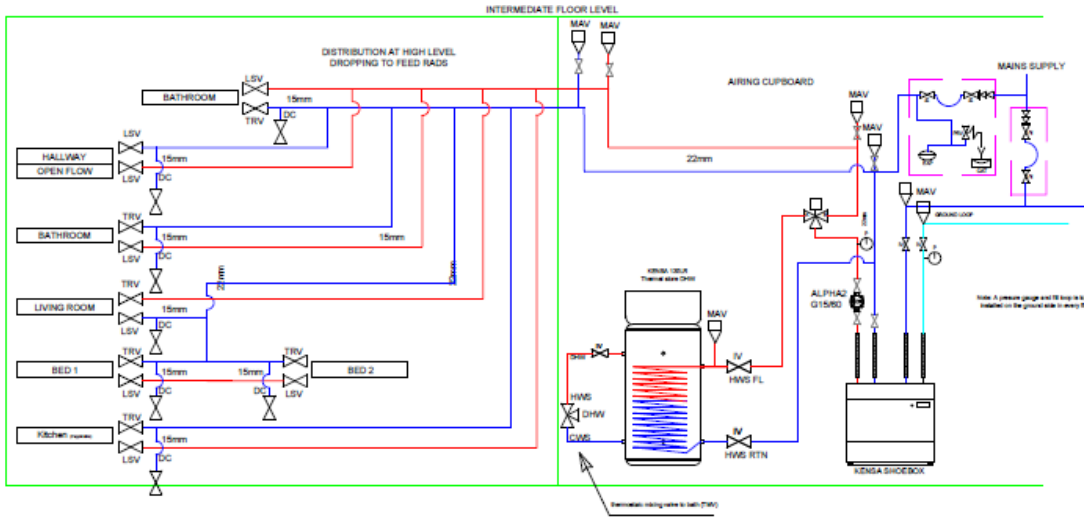
GREATER LONDON
ENERGY EFFICIENCY
REGIONAL AWARDS 2018
LARGE
SCALE PROJECT
WINNER

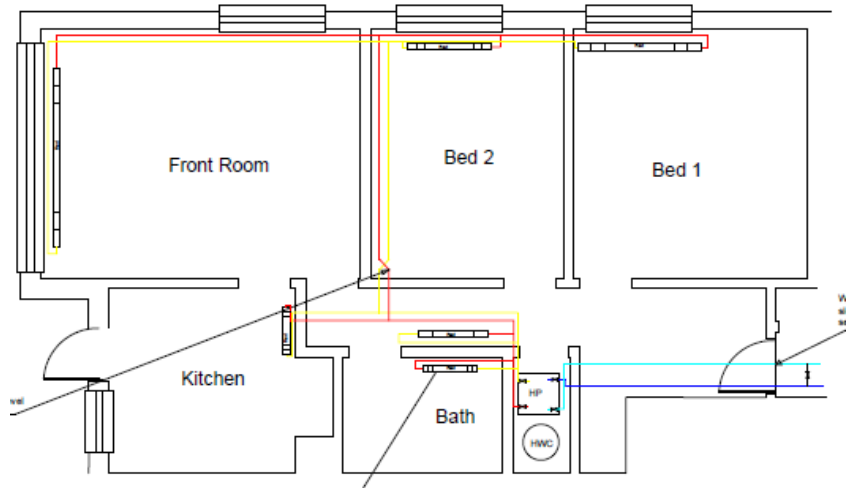
Tenant liaison

- Residents remained in occupation throughout the works
- Resident Liaison Officers consulted each family before, during and after works
- Communal meetings held for each block prior to works
- Individual plans agreed to ensure safe delivery of works
- Access to respite area for residents
- Ability to view mock-up for typical flat installation
- Opportunity to ask technical/general questions

Survey and Design

- Detailed property surveys to establish heat loads for accurate heat pump sizing and radiator sizing
- Borehole design was a combination of desktop analysis and on-site Thermal Response Test
- Risers designed to ensure no requirement for central circulation pumps
- Surveys carried out to locate all buried services – both externally and internally





Borehole drilling

- Specialist pre-drilling at each borehole location to rule out presence of UXO
- Channel Islands: 52 boreholes, 10,700 metres, 16 arrays
- Kettering Road: 48 boreholes, 10,000 metres, 16 arrays
- Each array serves half a tower block – 6 or 7 floors and 24-27 flats
- Drilling took about three months at each site


Welch
Keys
Woolpack
Dorset
Kettering Rd
GeniusEnergyLab

Trenching and headering

- Trenches are dug from each borehole
- Pipework (HDPE) is installed at the bottom of the trench connecting the boreholes to the manifolds
- Manifolds group the boreholes together into two arrays
- Two pairs of pipes run from manifolds into the basement of each tower block
- All ground reinstated at the end to match what was there previously

