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EXPLORING THE DEPLOYMENT OF SHARED GROUND HEAT EXCHANGE

DR FRIN BALE, SCHOOL OF EARTH & ENVIRONMENT / SCHOOL OF CHEMICAL & PROCESS ENGINEERING, UNIVERSITY OF LEEDS

STAKEHOLDER WORKSHOP
16 FEBRUARY 2022

INTRODUCTION TO THE RESEARCH TEAM

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- Frin Bale (UoL)
- David Barns (UoL)
- Josh Turner (UoL)
- Saleh Meibodi (UoL)
- Sumedha Basu (UoL)
- Fleur Loveridge (UoL)
- Simon Rees (UoL)
- Martin Fletcher (Leeds Beckett)

- Contributions from Bill Kirkup and Denny Gray (CAG consultants)
- Support from Policy Leeds

HOW THIS EVENT WILL WORK!

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- Hybrid event
- Chatham house rules
- Consent
- Miro boards and post-it notes

Aim for today: Capture practitioner perspectives of SGHE to contribute to policy development

AGENDA

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13:00 – 13:05	Welcome and introduction
13:05 – 13:30	Overview of technology and research • Benefits and challenges
13:30 – 14:15	Breakout session 1: • Technical & design • Local implementation
14:15 – 14:45	Break and policy mapping activity
14:45 – 15:30	Breakout session 2: • Business models • National policy & design • Users (online)
15:30 – 16:00	Wrap-up • What have we missed? • Next steps
16:00	Close

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BACKGROUND TO SHARED GROUND HEAT EXCHANGE

TECHNOLOGY SPECIFICS, BENEFITS & CHALLENGES, POLICY LANDSCAPE

DAVID BARNS, SCHOOL OF EARTH & ENVIRONMENT, UNIVERSITY OF LEEDS

PROJECT OVERVIEW

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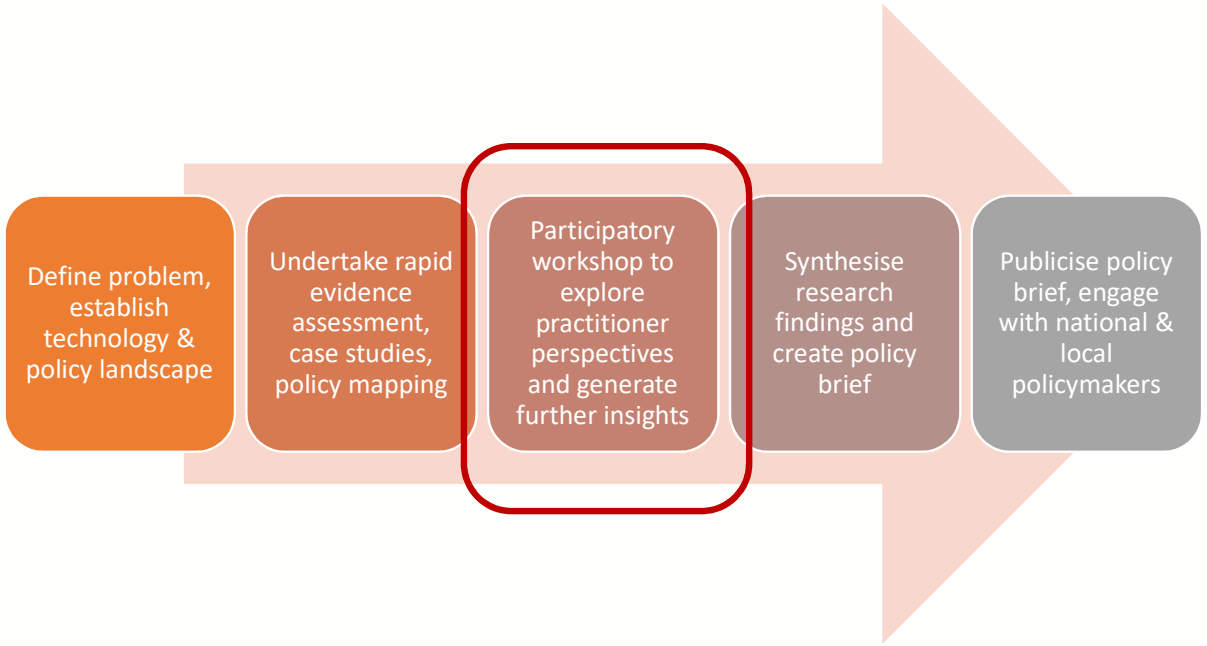
- Timeframe: December 21 – March 22
- Team: University of Leeds, Leeds Beckett University
- Research approach:
  - Rapid evidence assessment
  - Case studies
  - Policy mapping
  - Stakeholder perspectives
- Areas of focus
  - Benefits and challenges
  - Technical and design
  - Business models (who installs, owns and manages the system? e.g. utility model)
  - Users / consumer protection
  - National policy and regulation
  - Local implementation



