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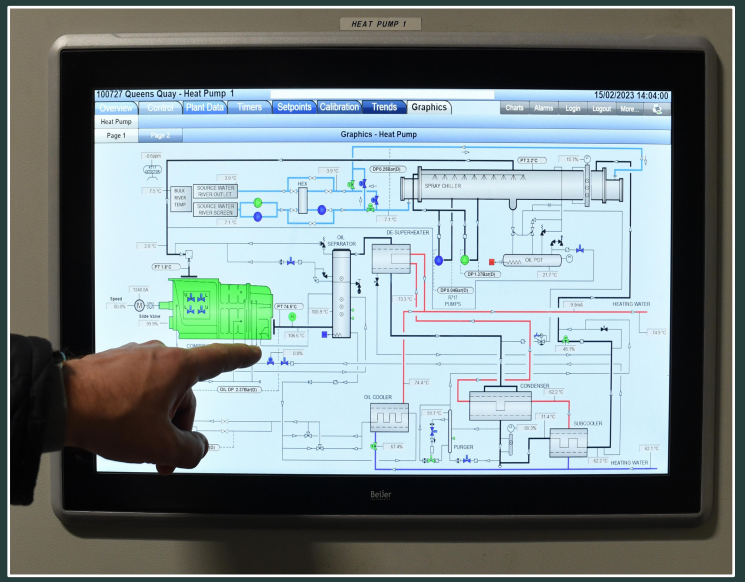
Manufacturing for Clean Heat in Scotland



Factsheet 4: Technology Enablers

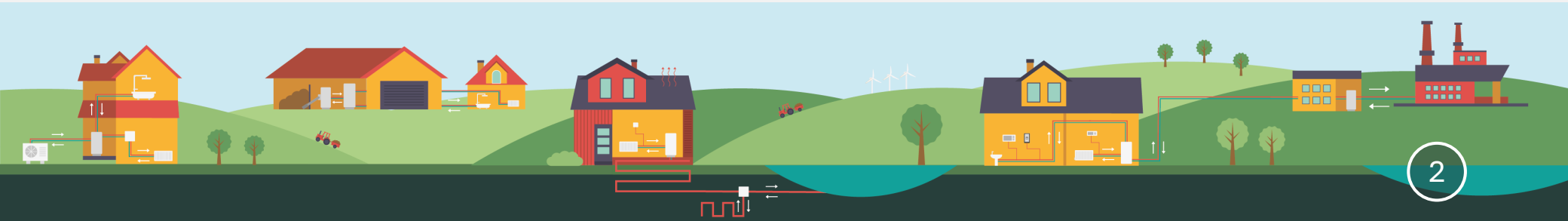
What is Clean Heat?

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 optimise usage through sensors, controls, and efficient design.

These factsheets aim to guide Scottish manufacturers to understand and enter the clean heat sector. Factsheet 4 focusses on the key digital components that control the clean heat system.

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 • Domestic Heat Pumps • Electrode Boilers • Electric Boilers • Geothermal Drill Rigs	• Pipework • Circulation Pumps • Valves • Corrosion Control • Storage Buffers	• Radiators • Underfloor Heating • Infrared Panels • Hot Water Cylinders • Storage Heaters	• Control Panels • Thermostats • Sensors and Meters • Actuators • Design Apps	• Cladding • Insulation • Windows & Doors • Ventilation Systems • Offsite Manufacturing	• Large Thermal Store • Large Pumps • Structural Steel • Electrical Switchgear • Cabling

Clean heat presents significant market opportunities for Scotland, UK and internationally. 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).



Technology enablers in residential and industrial clean heat systems provide real time monitoring and control of energy systems.

What are technology enablers?

Technology Enablers work together across the Internet of Things (IoT) as a network of interconnected devices to enable real time monitoring. This can create automated, and intelligent clean heat systems that enhance energy efficiency, reduce carbon emissions, and improve end user comfort.

Technology enablers are used across all clean heat products, including industrial heat pumps, individual heat pumps, district heat networks and direct electric heating solutions.

