GROUND SOURCE HEAT PUMPS AND SHARED GROUND LOOP ARRAYS

Kensa Contracting

Version 1

The UK's leading ground source heat pump manufacturer and installation contractor

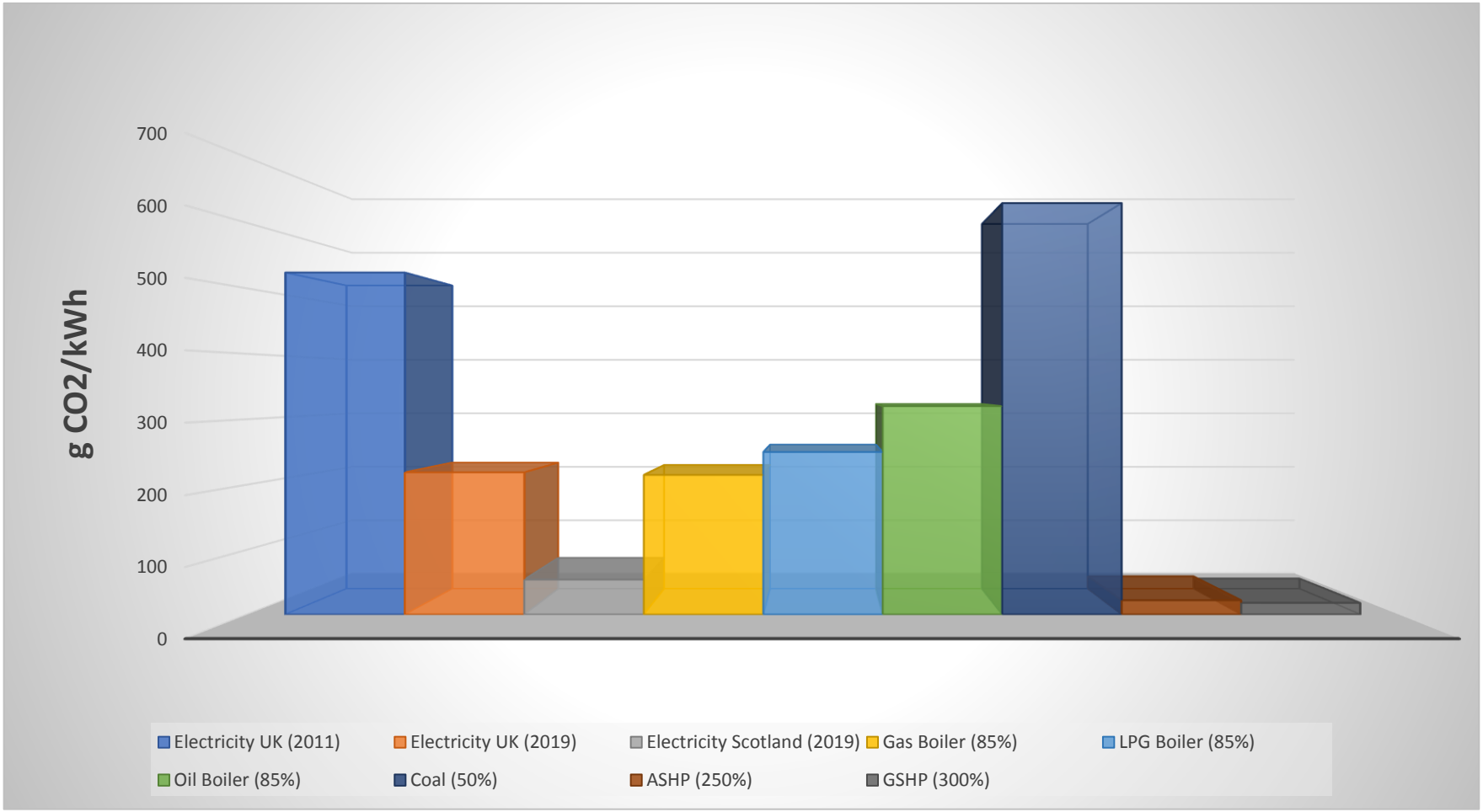
Our aims

- Decarbonise heat across all sectors
  - Scottish Energy Strategy 2017: The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources by 2030
  - Building standards: will be tightened to ensure that new homes use renewable heat from 2024, with standards for non-domestic buildings also tightened. A new Zero Carbon Standard for public sector buildings will be consulted on later this year.

- Reduce fuel poverty in rural and urban communities
  - Currently 25% of Scottish household are in fuel poverty
  - 7% of Scottish households are in extreme fuel poverty

- Provide a simple, effective and low maintenance solution to achieve the first two aims

CARBON INTENSITY OF HEATING FUELS UK (per unit of heat delivered) grams CO2 per kWh



Kensa Contracting
A KENSA GROUP COMPANY

INTRODUCING KENSA

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor


Kensa Group
Kensa Heat Pumps
A KENSA GROUP COMPANY
Kensa Contracting
A KENSA GROUP COMPANY
Kensa Utilities
A KENSA GROUP COMPANY

