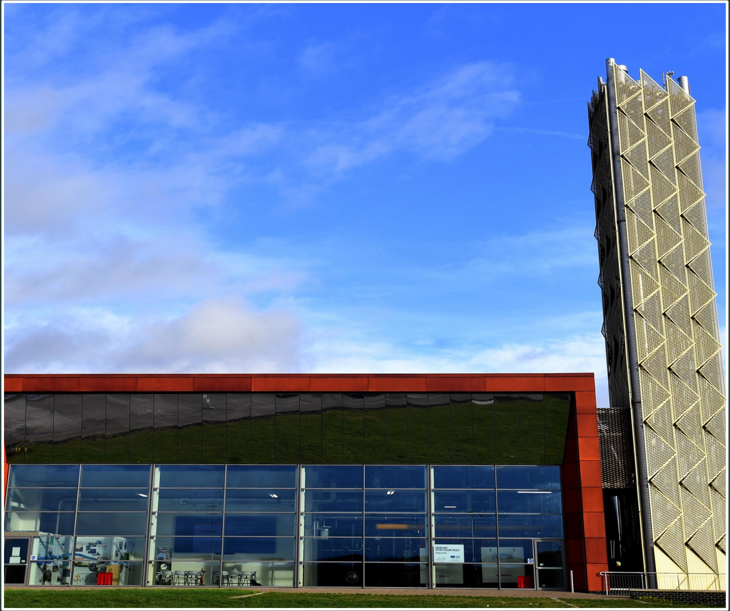
Manufacturing for Clean Heat in Scotland



Factsheet 6: Energy Centre Construction

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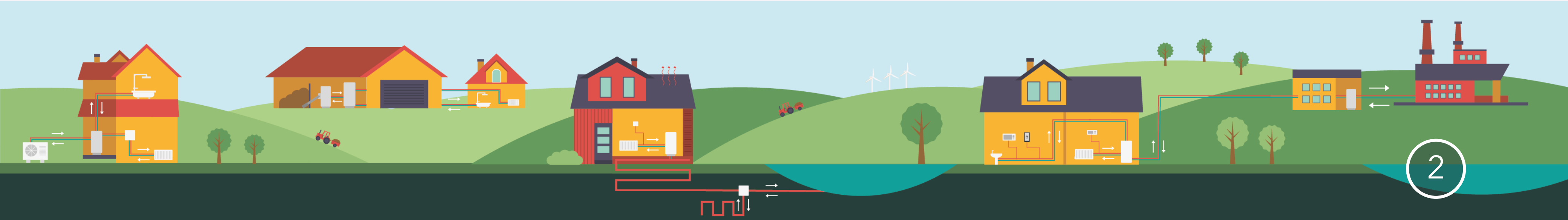
What is Clean Heat?

Clean heat refers to heat generation, distribution, and building energy efficiency technologies that provide heating and hot water with minimal environmental impact. Key technologies include heat pumps, heat networks, and direct electric systems, supported by measures to reduce heat demand and optimize usage through sensors, controls, and efficient design.

These factsheets aim to guide Scottish manufacturers to understand and enter the clean heat sector. Factsheet 6 focuses on key technologies used for Energy Centre Construction.

Factsheet 1	Factsheet 2	Factsheet 3	Factsheet 4	Factsheet 5	Factsheet 6
Heat Generation	Heat Network Distribution	Heat in Properties	Technology Enablers	Building Energy Efficiency	Energy Centre Construction
• Industrial Heat Pumps	• Pipework	• Radiators	• Control Panels	• Cladding	• Large Thermal Store
• Domestic Heat Pumps	• Circulation Pumps	• Underfloor Heating	• Thermostats	• Insulation	• Large Pumps
• Electrode Boilers	• Valves	• Infrared Panels	• Sensors and Meters	• Windows & Doors	• Structural Steel
• Electric Boilers	• Corrosion Control	• Hot Water Cylinders	• Actuators	• Ventilation Systems	• Electrical Switchgear
• Geothermal Drill Rigs	• Storage Buffers	• Storage Heaters	• Design Apps	• Offsite Manufacturing	• Cabling

