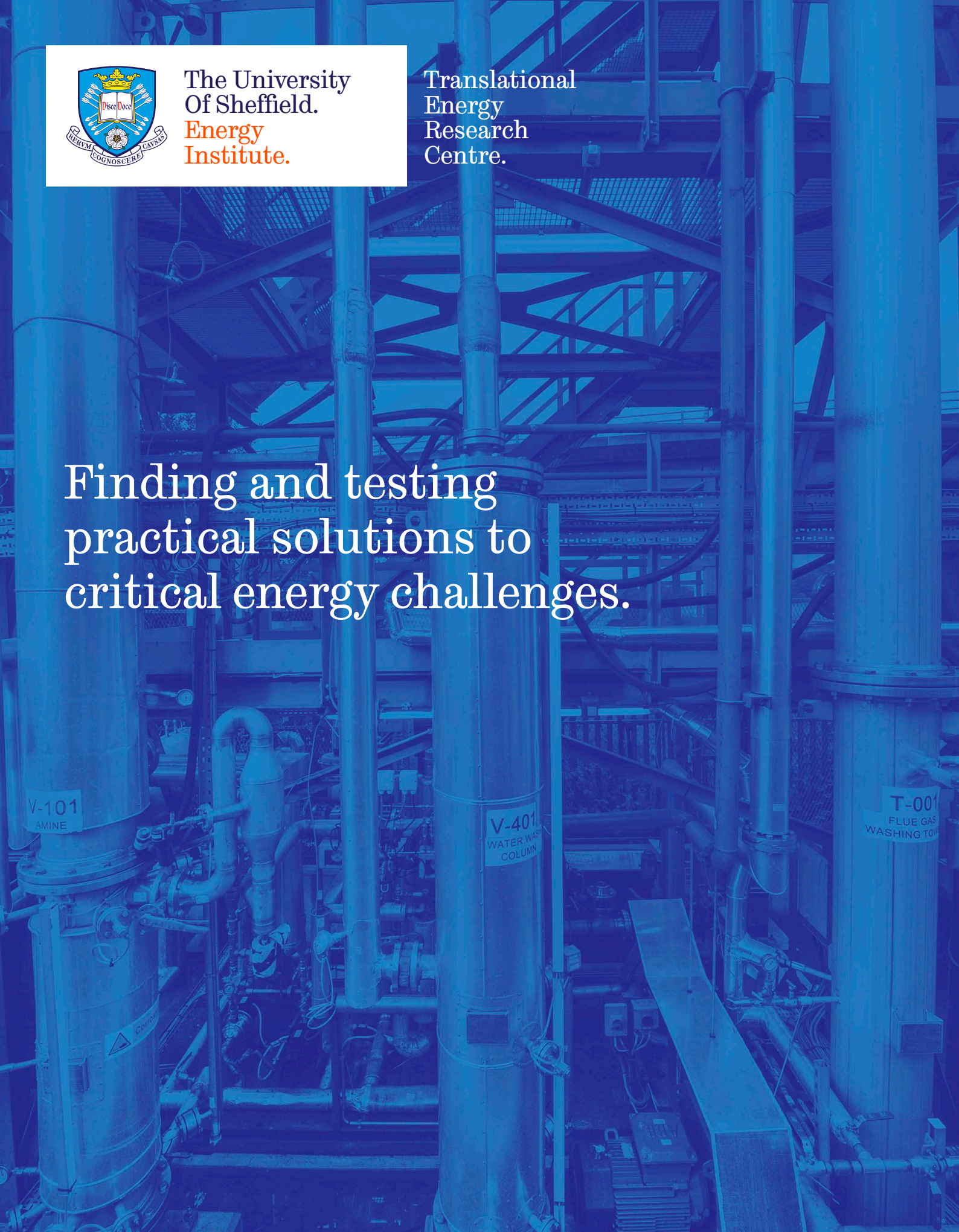
The University Of Sheffield.
Energy Institute.

Translational Energy Research Centre.

Finding and testing practical solutions to critical energy challenges.



Funded by:

European Union
European Regional Development Fund

Department for Business, Energy & Industrial Strategy

Welcome to the Translational Energy Research Centre

One of the largest and best-equipped low-carbon energy, combustion and CCUS research and development facilities in Europe.