KENSA HEAT PUMPS

INTRODUCING KENSA

- UK market leader
- Established 1999
- UK's only GSHP manufacturer
- Based in Cornwall & Devon
- Single technology solution provider
- Industry accredited
- 5000+ Kensa GSHPs in use
- Award winning

2011		2012		2013		2014		2015		2016		2017	
IVT	16-20%	Kensa	21-25%	Kensa	16-20%	Kensa	21-25%	Kensa	26-30%	Kensa	31-35%	Kensa	31-35%
Nibe	16-20%	IVT	16-20%	Nibe	11-15%	Nibe	16-20%	Nibe	21-25%	Nibe	16-20%	Nibe	21-25%
Kensa	6-10%	Nibe	6-10%	IVT	11-15%	IVT	11-15%	Vaillant	6-10%	Vaillant	6-10%	Stiebel Eltron	11-15%
Danfoss	6-10%	Danfoss	6-10%	Dimplex	6-10%	Dimplex	6-10%	Danfoss	6-10%	Neura	6-10%	Vaillant	6-10%
Dimplex	6-10%	Dimplex	6-10%	Danfoss	6-10%	Danfoss	6-10%	IVT	6-10%	Stiebel Eltron	6-10%	Mastertherm	6-10%
Bosch	6-10%	Bosch	1-5%	Steibel Eltron	6-10%	Vaillant	6-10%	Dimplex	1-5%	IVT	6-10%	Others	16-20%
Calorex	6-10%	NuTherm	1-5%	Vaillant	1-5%	Steibel Eltron	1-5%	Steibel Eltron	1-5%	Danfoss	1-5%		

UK Heat Pump Market Shares. Source: BSRIA (2011—2018)

Kensa Contracting
A KENSA GROUP COMPANY

Kensa Contracting has an award-winning heritage with thousands of successful installations in both retrofit and new build properties.

- Delivery of larger scale GSHP projects
- Turnkey project management solution
- Full or shared project management options
- Equipment supplied by Kensa Heat Pumps

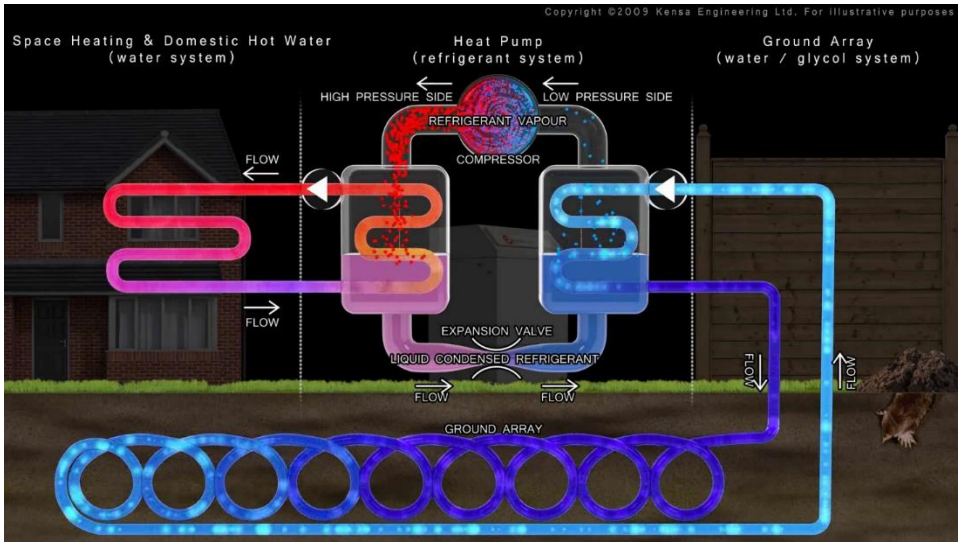
GROUND SOURCE HEAT PUMP TECHNOLOGY

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

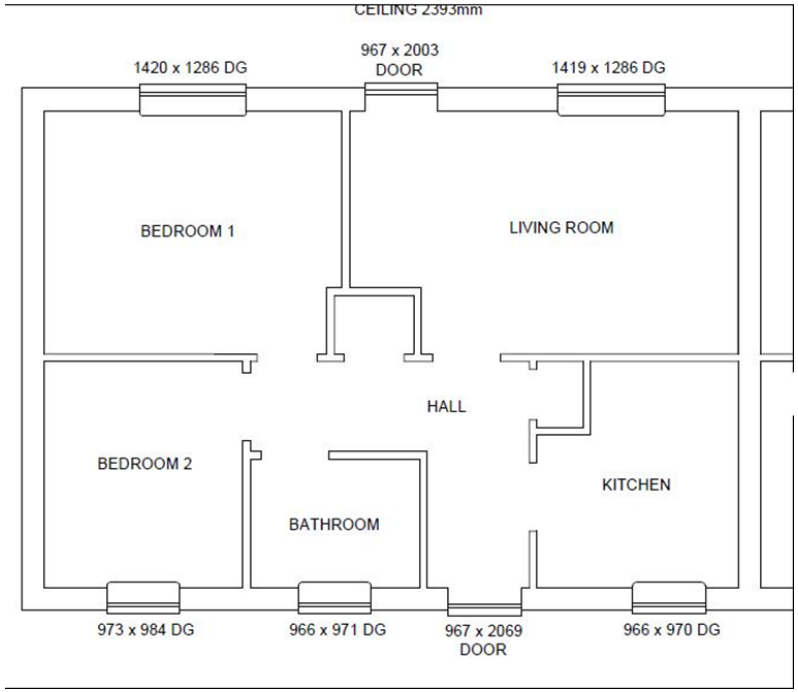
The basics:

- Non combustion heating system
- Produces up to three times more energy than it consumes
- Ground provides a highly efficient source of heat
- Unaffected by air temperature
- Recharged by solar energy and rainfall
- Ground type (thermal conductivity) needs to be factored into sizing calculations
- Correct sizing is important to avoid over extract



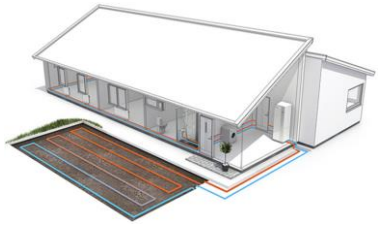
https://www.kensaheatpumps.com/how-a-ground-source-heat-pump-works/

- Elemental heat loss calculation to BS EN 12831
- Heat loss carried out room-by-room
- Size to 100% of peak load
- No backup required
- Size hot water cylinder depending on need
- Choose heat pump depending on high output or high temperature
- Borehole sizing based on peak load and annual load



OTHER METHODS OF HEAT EXTRACTION

Straight pipe



- Collector pipework laid horizontally
- Requires large land area
- Not that sensitive to ground type
- Can be oversized easily
- Cost effective
- Quick to install

Slinkies

- Pre coiled pipework laid in trenches 1-2m below ground
- Requires large land area, but less digging
- Not that sensitive to ground type
- Can be oversized easily
- Cost effective
- Even quicker to install

Surface water (closed loop)

- Ideal solution where surface water (e.g. lake) is available
- Uses pond mats featuring slinky pipe on steel frames
- Extremely efficient
- Cost effective
- Reduced maintenance compared to open loop

Aquifer or mine water (open loop)

- Extracts ground water from an underground aquifer or mine
- Efficient
- Costly to maintain
- Considerations need to be taken regarding corrosion issues, filtration and extraction

https://www.kensaheatpumps.com/the-technology/heat-sources-collectors/

In brief:

- Extremely low CO_2 emissions enabling easy carbon and building regulations compliance
- No point of use NOx or SOx emissions
- Lowest energy bills; slightly lower than air source heat pumps, LPG & oil
- Ultra-efficient and reliable
- Minimal service and maintenance costs
- 20 – 25 year heat pump unit life expectancy
- >100 year ground array life expectancy - PE100 pipe is easy to install, light, flexible, corrosion-free and has a service life of up to 100 years.
- Ideally suited for time of use tariffs
- Completely unobtrusive – no visual impact

GROUND SOURCE vs AIR SOURCE

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	✓	✗
Legacy value for subsidy spend	✓	✗
Ability to cool	✓	✗

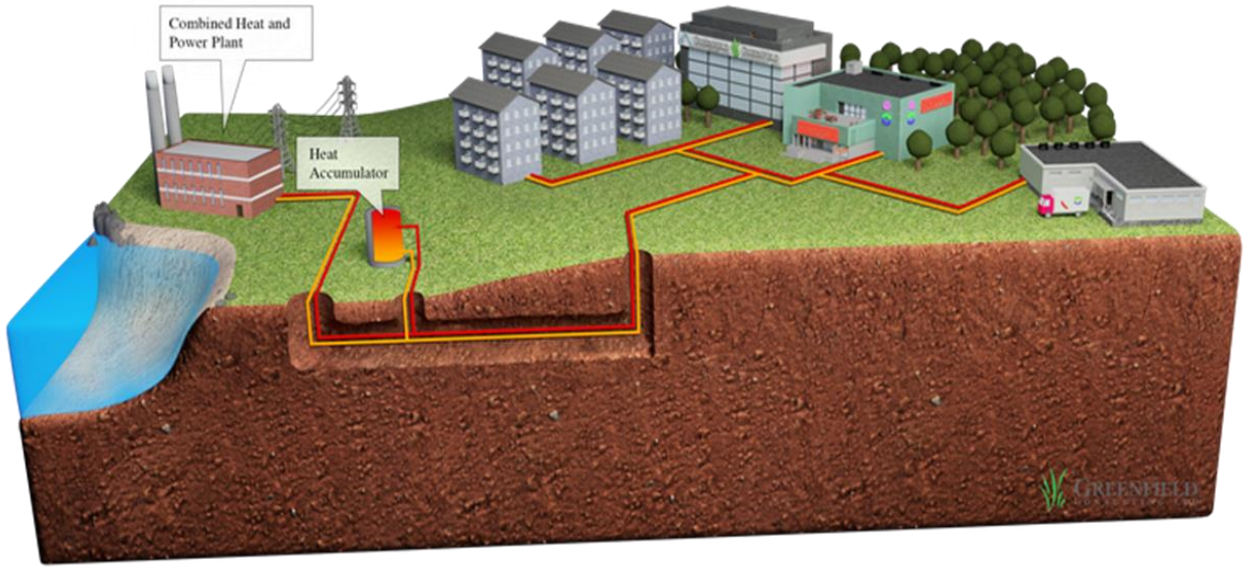
DISTRICT HEATING
VS
SHARED GROUND LOOP ARRAYS