Clean heat presents significant market opportunities for Scotland, UK and International. Clean heat is essential for all buildings to meet Scotland's 2045 net-zero target. This will be achieved via Local Heat and Energy Efficiency Strategies, regulations, and the proposed Heat in Buildings Act. Already, from April 2024, all new buildings must include clean heat systems. Existing buildings will require energy efficiency upgrades and clean heat retrofits and urban areas will see new heat networks (Heat Networks Act 2021).



Energy Centres are an efficient way of generating and supplying heat to a community using a mix of low carbon technologies.

Key components include:

- Large Thermal Store
- Large Pumps
- Structural Steel
- Electrical Switchgear
- Cabling

What is an Energy Centre?

Energy centres replace individual domestic boilers, supplying heating and hot water to homes and businesses through distributed energy.

A purpose-built facility that centralises the equipment needed to meet the energy requirements of a district heat network.

Benefits of an Energy Centre

Energy centres are integral to the success of clean heat networks, offering:

- Reduced Carbon Emissions: Using low-carbon and renewable energy sources, energy centres significantly cut greenhouse gas emissions, helping to combat climate change
- Energy Efficiency: Centralised production and distribution of heat optimises energy use, reducing waste and improving overall efficiency
- Cost Savings: Clean heat networks can lower energy costs for consumers by using more efficient technologies and benefiting from economies of scale
- Flexibility and Scalability: Integration of renewable energy sources, such as biomass, geothermal, heat pumps and solar, and can be scaled to meet increasing demand
- Local Economic Benefits: Investment in clean heat networks can stimulate local economies by creating jobs and attracting new businesses

Large thermal energy storage (TES) supplies heat for later use and to match supply to demand in heat networks.

Key Bill of Materials

1. Tank
2. Insulation
3. Air separator
4. Swing check valve
5. Heat source
6. Spring loaded check valve
7. Mixing valve
8. Low temperature distribution system

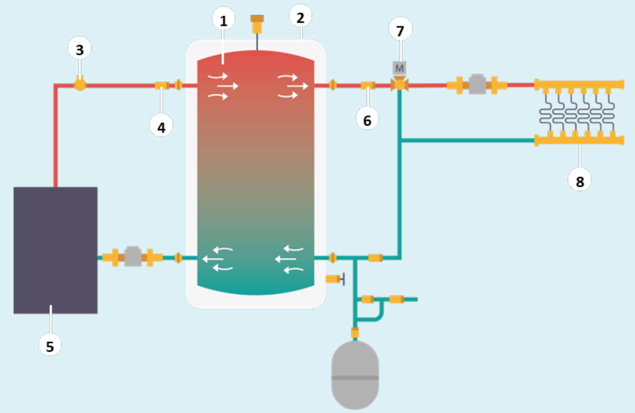


Diagram of a large thermal store

Large Thermal Store

Thermal stores have internal sparge pipes and deflector plates which prevent the flow bypassing the stored water. The store should be sized to deal with the peak domestic hot water demand for a minimum of 10 minutes/600 seconds (DS439).

Larger thermal energy storage can help the district heat operator to use the cheaper time of use electricity tariffs.

Subcomponents	Tank, sparge, deflector plates, insulation, heat exchanger, buffer / expansion vessel, sensors, air separators, valves
Typical Capacity	100s – 1000s litres
Typical Pressure	1 – 30 bar
Standards	BS 5422:2023 - Thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40 °C to +700 °C. BS 853-1:1990+A3:2011 - Specification for vessels for use in heating systems. Calorifiers and storage vessels for central heating and hot water supply

*** The dimensions are approximate and can vary based on the specific requirements of the materials and the manufacturer's design standards.**

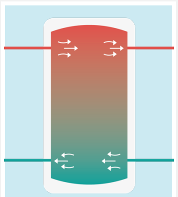
The typical manufacturing processes of large thermal store.