Riser installation

- Risers installed in stairwells from basement to top floor
- Core drilling on each floor
- Four pipes from basement to 6th floor
- Two pipes from 7th to 13th floor
- Branches taken off at each floor to serve the four flats
- Pipework insulated to prevent condensation
- All boxed in once completed
- All work approved by Enfield Council's fire safety team

Flat installation

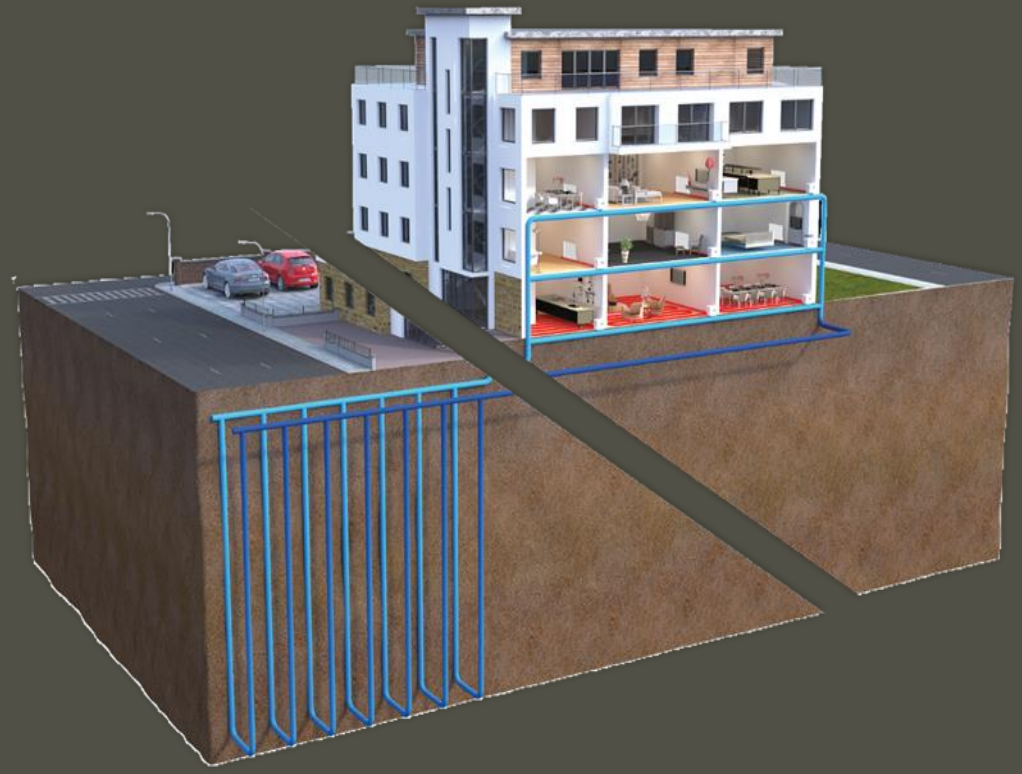
- Existing hot water cylinder and storage heaters removed (where fitted)
- New radiators and distribution pipework installed
- Heat pump installed in airing cupboard
- Shelf fitted and hot water tank installed above heat pump
- New controls – dial thermostat and twin channel programmer
- Ground array flushed and filled with anti-freeze
- Heat pump system switched on
- Existing electric UFH system de-commissioned
- Making good and pipework painted
- System handed over to resident

Key outcomes

- £4.3 million Funding Claimed
- ECO and RHI
- 773 tCO2 saving/yr
- Significant reduction in maintenance costs for Enfield Council
- Running costs for residents reduced from £900/yr to £350/yr
- Fuel poverty impact!

Potential for Innovative Financing Mechanisms

- Ambient loops are similar to gas mains infrastructure
- The Council or a separate entity could invest in the ground array
- Charge an Annual Connection Fee (ACF) similar to gas standing charge
- Opportunity to recover initial capital cost of ground array over time
- Once capital cost have been recovered, ACF could continue to generate income overtime
- Third party investment possible



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SYSTEM DESIGN & PROJECT DELIVERY

Kensa Contracting offers flexible service delivery options depending on the level of project management required.

This can include:

- feasibility studies, geological surveys & financial modelling
- ground array sizing, design & installation
- heat pump selection, installation & commissioning handover
- integration with existing or upgraded heat emitters
- integration with existing or upgraded heating controls
- sub-contractor management
- tenant liaison and householder education
- support with grant funding applications
- after sales support

https://www.kensaheatpumps.com/the-technology/installation-fullfilment/kensa-contracting-ltd/

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GROUND SOURCE HEAT PUMPS AND SHARED GROUND LOOP ARRAYS

Conclusions

- The technology is well developed and has been deployed at scale
- Achieves lowest carbon and lowest running cost
- Government funding for shared ground loop heat pumps is in place to stimulate significant growth
- Kensa has the knowledge and expertise to deploy this technology at significantly increased scale
- GSHP are a sustainable heating solution for both new build and retrofit projects
- We can support you with business case development, feasibility reports and grant funding applications
  - **Free of charge for APSE Local Authorities**

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Questions?

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