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

Drawbacks:

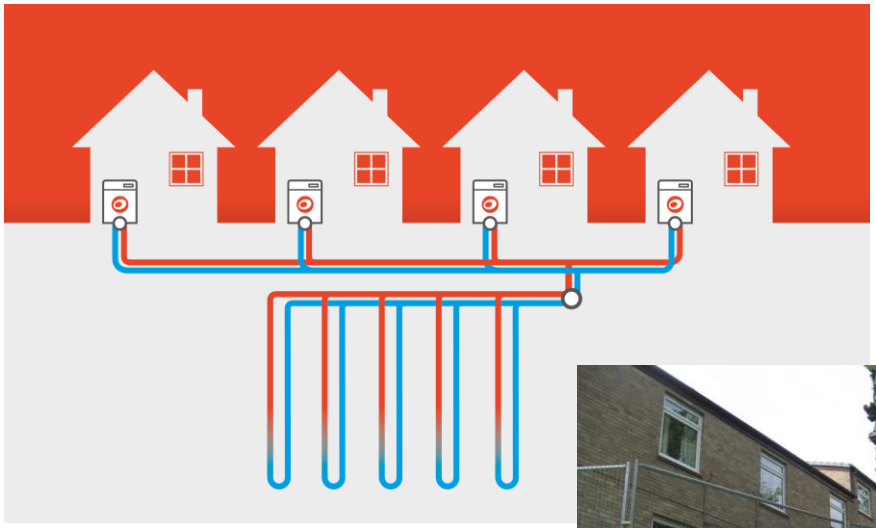
- Heat loss through network
- Overheating in risers & corridors
- Networked heat metering
- Requires split-billing
- Single heat energy provider
- Complex funding claims
- Large & unsightly central plant
- ESCO purchases energy
- Highly specialised servicing
- Back up system required



Shared ground loop arrays are a form of ultra-low temperature heat network connecting Kensa ground source heat pumps inside individual dwellings.

A different approach:

- Link as few as two properties
- Infinitely scalable for large developments
- Suitable for single and multiple occupancy dwellings
- Communal ground array pipework
- Individual heat pump in each dwelling
- Mimics a traditional gas framework

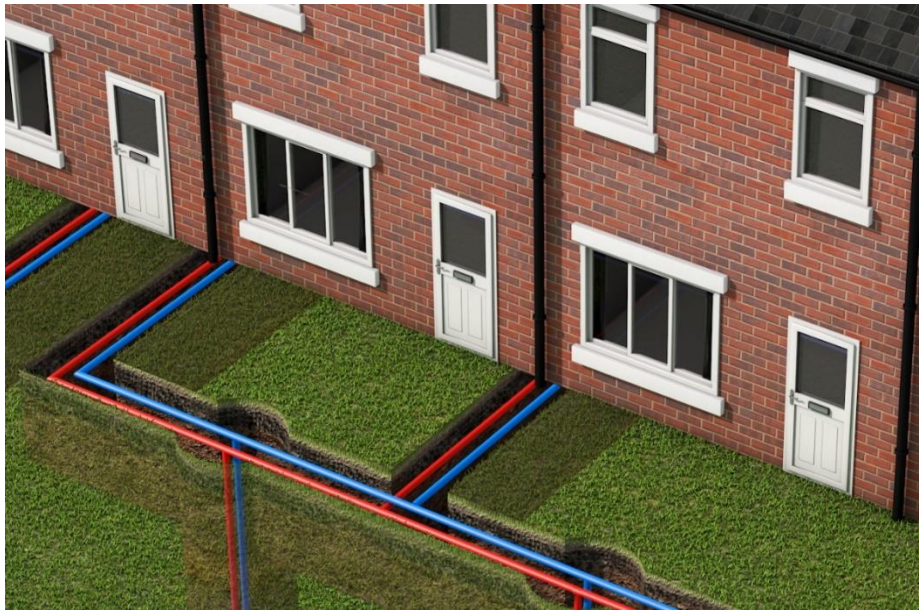


https://www.kensaheatpumps.com/the-technology/heat-sources-collectors/shared-ground-loop-arrays/

TERRACED HOUSING AND FLATS

SGLA BENEFITS

- Scalable and flexible solution
- Ambient temperature distribution
- No district heat losses and no overheating
- Potential for free summer cooling
- Individual heat pump in each dwelling
- Powered from occupants own electricity supply
- Householders able to switch energy suppliers
- Lowest running costs
- Independent billing and independent heat
- Eligible for 20 years payback from the Non Domestic RHI
- Split ownership permitted
- Ground arrays 100> year lifetime
- Planning exempt



KENSA'S SHOEBOX HEAT PUMP

A perfect fit for Shared Ground Loop Arrays:

- 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

https://www.kensaheatpumps.com/ground-source-heat-pump-products-services/shoebox-ground-source-heat-pump/

For developments with multiple properties, vertical boreholes are typically used to extract heat energy and are linked together to form the shared ground array.