WHAT IS SHARED GROUND HEAT EXCHANGE?

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- Working definition
  - *'Systems which comprise distributed heat pumps using ground-sourced heat and a low temperature heat network that serves more than one household'*
- Electrified heating to many properties from a shared ground heat exchanger
  - Ground heat exchanger provides thermal storage
  - Summer heat stored for winter use
- Distributed heat pumps combined with ambient temperature network
  - Shared heat (& cold) to multiple dwellings
  - Each dwelling has own heat pump
  - Free-floating temperature / uninsulated pipes
- Also known as 'shared ground loops', 'ambient heat networks', 'fifth generation district heating and cooling', and many more…

SHARED GROUND HEAT EXCHANGE CASE STUDIES

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Enfield, London

Largest shared ground heat array in England with 400 flats retrofitted with Shoebox heat pumps

Courtesy of Kensa Contracting

Project highlights

- **Largest district ground source system in England**
- **Residents select own energy provider and choose the best tariff for them**
- **Project completed in under one year with residents remaining in their homes throughout**

Project details

A pioneering scheme in urban shared ground heat exchange development. The London Borough of Enfield wanted to replace obsolete electric heating for local authority tenants and leaseholders.

In designing the system, Kensa split the installation into 16 "micro-districts" each supplying half a tower block, simplifying project logistics and allowing for parallel workflows, reduced timescales and disruption to tenants.

The project expects to save 773tCO_2 per year, and it is understood that tenants have saved £450–£700 per year in heating and hot water costs, giving nearly £9 million in collective lifetime bill savings over the nominal 40-year system lifetime.

To facilitate the works, the primary contractor set up a site office in the basement of the tower blocks for staff facilities and a resident meeting and respite area for when work was taking place in their dwelling. Leaseholders were charged a discounted rate to connect to the system, taking into account income to landlord of RHI for 20 years.

Key project information

Setting:	Urban
Type of properties:	Residential, high-rise blocks
No. of dwellings:	400
No. of buildings:	8
Type of project:	Retrofit
Tenancy type:	Social & leasehold
Project developer:	London Borough of Enfield
Installer	ENGIE / Kensa Contracting
Heat pump:	Kensa Shoebox 3/6 kW
Ground heat exchangers	128 boreholes in 16 clusters of 8
Total project size	1.8MW (est.)
Previous heating system	Electric heating

Courtesy of Kensa Contracting

References & further information

https://www.kensaheatpumps.com/englands-largest-district-ground-source-system-breaks-new-ground/

https://www.kensacontracting.com/englands-most-innovative-district-ground-source-system-wins-industry-oscar/

Barns, D. 2022. Unlocking the potential for thermal energy storage in the UK (PhD thesis)

Policy Leeds

Bromford, Shropshire

Replacement of electric night storage heaters with communal ground array in off-gas rural site

Courtesy of Kensa Contracting

Project highlights

- **Individual Kensa 6kW shoebox heat pumps installed in every bungalow**
- **Sited in airing cupboards along with new hot water tank**
- **Residents expected to save £300-£350 per year on heating bills**

Project details

Bromford Housing Association worked with Kensa Contracting to provide lower-cost, lower carbon heating and hot water to residents. The system features remote monitoring by the social landlord, with tenants able to make minor adjustments.