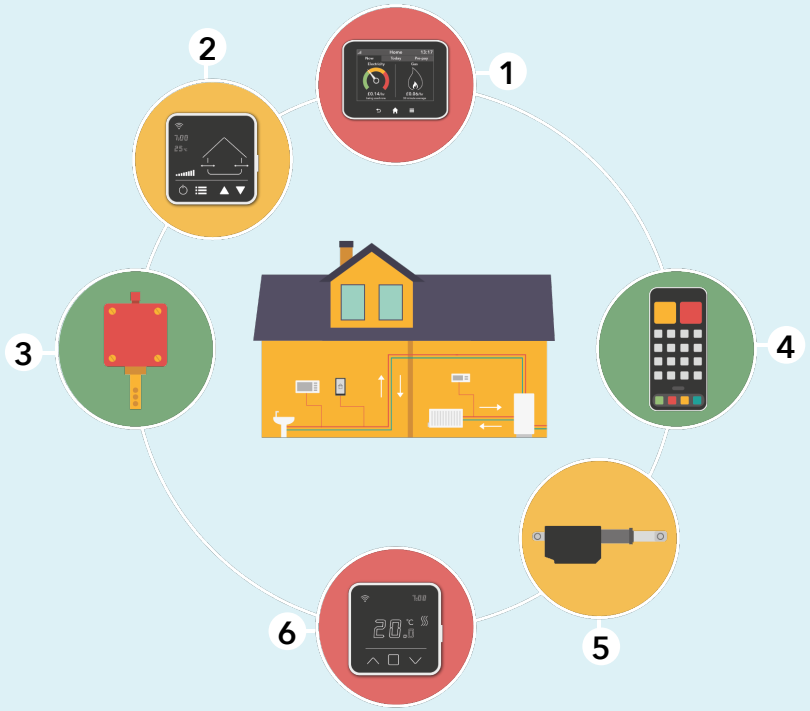
Key technology enablers include:

- Control Panels
- Thermostats
- Sensors
- Meters
- Design apps

Benefits of Technology Enablers:

- Enhanced Efficiency: Real-time monitoring and control optimise energy use.
- Automation: Enables remote management and automated responses to changing conditions
- Provide real-time information on environmental conditions and system performance.
- Centralise management and monitoring of the heating system, with integration of data from sensors and IoT devices for accurate adjustments.
- Track energy consumption for better management and cost saving, facilitating smart billing and energy-saving opportunities.
- Regulate indoor temperature based on user preferences and real-time data, smart adjustments learning user habits and adjust settings automatically.
- Help plan and simulate efficient heating systems with integration ensuring seamless incorporation of IoT devices, thermostats, meters and sensors.

Technology enablers provide a connected ecosystem that work together to provide real-time control of clean heat systems.



A connected ecosystem of technology enablers.

Key Bill of Materials

1. Meters
2. Control Panels
3. Sensors
4. Design apps
5. Actuators
6. Thermostats

Key technology enabler components are control panels, thermostats and sensors.

Control panel

Control Panels

User interface for managing and monitoring clean heat systems. They integrate data from sensors and IoT devices, so users can control heating settings, view system status, and receive alerts

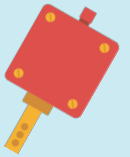
Subcomponents	Thermostat, sensor, relay, diodes, resistors, capacitors, microprocessors, PBBs, power supply unit, user interface panel
Typical Weight	2 kg to 5 kg
Typical Dimensions	Dependent on system requirements
Standards	BS EN 61433 BS EN 60204-1 BS EN 60730, BS EN 61000

Thermostat

Thermostats

Regulate temperature by controlling the heating system. Smart thermostats learn user preferences, adjust settings automatically, and be controlled via mobile apps

Subcomponents	Sensors, control unit, user interface, power supply. housing
Typical Weight	0.14 kg
Typical Dimensions	0.1 m (d) x 0.03 m (h)
Standards	Boiler Plus : standard for domestic gas boilers



Sensor

Sensors

Detect and measure properties like temperature, humidity, and pressure. Providing data needed to monitor system performance and environmental conditions

Subcomponents	Sensing element, signal conditioning circuit, processor, communications interface, power supply, housing
Typical Weight	0.5 kg to 1 kg
Typical Dimensions	0.1 m (l)
Standards	IEEE 2700 2017, ISO/IEC 30141

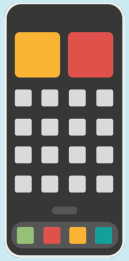
Key technology enabler components are meters, design apps and actuators.

Meter

Meters

Measure energy used. Provide data for billing, energy management, and efficiency improvements. Communicate with system devices to provide real-time usage data and dynamic pricing

Subcomponents	Flow sensor, temperature sensor, processor, interface display unit
Typical Weight	0.1 kg to 0.3 kg
Typical Dimensions	0.2 m (w), 0.1 m (h), 0.06 m (d)
Standards	EN 1434, OIML R75, ISO 4064

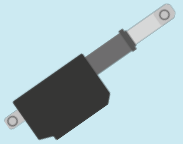


Design apps

Design Apps

Used to optimise clean heat systems. Model different scenarios, simulate system performance, ensuring system meets regulatory standards and efficiency goals. Assist integration of IoT devices.