- Closed loop pipework in vertical hole
- Dependant on site geology
- Requires specialist installation
- Typically 100-150m deep
- Gives 30-60 Watts per metre
- Space efficient and quick
- More expensive than slinkies or water
- Economies of scale can be realised
- >100 year borehole life expectancy

https://www.kensaheatpumps.com/district-ground-source-heat-pumps-installation-in-tower-blocks

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 RHI & ECO grant funding applications
- warranty & after sales support

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

GSHPs & HOUSEBUILDERS

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

COMPARISON TO OTHER TECHNOLOGIES

Technology	Carbon Intensity of Fuel ($kgCO_2e/kWh$)*	System efficiency	Carbon Intensity of Heat ($kgCO_2e/kWh$)	Annual Carbon Emissions ($kgCO_2e$) 10,000kWh annual heat demand
GSHP	0.233	300%	0.078	777
ASHP	0.233	230%	0.101	1013
Oil Boiler	0.298	85%	0.351	3506
LPG Boiler	0.241	85%	0.284	2835
Night Storage Heaters	0.233	100%	0.233	2330
Mains Gas Boiler	0.210	85%	0.247	2471

*Source – SAP10.0 (24/07/18)

THE APPEAL OF HEAT PUMPS

GSHP's & HOUSEBUILDERS

- Contributes towards lowest cost & lowest CO2 compliance strategy
- Heat pumps may be supplied at no cost to the house builder dependent upon emerging business models
- System architecture is scalable and can be installed as and when required
- No additional planning permission required
- Installation does not impact the appearance of the property
- Mimics traditional gas boiler arrangements – appliance producing hot water, cylinder, controls

GSHPs & HOUSEHOLDERS

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

Technology	Fuel Cost per unit	Fuel Units	kWh/unit	Efficiency	Fuel cost per kWh	Annual Running Costs (10,000kWh demand)	Annual Standing Charge	Annual Servicing	Total annual costs
GSHP	15p	kWh	1	350%	4.3p	£429	£90	£0	£519
ASHP	15p	kWh	1	250%	6.0p	£600	£0	£0	£600
Oil Boiler	45p	Litres	9.8	85%	5.4p	£540	£0	£150	£690
LPG Boiler	40p	Litres	6.6	85%	7.1p	£713	£0	£140	£853
Night Storage Heaters	9p	kWh	1	100%	9.0p	£900	£0	£0	£900
Mains Gas Boiler	4p	kWh	1	85%	4.7p	£470	£95	£120	£590

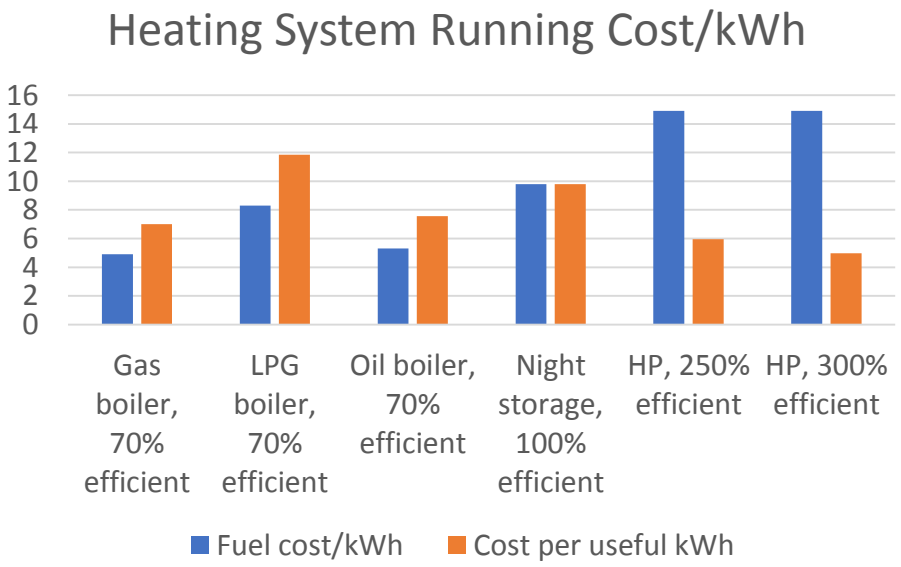
- Distribution system sized to 45°C flow temperature
- Radiators oversized
- Timeclock
- Central thermostat
- TRV on radiators
- Hot water priority
- 60°C stored hot water
- Local hot water cylinder

Ground Source Benefits

Ground source heat pump benefits

- Lowest possible tenant heating and hot water energy costs
- Estimated 30% running cost saving
- Improvement in Comfort and Control
- Minimal service and maintenance costs
- 20 – 25 year heat pump unit life expectancy
- >100 year borehole life expectancy
- Extremely low lifetime ownership costs

Running cost benefits



TENANT TESTIMONIALS

“We were spending £70 per week before on electric, we have now knocked that down by just over half, so it's a big difference and the house is really warm now.

“The system is very easy to use, simple, it's not hard at all, anyone could do it.”