Nigel Gosling, Senior Contracts Manager, Bromford Housing Association said:

"The installation was very positive for our first experience of GSHP, and we would be confident to look at further installs through Kensa. The set up was well organised and coordinated. The pre and during works information provided to us and the customers was first class, and the use of known heating installers helped all works run to plan."

Feedback from residents:
"I'm now spending less on my whole house heating as I was on one electric heater previously!"
"The heating is great, comes on when I want it."

Following positive feedback from residents, Bromford Housing Association has since undertaken further projects with Kensa at sites in Gloucestershire to further upgrade their social housing stock and improve resident comfort.

Key project information

Setting:	Rural
Type of properties:	Residential, bungalows
No. of dwellings:	16
Type of project:	Retrofit
Tenancy type:	Social
Project developer:	Bromford Housing Association
Installer	Kensa Contracting
Heat pump:	Kensa Shoebox 6kW Twin
Ground heat exchangers	8 boreholes
Total project size	96kW (est.)
Previous heating system	Electric night storage heaters

Courtesy of Kensa Contracting

References & further information

https://www.kensacontracting.com/ground-source-review-bromford-housing-association/

https://www.kensacontracting.com/ground-source-review-bromford-phase-two/

Policy Leeds

Daisyfield Towers, Blackburn

Innovative scheme to retrofit shared ground heat exchange systems to three tower blocks in built-up urban area, trialing space-saving medium-depth boreholes in largest scheme of its kind in the UK

Courtesy of Kensa Contracting

Project highlights

- **Estimated lifetime carbon savings of 6,556 tonnes of CO_2**
- **Installation carried out in conjunction with electrical works and sprinkler system**
- **Residents remained in homes throughout installation**
- **Innovative medium-depth (up to 300m) boreholes drilled underneath green spaces adjacent car parks**

Project details

Together Housing and Kensa Contracting have been working together since 2018 on a programme of retrofitting shared ground heat exchange systems to existing dwellings across their housing portfolio.

In this scheme, obsolete gas boilers were removed and replaced with Kensa's individual in-dwelling heat pumps linked to a shared ground array as part of a £4.6m improvement programme including electrical upgrades and a new sprinkler system.

Due to the highly congested urban location, Kensa worked with specialist designers and drilling experts to trial 300m depth boreholes to reduce the number of boreholes required.

The scheme serves 183 properties as well as communal areas and a ground floor café and is expected to produce a lifetime CO_2 saving of 6,556 tonnes whilst saving residents money.

Key project information

Setting	Urban
Type of properties	Residential, high-rise blocks
No. of buildings	3
No. of dwellings	183
Type of project	Retrofit
Tenancy type	Social tenants
Project developer	Together Housing
Installer	Kensa Contracting, Genius Energy Lab, Geodrill
Heat pump	Kensa Shoebox 3/6kW
Thermal storage	Included, type unknown
Ground heat exchangers	84 boreholes, 300m depth
Total project size	820kW (est.)
Previous heating system	Individual gas boilers

References & further information

https://www.kensacontracting.com/together-housing-daisyfield/

https://www.procure-plus.com/wp-content/uploads/2020/12/PP-Together-HPCY-V3.pdf

WHY CHOOSE SHARED GROUND HEAT EXCHANGE?

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- Compared to gas boilers
  - Electrified systems become lower carbon over time as the grid decarbonises
  - Connects heat and electricity sectors to support grid balancing and renewables
  - Can provide both heating and cooling
- Compared to direct electric heating
  - Higher efficiency – heat pumps deliver 3-5 units of heat for each unit of electricity
  - Lower grid impacts and competition with other electrification requirements
- Compared to individual heat pumps
  - Can serve multiple households from shared ground array, shared waste heat supply etc.
  - Applicable to settings where individual heat pumps are not viable – space, appearance, etc.
  - Demand diversity and impact on sizing

WHY CHOOSE SHARED GROUND HEAT EXCHANGE?