Component Procurement → **Manufacture** → **Subassembly** → **Final Assembly** → **Cleaning & Surface Treatment** → **Testing and Quality Control**

Large Thermal Store Tank: Manufacturing Process

Plate by Plate Assembly:
Assembling the tank's shells, bottoms, and roofs plate-by-plate. Shell and bottom assembly is carried out on the construction site.
Strict provision of their shape and the set of technological decisions, prevent residual distortion of the metal frameworks while edging and transporting.

Coiling Method:
The shell, bottom and roof are brought to site as coiled strip panels, for welding. This makes the installation period 3-4 times shorter by reducing the welding procedures in the construction area whilst providing high quality of welding joints due to two-side automatic welding.
Thermal stores can also be brought to site as a packaged unit.



Large thermal store

Enclosure Fabrication: Cutting, bending and welding the metal sheets to form the enclosure.
→ **Plate Rolling:** Plates are rolled to the required thickness and shape
→ **Welding:** Components welded to form the shell of the tank
→ **Cleaning and Surface Treatment:** To prevent corrosion, via sandblasting, priming and applying protective coat
→ **Assembly:** Assembled as a pre-built structure or built on site as coiled strip panels or plate-by-plate

Pumps in energy centres distribute heat often via a primary circuit pump, ensuring minimum system flow rate.

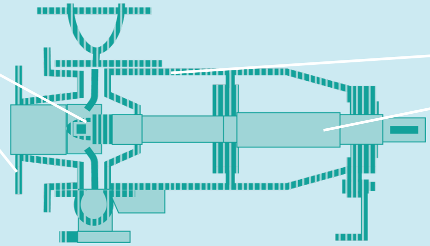


Diagram of a large pump

Large pumps

Due to the workload of an energy centre, the pumps are designed to have a long lifecycle and be maintenance friendly.

Good practice also means that the pump should have a low Net Positive Suction Head (NPSH) value.

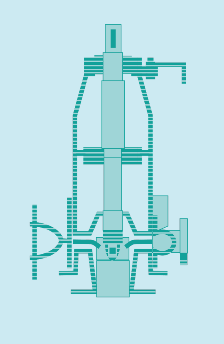
Subcomponents	Casing, impeller, shaft, bearings	
Typical size	Height	2 to 4 m
	Width	1 to 3 m
	Length	2 to 6 m
Standards	UKCA/CE mark - Demonstrates that the pump meets the minimum requirements to be placed on the market in the UK or any EU member state. BS EN ISO 12100 - Safety of machinery. General principles for design. Risk assessment and risk reduction BS EN ISO 13854 - Safety of machinery. Minimum gaps to avoid crushing of parts of the human body ISO 14414 - Pump system energy assessment	

*** The dimensions are approximate and can vary based on the specific requirements of the materials and the manufacturer's design standards.**

The typical manufacturing processes for the assembly of a large pump.

Component Procurement → **Manufacture** → **Subassembly** → **Final Assembly** → **Cleaning & Surface Treatment** → **Testing and Quality Control**

Large Pumps: Manufacturing Process



Large pump

Casting: Pump casing, Impeller, shaft and rotors are cast from metals such as stainless-steel cast iron or aluminum

→

Machining: After casting, components are machined to precise dimensions. This can include lathe turning, milling and CNC machining

→

Forming: Components formed into final shapes using bending, rolling, and stamping