"I've lived with many heating systems, coal, oil, gas, storage heaters, but ground source has to be my favourite, it provides a nice, gentle, constant heat that keep my home really comfortable."

“Night storage heating was extremely dear, especially given that you didn’t get any heat after tea time.

“I’ve been writing down how much money I’ve been putting in since the heat pump installation, I reckon I’m saving between 35-40% to what I was putting in before.”

SUBSIDY SUPPORT

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

FUNDING IN SCOTLAND 

- **Low Carbon Infrastructure Transition Programme:** provides a range of support, from expert advice to financial support to assist the development and delivery of private, public and community low-carbon projects in Scotland. Currently open to applications deadline 25th October 2019.
- **District Heating Loan Fund:** open to local authorities, registered social landlords, small and medium sized enterprises and energy services companies [ESCOs] with less than 250 employees. Loans available up to £1M at 3.5% over 15 years.
- **Energy Investment Fund (EIF):** £20M towards accelerating the development of commercial low carbon energy projects in Scotland. Delivered by SIB.
- **Warm Home Fund:** £150m designed to support local authorities, registered social landlords and other organisations working in partnership with them, to address some of the issues affecting fuel poor households.
- **Ofgem Energy Redress Fund:** Grant funding to support innovation in protecting vulnerable energy consumers
- **CARES:** Several grant & loan options available for the development of local energy projects

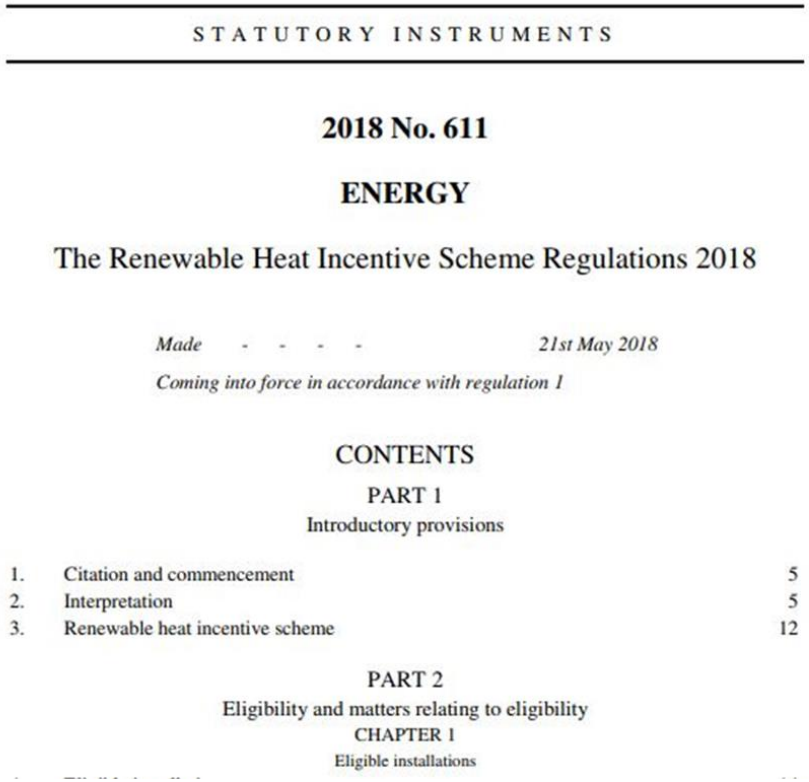
WHY NOW? CHANGES TO RHI

SUBSIDY SUPPORT

- RHI regulations were refined in February 2018 with the intent of increasing ground source heat pump deployment

- RHI based on the Energy Performance Certificate (EPC)
  - No heat meters
  - Payments based on deeming
  - No occupant effects
  - Predictable quarterly income
  - Index linked CPI
  - Simple RHI admin

- Introduction of Assignment of Rights enabling split ownership
  - Mimics gas network
  - Simplified house purchase
  - Stable asset for funders



STATUTORY INSTRUMENTS

2018 No. 611

ENERGY

The Renewable Heat Incentive Scheme Regulations 2018

Made - - - - 21st May 2018

Coming into force in accordance with regulation 1

CONTENTS

PART 1

Introductory provisions

PART 2

Eligibility and matters relating to eligibility

CHAPTER 1

Eligible installations

Kensa Contracting
A KENSA GROUP COMPANY

SGLA COSTED EXAMPLES

Kensa Contracting
A KENSA GROUP COMPANY

The UK's leading ground source heat pump manufacturer and installation contractor

KINLET, SRHA – NEW BUILD HOUSES

In brief:

- Small new development of 8 houses
- Off the mains gas network
- 3 x communal borehole arrays

- Kensa carried out all works up to the heat pump location
- The developer's M&E contractor carried out all internal works
- Kensa provided MCS accreditation

- Properties averaged a running cost of £33 per month
- 20%-30% lower than a fossil fuel alternative
- SRHA claimed £2,836 in RHI income over the first two quarters of heat pump operation
- Over the 20 year income stream, the cost of installation will be fully recovered

"The delivery of affordable warmth is important to Shropshire Rural. Given that the majority of our housing stock doesn't have access to mains gas, Kensa's GSHP solution is proving to be very helpful.