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- Compared to traditional (high temperature) district heating
  - Not subject to energy losses of traditional DH (and subsequent overheating of dwellings)
  - Resident can choose their own energy (electricity) provider
  - Operator does not have to take on complexity of heat metering & billing
  - Can deal with low occupancy levels
  - Distributed heat pumps mean resident has more control over their heating
  - Can potentially simulate a utility model where residents can choose to connect or not as they wish

CHALLENGES TO SHARED GROUND HEAT EXCHANGE DEPLOYMENT

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- Novelty
  - Very few suppliers, with near monopoly market status and low levels of awareness
  - Absence of guidelines and standards, knowledge held by a few companies
  - High capital costs due to complexity, novelty and increased pipe sizes
  - No 'ideal' business model for system designers, installers, operators
- Technology & design
  - User acceptance of different type of technology & operation
  - Work most efficiently in well-insulated properties
  - Need for in-dwelling thermal storage?
  - Complexity in terms of planning, designing and controlling systems
- National policy and regulation
  - Electrified approach means users suffer from 'spark gap'
  - Heat is not a statutory utility, developers don't have the right to dig up street
  - Lack of regulation in heat sector (up to now) means customers can suffer
  - Policy appears to focus on micro and large scale and may miss out 'meso' scale approaches like SGHE
- Local implementation
  - Developer default moving from gas boilers to direct electric heating
  - SGHE very context and user sensitive which runs counter to national / centralised decision-making

POLICY CONTEXT

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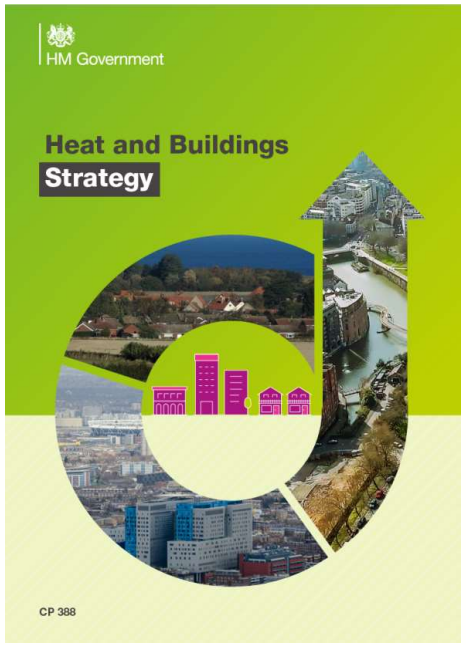
- Heat & Buildings Strategy released Oct 2021, part of wider Net Zero Strategy
- New heating systems to be net zero compatible (i.e. gas boilers phased out) from 2035 (new properties 2025)
- Decision around future of gas grid by 2026
- Focus on options
  1. Heat pumps (i.e. individual, low density settings), 600,000 pa 2028
  2. Heat networks (city-scale, high density settings), no target, focus on e.g. zoning
  3. Hydrogen, lots of trials
- SGHE falls between 1-2, risk of technology being overlooked on national and local level?



HEAT NETWORK ZONING

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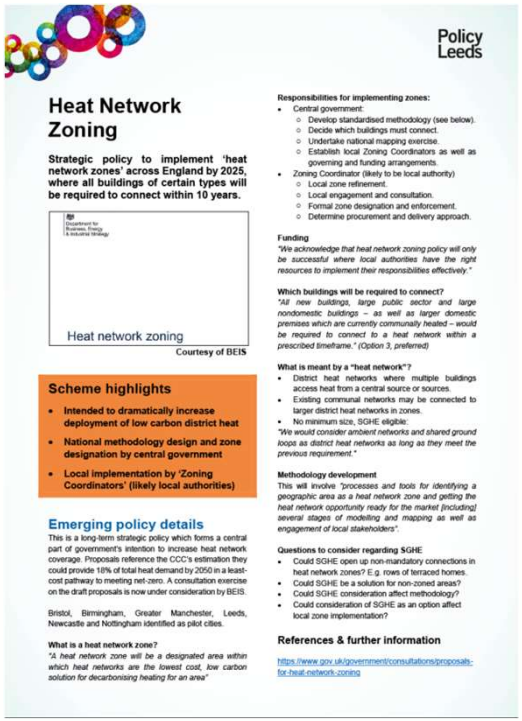
- Applicable to England only, to be in place by 2025, consultation closed 19/11/21
  - Scotland legislation passed 2021
- What is a heat network zone?
  - *"a designated area within which heat networks are the lowest cost, low carbon solution for decarbonising heating"*
- Which buildings will be required to connect? Option 3 (high ambition) preferred
  - *"All new buildings, large public sector and large nondomestic buildings – as well as larger domestic premises which are currently communally heated – would be required to connect to a heat network within a prescribed timeframe."* (10 years)
- Residential premises without communal not required to connect
- What do they mean by heat networks?
  - Distribute heat to multiple buildings from a central source or sources
  - Communal when connected to wider networks
  - No minimum size, SGHE eligible as long as those conditions are met
- Role of central government:
  - Develop standardised methodology, decide which buildings must connect
  - National mapping exercise, appoint Zoning Coordinators
- Role of local authorities as Zoning Coordinator
  - Local zone refinement and formal designation
  - Determine procurement and delivery approach