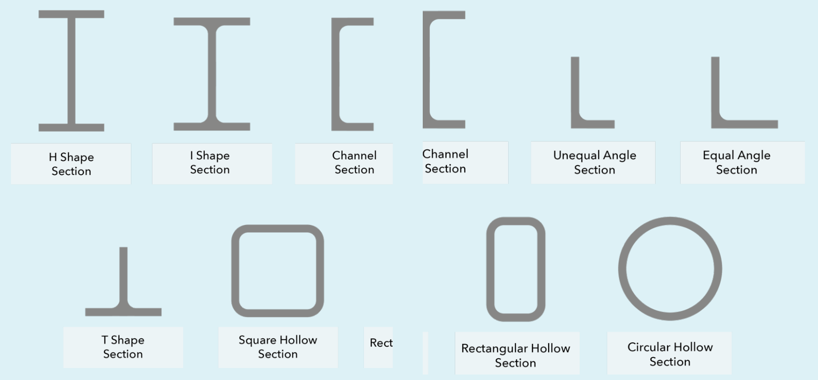
→

Finishing and Painting: Components cleaned, polished and painted to prevent corrosion and enhance longevity

→

Assembly: Casing, shafts and impellers are assembled with other components

Structural steel is widely used in construction for its strength, ductility, and versatility in shape and size.



Commonly used shapes of structural steel

Typical Size	Height	100 – 500 mm
	Width	50 – 200 mm
	Thickness	5 – 20 mm
Standards	EN 10025 - Hot rolled products of structural steels EN 10219 – Cold formed welded steel structural hollow sections	

*** The dimensions are approximate and can vary based on the specific requirements of the materials and the manufacturer's design standards.**

Structural steel

H-Beams and I-Beams are among the most common steel sections in construction of energy centres, as they offer outstanding strength and support for a variety of load combinations. New energy centres can be built in any shape or style but are typically steel framed buildings.

Materials	Advantages	Disadvantages
Carbon Steel	• Weldability • High tensile strength • Yield strength	• Increased brittleness • Limited formability • High cost
Stainless Steel	• Low maintenance • Durability • Corrosion resistant	• High cost • Difficult to weld • Susceptible to temperature fluctuations
High-Strength Low-Alloy Steel	• Enhanced mechanical properties • Improved corrosion resistance	• High cost • Reduced ductility
Quenched and Tempered Alloy Steels	• Tougher • Less brittle • Higher strength	• Lower tolerance levels • Potential for die failure • Need for secondary operations

The typical manufacturing processes for the assembly and the fabrication of structural steel components.

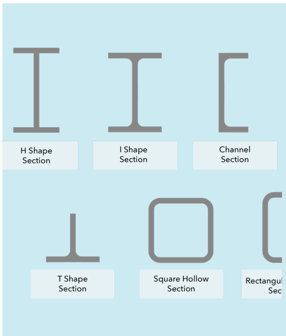
Component Manufacture → **Manufacture** → **Subassembly** → **Final Assembly** → **Cleaning & Surface Treatment** → **Testing and Quality Control**

Structural Steel: Manufacturing Process

Manufacturing:
Oxygen is blown through molten iron in a blast furnace or scrap steel / iron are electrically melted in an arc furnace

→

Casting:
Molten steel is cast into desired shape for further processing, such as slabs, billets or blooms



Structural steel

Hot Rolling:
Cast steel is put through rolling mills at >926°C, to improve workability for subsequent processing stages.

→

Welding:
Used to join steel structural components. Done either manually or automatically / semi-automatically. Automating the process requires specialised machinery, however the process is faster and typically results in higher quality welds.

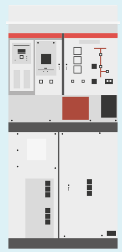
→

Bending:
The steel beams are bent into their final form via cold bending, incremental bending, hot being or induction bending.

→

Finishing:
Surface treatments such as galvanising are applied to protect from corrosion and enhance durability.

Electrical equipment includes transformers and fault limiting reactors, switchgear, power and control cabling installations.



Electrical switchgear

Electrical switchgear

Switchgear systems protect the electrical equipment and circuits, automatically disconnecting specific parts from the power supply when there is a problem detected, such as an electrical fault. Also allows for necessary maintenance work to be carried out. An insulating medium is used within a switchgear enclosure to protect from unintended faults. While air is the most common insulator, gas, fluid and solid approaches are also available.