We now have more than a third of our homes now getting their heat and domestic hot water in this way; whether through retrofitting or by incorporating the ground source heat pump into new homes."

- Ian Richardson, SRHA

In brief:

- New build, phased installation
- 27 flats, 9 houses
- Each dwelling has its own Kensa Shoebox heat pump
- Heat pump and cylinder fit in airing cupboards
- 4 shared ground loop arrays
- 17 boreholes, 95-130m deep
- £146,000 ground array cost
- £368,000 RHI return
- 13.7 tCO_2 saving/yr
- Running costs for residents reduced from £900/yr to £350/yr

Shared Ground Loop Array System Based on average property for completed scheme	
Lifetime CO_2 savings	83 tonnes
Typical annual running cost saving vs NSH	£352
Total capital cost (exc. VAT)	£13,540
Heat pump, cylinder, metering and ancillaries	£4,530
Boreholes and ground collector system	£4,820
New radiator system supply and install	£3,900
Design and project management	£290
Existing system replacement costs (fuel switch)	£8,000
ECO funding contribution	£1,356
Total additional cost	£4,184
Total RHI contribution	£14,077
Payback period	7 years

In brief:

22 flats and 1 site office

Previously heated by electric NSH

Hanover Housing Association

In brief:

- Retrofit project
- 402 flats
- 8 tower blocks, 13 storey
- 96 boreholes
- 212m typical borehole depth
- £4.6 million project
- £4.3 million RHI return
- 773 tCO_2 saving/yr
- Running costs for residents reduced from £900/yr to £350/yr
- https://www.kensaheatpumps.com/kensa-contracting-engie-enfield-council-win-at-the-hv-news-awards-2019/

In brief:

- Northumberland County Council – Stakeford Depot
- Offices, vehicle servicing, signwriting
- Replace existing gas boiler
- Trend BMS Control
- 5 x 75kW Kensa Plantroom Heat Pump
- 1 x 6kW Kensa Shoebox for hot water
- 42 boreholes to 157m
- £650k retrofit all-in price
- £841k RHI income over 20 years
- £175k Running cost savings over 20 years

SGLA PROJECT OVERVIEW

ENGIE & Enfield Council

The UK's leading ground source heat pump manufacturer and installation contractor

In brief:

- Client: Enfield Council
- Principal Contractor: **ENGIE**
- Specialist subcontractor: **Kensa**
- England's largest shared loop district GHSP system
- Eight tower blocks – up to 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**
- Total contract value: **£7.3m**

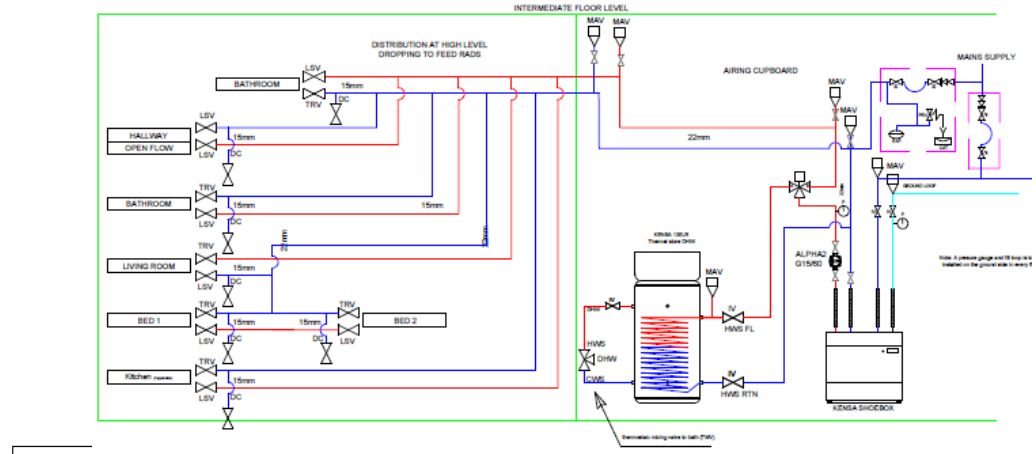
GREATER LONDON ENERGY EFFICIENCY REGIONAL AWARDS 2018 LARGE SCALE PROJECT WINNER