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Heat Network Zoning

Strategic policy to implement 'heat network zones' across England by 2025, where all buildings of certain types will be required to connect within 10 years.

Heat network zoning

Courtesy of BEIS

Scheme highlights

- **Intended to dramatically increase deployment of low carbon district heat**
- **National methodology design and zone designation by central government**
- **Local implementation by 'Zoning Coordinators' (likely local authorities)**

Emerging policy details

This is a long-term strategic policy which forms a central part of government's intention to increase heat network coverage. Proposals reference the CCC's estimation they could provide 18% of total heat demand by 2050 in a least-cost pathway to meeting net-zero. A consultation exercise on the draft proposals is now under consideration by BEIS.

Bristol, Birmingham, Greater Manchester, Leeds, Newcastle and Nottingham identified as pilot cities.

What is a heat network zone?

"A heat network zone will be a designated area within which heat networks are the lowest cost, low carbon solution for decarbonising heating for an area"

Responsibilities for implementing zones:

- Central government:
  - Develop standardised methodology (see below).
  - Decide which buildings must connect.
  - Undertake national mapping exercise.
  - Establish local Zoning Coordinators as well as governing and funding arrangements.
- Zoning Coordinator (likely to be local authority)
  - Local zone refinement.
  - Local engagement and consultation.
  - Formal zone designation and enforcement.
  - Determine procurement and delivery approach.

Funding

"We acknowledge that heat network zoning policy will only be successful where local authorities have the right resources to implement their responsibilities effectively."

Which buildings will be required to connect?

"All new buildings, large public sector and large nondomestic buildings – as well as larger domestic premises which are currently communally heated – would be required to connect to a heat network within a prescribed timeframe." (Option 3, preferred)

What is meant by a "heat network"?

- District heat networks where multiple buildings access heat from a central source or sources.
- Existing communal networks may be connected to larger district heat networks in zones.
- No minimum size, SGHE eligible.

"We would consider ambient networks and shared ground loops as district heat networks as long as they meet the previous requirement."

Methodology development

This will involve *"processes and tools for identifying a geographic area as a heat network zone and getting the heat network opportunity ready for the market [including] several stages of modelling and mapping as well as engagement of local stakeholders".*

Questions to consider regarding SGHE

- Could SGHE open up non-mandatory connections in heat network zones? E.g. rows of terraced homes.
- Could SGHE be a solution for non-zoned areas?
- Could SGHE consideration affect methodology?
- Could consideration of SGHE as an option affect local zone implementation?

References & further information

https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning

POLICY MAPPING – 6 FUNDING STREAMS EXPLORED

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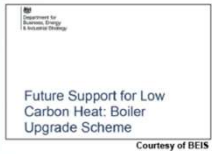
Boiler Upgrade Scheme

Capital grants for households and businesses to replace fossil fuel heating with low carbon alternatives.



Courtesy of BEIS

Scheme highlights

- **Heat pumps have priority with £5,000 per ASHP and £6,000 per GSHP**
- **Open to domestic and non-domestic installations**
- **Scheme to open Apr 2022**
- **Small SGHE systems eligible**

Scheme details

This successor scheme to the Renewable Heat Incentive (and formerly known as Clean Heat Grant) will provide capital grants to households and businesses towards the capital and installation cost of low carbon heating.

Ofgem have been appointed to manage the delivery of the scheme which will be open to the property owner or can be carried out with owner's consent.