Typical Size	Height	1500 – 2000 mm
	Width	50 – 1000 mm
	Thickness	1000 – 2000 mm
Standards	HSG230 – Health & Safety Executive - Keeping electrical switchgear safe IEC 62271 - High-voltage switchgear and control gear BS EN 61439 - Low-voltage switchgear and control gear assemblies	

*** The dimensions are approximate and can vary based on the specific requirements of the materials and the manufacturer's design standards.**

Materials	Advantages	Disadvantages
Fibreglass	• Low cost • Modifiable • Corrosion resistant	• Shorter lifetime • Difficult to recycle • Low impact resistance
Polycarbonate	• Durability • Fire resistant	• Higher cost • Chemical resistance • Risk of brittleness
Stainless Steel	• Low maintenance • Durability • Corrosion resistant	• High cost • Installation challenges • Conductivity considerations
Aluminium	• Lightweight • Non-corrosive • Recyclable	• Thermal conductivity • High cost

Energy Centre Construction: Electrical Switchgear – Manufacturing Process

The typical manufacturing processes of electrical switchgear.

Component Procurement → **Manufacture** → **Subassembly** → **Final Assembly** → **Cleaning & Surface Treatment** → **Testing and Quality Control**

Electrical Switchgear: Manufacturing Process

Component Procurement:
Sourcing high-quality components such as circuit breakers, disconnectors, transformers, and auxiliary equipment from trusted suppliers.

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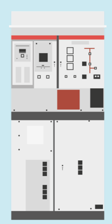
Enclosure Fabrication:
The fabrication process involves cutting, bending, and welding the metal sheets to form the enclosure according to the design specifications.



Electrical switchgear

Component installation:
Positioning and mounting the internal components, according to the design requirements.

→

Testing and Quality Assurance:
Switchgear must undergo rigorous testing. Tests include: functionality tests, insulation resistance tests, current withstand tests, and circuit breaker operation tests.

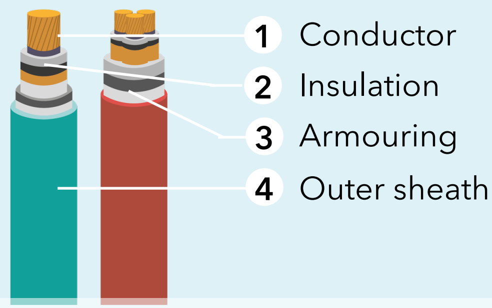
→

Finishing and Painting:
The enclosure is cleaned, polished, and painted to provide a protective finish, to prevent corrosion and enhance the longevity of the switchgear.

→

Packaging and Shipment:
Switchgears must be adequately protected to withstand vibrations, shocks, and other potential damages during transit.

Electrical cables are the principal means of transmitting the electricity used within an energy centre.



Electrical cables

Electrical cabling

Is an assembly of one or more wires, used as a conductor to carry electric current.

The number of cores in a cable vary but is driven by the energy centre's requirements and electrical design. Single-core cables are most suitable where high voltage and high current need to be transmitted. Multi-core cables are more suitable for communication, data transmission, control systems, and power supply.

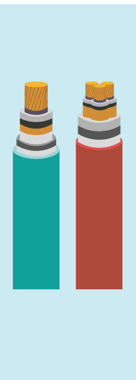
Typical Size	Cross-sectional area	0.5 – 300 mm²
	Length	1 – 100 m
Standards	BS EN 50288-7 - multi-element cables for analogue of digital transmission. BS 5467 - Thermosetting insulated, armoured cables rated at 600/1 000 V and 1 900/3 300 V. BS 7629 - 300/500 V fire resistant, screened, fixed installation cables BS 7846 - Thermosetting insulated, armoured, fire-resistant cables of rated voltage 600/1 000 V. BS 7671 – IET wiring regulations IEC 60502 - Cables with extruded insulation and accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV)	

* **The dimensions are approximate and can vary based on the specific requirements of the materials and the manufacturer's design standards.**

The typical manufacturing processes of electrical cabling.