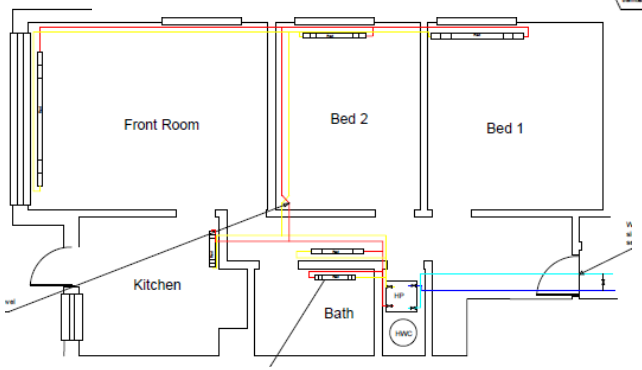
1. Tenant liaison

- Resident 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

2. Survey and Design

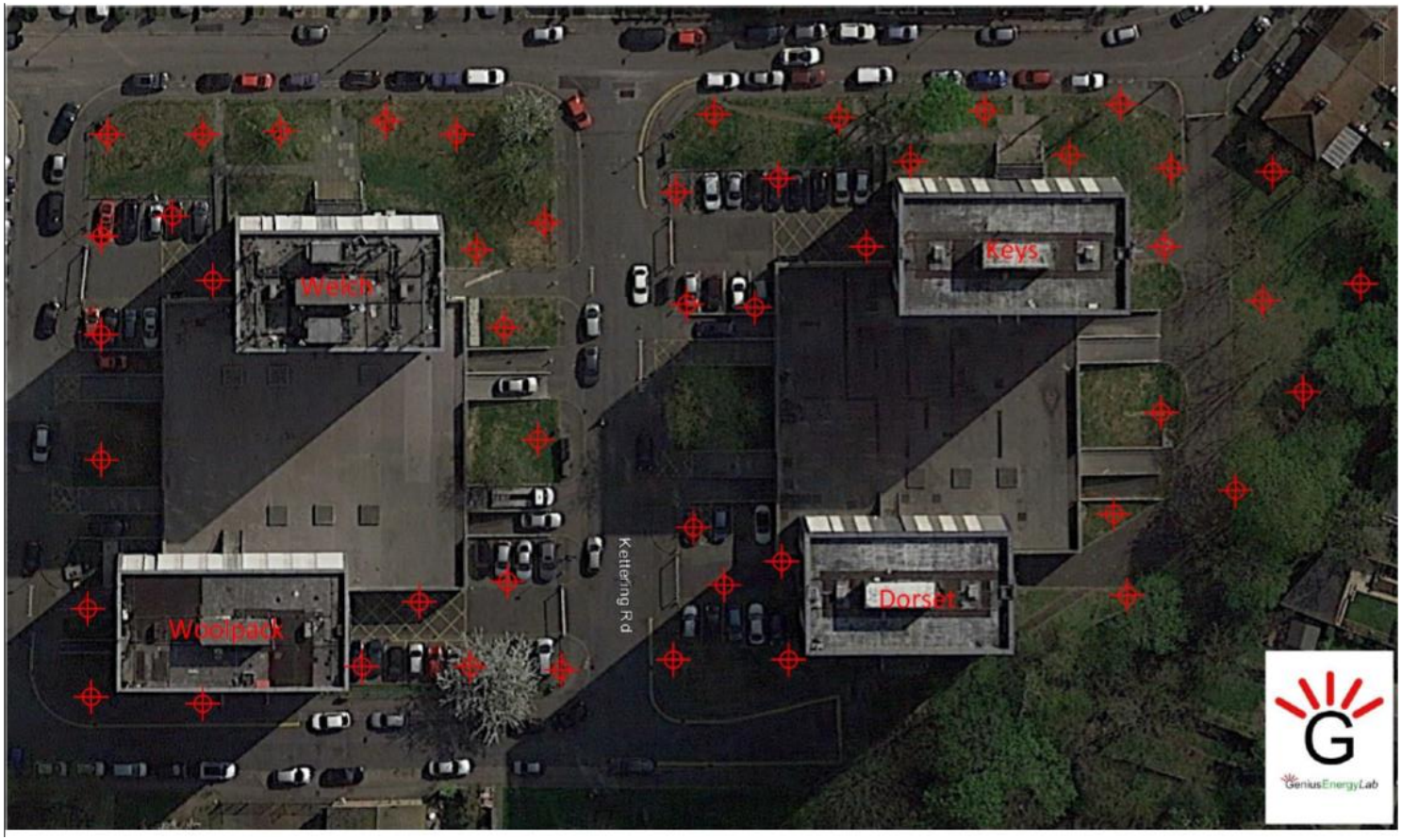
- Detailed property surveys to establish heat loads for accurate heat pump sizing and radiator sizing
- Borehole design was a combination of desktop analysis and on-site Thermal Response Test
- Risers designed to ensure no requirement for central circulation pumps
- Surveys carried out to locate all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





3. Borehole drilling

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


Welch
Keys
Woolpack
Dorset
Kettering Rd
GeniusEnergyLab

4. 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

5. 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
- Will all be boxed in once completed
- All work approved by Enfield Council's fire safety team

6. 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

7. Key outcomes

- £4.3 million RHI return
- ECO funding obtained for client
- 773 tCO_2 saving/yr
- Running costs for residents reduced from £900/yr to £350/yr
- Significant reduction in maintenance costs for Enfield Council

CONCLUSIONS

Conclusions

- The technology is well developed and has been deployed at scale
- Government funding for shared ground loop heat pumps is in place to stimulate significant growth
- Investment returns on shared ground loops are attractive both in return rates and potential volumes
- 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
- GHSPs are the long term future solution for new build and retrofit. In the short term, the RHI offers a unique opportunity to developers.

CONTACT DETAILS

Matthew Black | Sales & Business Development - Scotland

| 07984 274164 | matthew.black@thekensagroup.com |

www.kensaheatpumps.com

www.kensacontracting.com

Accreditations