It will be operated via a voucher scheme with the two-stage claim process now planned to be installer-led with customer approval. Contractors must be MCS accredited and member of consumer code.

Property eligibility

- Domestic & non-domestic properties.
- Excluding social housing and new build (aside from self-build).
- Currently heated by fossil fuel or direct electric.
- Hold a valid EPC with either:
  - no recommendation to install loft or cavity insulation, or
  - this is to be done during installation process, or
  - exemption e.g. due to listed status.

"We understand that there may be non-social housing projects where the installation of a shared ground loop system may be desirable. These will be eligible for support under the Boiler Upgrade Scheme up to a total system capacity of 45 kWth"

Technology eligibility & funding

- ASHPs - £5,000.
- GSHPs - £6,000.
- SGHE (up to around 10 properties) - £6,000 per HP.
- Biomass boilers (rural, off-grid locations, not suitable for heat pump) - £5,000.
- Technology must be able to meet full heating and hot water needs of property, but can be combined with supplementary heating e.g. electric immersion.

Recognising that the grant will not cover all costs, government expects the scheme to work alongside the current Green Home Finance Innovation Fund and Green Home Finance Accelerator programme to launch in 2022 to encourage development of innovative financial models.

Key scheme information

Scheme value	**£450m**
Applicable to	**England & Wales**
Applicant eligibility	**Domestic and non-domestic customers**
Grant to be claimed by	**MCS accredited installer**
Technology eligibility	**ASHPs, GSHPs, SGHE, biomass boilers (rural)**
Heat pump efficiency	**Minimum SCOP 2.8**
Cost eligibility	**£5,000-£6,000 per property**
SGHE eligible	**Yes, up to 45kWth**

References & further information

https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat

https://www.ofgem.gov.uk/environmental-and-social-schemes/boiler-upgrade-scheme-bus

Policy Leeds

Social Housing Decarbonisation Fund

£800m fund targeted at reducing carbon emissions and tackling fuel poverty in social housing.

Courtesy of BEIS

Scheme highlights

- **Fabric-first approach, with shared ground heat exchange recognised as eligible technology**
- **Wave 1 (£160m) closed; Wave 2 expected in 2022/23 financial year**
- **No minimum or maximum bid size, but applications to treat large number of properties encouraged**

Scheme details

This funding mechanism is aimed at social housing landlords including local authorities and Registered Providers. It is intended to tackle fuel poverty, reduce carbon, and improve comfort, health and well-being.

If Wave 2 operates along similar principles to Wave 1, bids can be made by consortia of local authorities and RPs but must be led by local or combined authorities.

Property / tenure eligibility

- Social housing EPC E-G (or D if not possible).
- Mixed tenure but 70%+ social, apply for infill funding, leaseholders pay 1/3 (£3,300 max), low income fully funded, whole-block approach may be justified.

Costs

- No minimum or maximum size/value of application.
- Landlord to provide 1/3 of costs.
- Maximum per-dwelling funding: EPC D = £10k, EPC E = £12k, EPC F/G = £16k.

Technology / approach

- Fabric-first (target to achieve 90 kWh/m² per year).
- Then heating technology which reduces cost (inc. heat pumps, high retention night storage heaters, biomass in exceptional circumstances).

A BEIS workshop for social housing providers to input into Wave 2 is to be held on 17 Feb 2022, and support to help bid development is provided by the Social Housing Retrofit Accelerator (see links below).

Key scheme information

Total scheme value	**£800m, 3 years from 2022**
Applicable to	**England only**
Funding type	**Capital grant**
Organisation eligibility	**Local authorities, RPs**
Bids submitted by	**Local authorities**
Property eligibility	**Social housing, EPC D or below, preferably F-G**
Resident eligibility	**Social tenants & low-income leaseholders**
Approach	**Fabric-first**
SGHE eligible	**Yes, following fabric measures**

References & further information

https://www.gov.uk/government/publications/social-housing-decarbonisation-fund

https://www.gov.uk/government/publications/social-housing-decarbonisation-fund-wave-1-successful-bids

https://www.housing.org.uk/news-and-blogs/news/social-housing-decarbonisation-fund-wave-2-beis-social-housing-workshop/

https://www.socialhousingretrofit.org.uk/

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Green Heat Network Fund

Capital grants to support development of low and zero carbon heat networks.