Wire Drawing → Insulation → Cabling → Subassembly → Testing and Quality Control → Packaging and Distribution

Electrical Cabling: Manufacturing Process



Electrical cables

Wire Drawing: Metal rods drawn through dies to create wires, improving its tensile strength. Wire is annealed to relieve internal stresses.

→ **Bunching:** Wires twisted to form strands, enhancing flexibility and strength, then compacted reducing their diameter, improving conductivity.

→ **Insulation Extrusion:** Insulation material is extruded onto the conductor, by heating and applying it around the wire. Wire is then cooled, to solidify the material.

↓ **Cabling:** Conductors are twisted together to form cables. Spaces are filled with non-conductive materials, for cable shape and add additional strength.

← **Shielding (If applicable):** The cable can be shielded using metal braids, tapes, or foils. Typically, copper or aluminium are applied over the cable, with an additional insulating layer.

← **Armouring (If applicable):** Metal tapes or wires are applied over the outer sheath if required. Then another sheath layer is applied over the armour, to protect from corrosion or mechanical damage.

↓ **Cable Extrusion:** Outer sheath extruded onto the cable, by heating the material. The cable is marked with key information, including manufacturer and cable's specifications.

→ **Testing and Quality Control:** Rigorous testing, including electrical, mechanical and environmental testing. Cables that fail any of these metrics are discarded.

→ **Packaging and Distribution:** Cables are cut to length, then coiled or wound onto reels. The reels are packaged securely, with protective layers / labels.

Summary of the key processes and equipment required for manufacturing energy centre components.

Process	Equipment/Facilities	Large Thermal Store	Large Pumps	Electrical Switchgear	Cabling	Structural Steel
Design and Prototyping	CAD Software, 3D Printers, CNC Machines	X	X	X	X	
Casting, Milling, Drilling	Furnaces, CNC Machining, Drilling Machines		X	X		X
Tube / Metal Forming and Bending	CNC Tube Benders, Roll Bending Machines, Stamping Presses, Wire Drawing			X	X	X
Manufacturing Facilities	Furnaces, CNC Machines, Drilling Machines, Cutting Stripping and Assembling Machines, Injection Molding and Extrusion Machines	X	X		X	
Welding, Brazing and Soldering	Welding Machines, Cutting Torches, and Fabrication Tools, Furnace	X	X	X		X
Painting Powder Coating and Plating	Spray Booths, Powder Spray Guns, Powder Feed System, Curing Ovens, Electroplating, Mixing and Dispensing Systems	X	X	X		X
Assembly Line	Conveyors, Robotic Systems, Assembly Machines	X	X	X		
Testing and Quality Control	Inspection Tools, Testing Equipment	X	X	X	X	
Calibration Facilities	Calibration Equipment, Testing Benches	X	X	X		

Market size and growth.

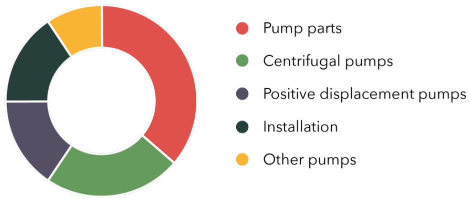
Thermal Storage

- At a global level, this market is expected to experience a 7.8% compound annual growth rate from 2024 to 2031. The global cladding market is expected to have a compound annual growth rate of 7.3% to 2030.

Large Pumps

- The industrial pump market had a revenue of over £700 million in 2023, with an expected CAGR of 3.2% to £900 million in 2030.