Subcomponents	User interface, data management, integrators, energy management, connectivity
Typical Weight	n/a
Typical Dimensions	n/a
Standards	ISO/IEC 25010, 27001, 30141



Actuator

Actuator

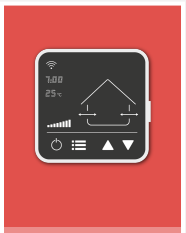
A clean heat actuator controls dampers, valves, fan speeds and heating zones in smart systems with high precision and efficiency

Subcomponents	Actuation element, processor, sensors, communication module, power supply, user interface, housing
Typical Weight	0.1 kg to 2.5 kg
Typical Dimensions	0.1 m – 0.3 m (l), 0.05 m – 0.15 m (w)
Standards	ISO 9001, RoHS

The typical manufacturing processes are detailed below for the assembly of technology enablers.

Design and Development → **Component Assembly** → **Firmware Development** → **Testing and Quality Control** → **Enclosure Assembly** → **Software Integration**

Control Panel and Thermostat: Manufacturing Process

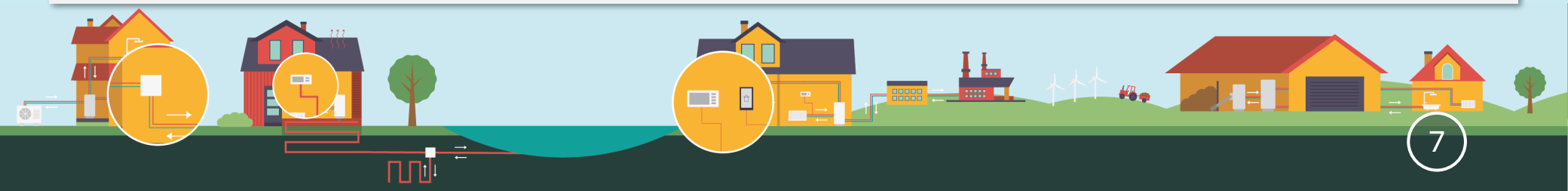


Control panel

PCB Manufacture and Component Assembly: Produce PCBs and assemble electronic components onto PCB → **Wiring and Cabling:** Install wiring and cabling to connect components → **Enclosure Fabrication:** Manufacture the enclosure that houses control panel components → **Software Development:** Development and testing of software that controls function of panel → **Quality Control and Calibration:** Inspection and testing of software, ensuring it accurately measures and controls heat

Thermostat

Material Selection: Choose high quality sensors and plastics for housing → **Component Manufacture:** Sensors, processors and other electronic components manufactures and tested for accuracy → **PCB Manufacture and Component Assembly:** Produce PCBs and assemble electronic components onto PCB → **Calibration and Testing:** Each thermostat is calibrated to accurately measure and control temperatures, under various conditions → **Quality Control:** Rigorous checks to ensure thermostat meets industry standards and specifications



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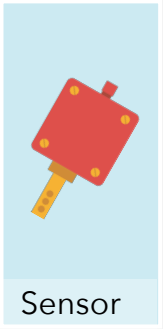
Sensor: Manufacturing Process

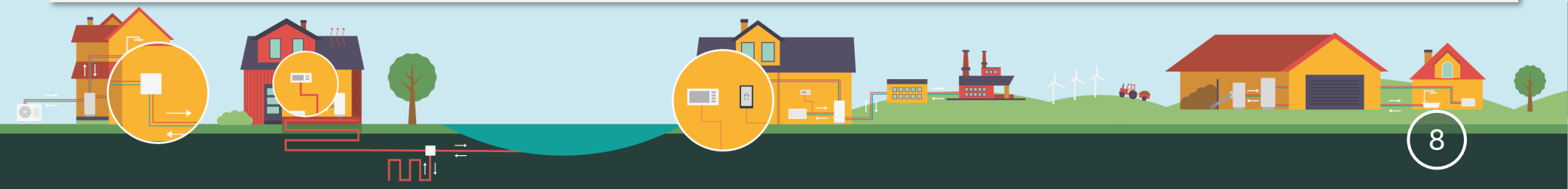


Sensor

Sensor Fabrication Manufacturing: thermocouples, RTDs or thermistors, by alloying, drawing and coating → **Substrate Preparation:** Substrates prepared using chemical or physical vapour deposition → **Component Assembly:** Micro assembly of small components, bonding and encapsulation → **PCB Manufacturing and Component Assembly:** Micro assembly of small components, bonding and encapsulation → **Calibration, Testing and Quality Control:** Ensure sensors are calibrated for accuracy and tested to meet performance targets

Meter

PCB Manufacturing: Produce PCBs to house electronic components → **Component Assembly:** Assemble electronic components onto PCB, integrating flow and temperature sensors → **Calibration and Testing:** Ensure sensors are calibrated to accurately measure flow and temperatures → **Software Programming:** Upload necessary programmes to calculate energy consumption → **Quality Control and Testing:** Conduct rigorous testing to ensure meter meets all specifications and standards



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Design and Development → **Component Assembly** → **Firmware Development** → **Testing and Quality Control** → **Enclosure Assembly** → **Software Integration**