Courtesy of BEIS

Scheme highlights

- **Grant funding to cover costs developing low carbon heat networks**
- **Open to public, private and third sector**
- **Transition scheme closed Oct 21; full scheme expected Apr 2022**

Scheme details

This successor scheme to the Heat Network Investment Project (HNIP) aims to build a pipeline of low carbon heat network projects through 11 funding rounds from Apr 22 – Sept 24.

Applications can be made by any type of organisation, and for new or existing heat networks which meet a set of 'gated metrics', primarily carbon reduction.

A distinction is made between eligible ambient loops ("centrally managed", 2GWh+) and non-eligible shared ground loops (two or more heat pumps with not more than one heat pump in a dwelling). However, SGL eligible *"when they form part of either aggregated communal networks or rural heat networks"*.

Costs

- (Transition phase) Commercialisation costs e.g. contract & procurement.
- (Full phase) Construction phase costs – up to 50% of total CAPEX inc. commercialisation costs.
- Maximum award of 4.5p per kWh of heat delivered to customers over first 15 years of operation (£1.35m for 2GWh/yr system).

Gated metrics

- Max 100gCO$_2$e/kWh thermal energy delivered.
- Price of heat to customers lower than fossil counterfactual (existing buildings) or low carbon counterfactual (new buildings).
- Social IRR 3.5%+ over 40 years.
- Urban networks: minimum customer demand 2GWh/yr (roughly 130 homes).
- Rural networks: minimum 100 homes.

Aggregation requirements

- When part of heat decarbonisation strategy for Local Energy Hub region / local heat mapping masterplan.
- Systems designed to enable future connection to wider network.

Key scheme information

Scheme value	**£270m**
Applicable to	**England & Wales**
Organisation eligibility	**Public, private, third sector**
Bids submitted by	**Heat network developer / operator**
Technology eligibility	**Various inc. waste heat, heat pumps, deep geothermal, solar thermal**
Network eligibility	**Min. 2GWh/yr (urban), 100 homes (rural)**
Cost eligibility	**50% of total CAPEX, up to 4.5p/kWh of heat delivered over first 15 years**
SGHE eligible	**Yes, when aggregated**

References & further information

https://www.gov.uk/government/publications/green-heat-network-fund-ghnf-transition-scheme

BREAKOUT SESSIONS

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- Breakout session 1
  - Technical & design
  - Local implementation
- Breakout session 2
  - Business models
  - Users / consumers
  - National policy and regulation
- Choose whichever you like
  - To change rooms:
  - Online attendees – leave Zoom breakout room and Open Innovations support will help you move
- Each room has a facilitator from the research team
- Each session has a number of prompt questions to consider
  - Other key questions welcome
- Make a note of any insights you think we should include
  - In-person – big post-its on breakout tables
  - Online – 'Miro' sticky notes in breakout room spaces
- Facilitator will group insights and ensure each question is discussed
- Online: Miro link will have been shared but if you don't have it or have any problems, ask Josh!

MIRO HANDY GUIDE

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- Join via URL (will have been shared)
- You don't need to sign up!
- To move around the board
  - Hold and drag **right** mouse button
- To zoom in and out
  - This is much easier with a mouse scroll wheel!
  - Otherwise bottom right
  - Zoom right out to see whole board

- To add sticky note
  - Select from left hand menu
  - Fourth option down
  - Or press 'n'
  - Choose colour
- If you accidentally delete
  - Undo button

POLICY MAPPING ACTIVITY

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- Do you think this policy will help SGHE deployment? If not, why not?
- Would you consider using this funding stream? If not, why not?
- What's missing?

NEXT STEPS

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- To publish
  - Data from Rapid Evidence Assessment
  - Case studies
  - Policy summaries
  - Policy briefing note
- Dissemination activities
- Seminars/meetings/blogs - ideas?

THANK YOU FOR YOUR PARTICIPATION AND ENGAGEMENT!

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Please keep in touch!

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https://urbanheatsystems.leeds.ac.uk/