Pump products and services segmentation in the UK:



Structural Steel

- **UK metal structures manufacturing industry revenue was £8.6 billion in 2023**.
- Following a drop in demand caused by COVID-19, demand for metal frameworks for construction has risen due to investment in transport infrastructure and growth in construction activity.

Electrical Switchgear

- The UK switchgear market size is projected to have a compound annual growth rate of 9.2% to 2030, reaching a value of more than £3 billion by 2028.
- The wider electrical equipment manufacturing market was estimate to have a value of £14.2 billion in 2022.

Electrical Cabling

- The UK wires and cables market size was estimated to have a value of over £5.5 billion in 2023, producing over 400,000 kilometres of cable annually. This market is projected to grow at a compound annual growth rate of 2.9% between 2024 and 2032.
- Aside from the growth in heat networks and energy centres, the wires and cables market is set to experience a healthy level of growth thanks to increasing grid and power demand, construction and telecommunications needs and continuing technological advancements.

Energy Centre Construction: Market Information (2)

Support available and competitor analysis.

Scotland

- The Heat Network Support Unit provides funding and information for district heat networks.
- The Heat Network Fund offers capital funding for low or zero-emission networks.
- The Scotland Heat Map estimates heat demand for buildings.
- Scottish Local Authorities have a Local Heat and Energy Efficiency Strategy (LHEES) and an LHEES officer (or similar) who can provide information on local plans for Heat Network Zones.

UK

- The Heat Network Exchange connects heat network companies with suppliers.

England & Wales

- The Department for Energy Security and Net Zero offers guidance on heat networks.
- The Heat Network Investment Project (HNIP) funds network deployment.
- The Green Heat Network Fund (GHNF) has grants for low-carbon networks.

Competitor Analysis

Vattenfall, Vital Energy and Gren Group are active ESCO's in Scotland, supported by consultants including Ramboll, Buro Happold, WSP, Arup and AECOM. FES are a Scottish based tier 1 contractor for several recent district heat projects.

- Thermal Store – Flexiheat (England), Hartwell Manufacturing (England), and Flamco (Netherlands)
- Large Pumps – SULZER (Switzerland), SPP Pumps (England), and Xylem (USA)
- Structural Steel – Tata Steel Europe Ltd (England), Severfield plc (England) and Kingspan Group Ltd (Ireland). WGM Engineering are an example of a Scottish steel fabricator for district heating.
- Switchgear – Eaton Industries (Ireland), Siemens (Germany), ABB (Switzerland), Danfoss (Denmark)
- Cabling – Leviton in Scotland, Cable Harnesses UK Ltd, Sumitomo Electric, Doncaster Cables.

Scottish Enterprise can support you to explore growth in clean heat.

Clean Heat Market Opportunities

Clean heat will play a crucial role in meeting Scotland's net zero targets. There is a huge growth potential for Scottish businesses too.

- For general enquiries, and to access our Clean Heat team, please contact us
- For specialist advice on manufacturing and productivity, contact the Scottish Manufacturing Advisory Service (SMAS)
- For information on domestic and international markets contact our Market Research service
- If you are based in the Highlands and Islands, or the south of Scotland, please contact Highlands and Islands Enterprise or South of Scotland Enterprise respectively.

Newsletter

Please complete this subscription form if you would like to receive an occasional newsletter from Scottish Enterprise on market opportunities relating to clean heat.

Subscribe here

Further Reading

- Economic Value of Clean Heat in Scotland (2024)
- Heat Pumps and Heat Networks Assemblies and Key Component Analysis (2022)
- Cost Analysis of a Typical 4th and 5th Generation Heat Network (2024
- Analysis of potential for Scotland to be leader in 5th Generation Heating and Cooling Networks | Scottish Enterprise

External Innovation Support Services in Scotland

- National Manufacturing Institute Scotland (NMIS) provides access to world-leading manufacturing facilities for collaborative R&D projects
- Built Environment - Smarter Transformation (BE-ST) provides collaborative innovation space and expertise for projects and materials for the built environment