Design App Software: Development Process

Design apps

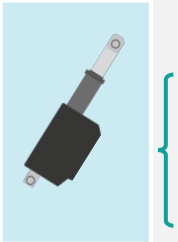
User Needs and Technical Specifications: Identify needs of target users and compatibility with heating systems, data security and smart home devices

→ **Design and Prototyping:** Develop intuitive and user-friendly interfaces, and develop working prototypes to test features

→ **Software Development:** Develop software applicable for task, which works across systems and devices

→ **System Integration:** Integrate app with heating systems, sensors and smart home platforms to enable effective operation

→ **Testing and Quality Assurance:** Test individual and system components to verify app works as expected



Actuator

Microfabrication: Manufacture the microcontroller and sensor components

→ **Component Assembly:** Assemble actuation element and integration of electronics into the actuator

→ **Calibration and Testing:** Ensure actuators are calibrated to accurately measure temperatures and other inputs

→ **Software Programming:** Upload programmes and communication protocols for remote monitoring

→ **Quality Control and Testing:** Conduct testing to ensure actuator meets all specifications and standards

Summary of the key processes and equipment required for manufacturing technology enablers.

Process	Equipment/Facilities	Control Panel	Thermostat	Sensor	Meter	Design App	Actuator
Design and Prototyping	CAD, 3D Printers, CNC Machines	X	X	X	X	X	X
PCB Fabrication	Photoresist application, UV Exposure Unit, Etching Tanks, Drilling, Plating Equipment	X	X	X	X		
Component Assembly	Pick and Place, Reflow Ovens, Wave Soldering	X	X	X	X		X
Manufacturing Facilities	CNC Machines, Cutting Stripping and Assembling Machines, Injection Molding Machines, Vapour Deposition Machines	X	X	X	X		X
Software Development Offices	Development Environment and Testing Frameworks	X	X	X	X	X	X
Testing and Quality Control	Inspection Tools, Testing Equipment	X	X	X	X	X	X
Calibration Facilities	Calibration Equipment, Testing Benches	X	X	X	X	X	X
Clean Room	Environmental Control	X	X	X	X		X
Storage and Handling Facilities	Climate Control Environment		X				

Market size and growth.

Market Size and Outlook

The market for clean heat technologies, including technology enablers, is part of the broader clean heat markets in the UK. The investment potential for heat networks alone is estimated to be between £60 billion and £80 billion by 2050. This includes technology enablers, which are essential to manage and optimise heat distribution.

Annual Deployment

- The UK aims to increase the number of heat pump installations from 55,000 per year in 2021 to 600,000 per year by 2028.
- Significant public investment, such as the £12 billion allocated for energy efficiency and low carbon heating, supports this growth.
- These investments and deployment targets indicate a robust and growing market for clean heat enablers, driven by the need to decarbonise heating systems across the UK.
- The UK smart thermostat market is projected to reach $542 million by 2030, growing at a compound annual growth rate (CAGR) of 17.4% from 2024 to 2030.
- The overall market for smart home technologies, which includes clean heat sensors, was valued at £1.2 billion in 2023 and is projected to grow at a compound annual growth rate (CAGR) of 15.3% from 2024 to 2031.

A control panel in a home.

Support available and competitor analysis.

Scotland

- The Scottish Government's Heat Network Fund provides capital funding to support the development of low or zero emission district heat networks.
- The Scottish Energy Transformation Fund (SIETF) supports industrial users, which can include adopting advanced control systems and sensors.
- Scottish Enterprise can support ambitious companies with innovation advice and support.

UK

The UK government has committed £4.5 billion to support advanced manufacturing technologies and their use in the transition to net zero.

England and Wales

- Innovate UK's Net Zero Heat Programme fosters growth and innovation.
- The Green Industries Growth Accelerator supports the development and production of advanced technologies, including control systems and sensors.

Competitor Analysis

Mitsubishi Electric, Star Renewable Energy and Sunamp are examples of Scottish manufacturers who adopt digital technologies in their products. Other Scottish manufacturers and suppliers include:

Meters

- Smart Metering Systems

Control Panels

- Amber Programmable Design, Craigalan Controls, Kelvin Control Engineers, Resource Data M-ment

Design apps

Heero Technologies, Snugg, ThermaFy, Urban Tide, Zuos

Thermostats/ controls

- Resideo

Building Energy Management Systems

- East Coast Controls, CC North, Prioto, IOTech

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

- Cost Analysis of a Typical 4th and 5th Generation Heat Network (2024)
- Assessment of Scotland's Opportunities in Digital Heat (2023)
- Economic Value of Clean Heat in Scotland (2024)

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
- Sensing & IoT (CENSIS) - Centre of Excellence for sensing, imaging and Internet of Things (IoT) technologies
- Data & AI (Data Lab) - Scotland's innovation centre for data science and AI