The Translational Energy Research Centre is a unique, national pilot-scale testing facility based at the University of Sheffield. We are working to discover, demonstrate and integrate low carbon conventional energy solutions, Carbon Capture Utilisation and Storage (CCUS) research and renewable energy generation solutions to work towards secure, affordable and sustainable energy systems for the future.

Our state-of-the-art, first-of-its-kind equipment and world-leading academic excellence combined with a whole energy system, plug-and-play approach gives you access to faster, more effective and better value research and development.

Expanding on the work of PACT.

Since 2012, the University of Sheffield's Pilot Advanced-Scale Capture Technology (PACT) facility, supported by BEIS and Engineering and Physical Sciences Research Council (EPSRC), has facilitated more than 70 industrial collaborations, booked over 500 test days and supported more than 30 research and training projects.

With such an impressive track record, demand for the facility has outstripped capacity. In order to build on the success of PACT, the Translational Energy Research Centre has been conceived to provide larger facilities and a higher-specification building with superior infrastructure.

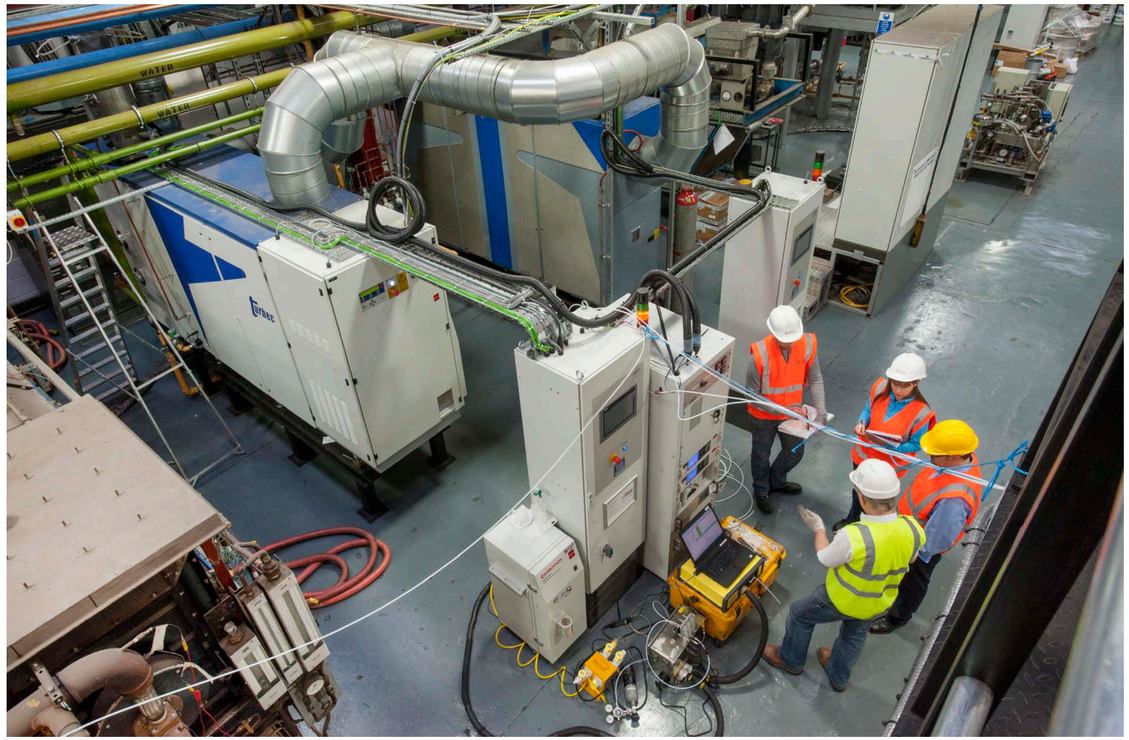
£21 million

The £21 million centre is part-funded by £10 million from the European Regional Development Fund (ERDF) and £7 million from the UK government's Department for Business, Energy and Industrial Strategy (BEIS).

A new centre for innovation, research, and development on a national and global scale

The Translational Energy Research Centre offers:

- A fast-track to turning early stage research into proven, sustainable, low-carbon products and services which are ready for deployment in the UK and beyond
- Large-scale facilities to research areas with significant growth potential
- Enhanced capacity, flexibility and collaboration space
- A large number of test days and an increased scope of testing for researchers, technicians and industrial partners
- A plug-and-play approach, allowing visiting researchers to join their equipment with our facilities to enhance testing and research



We work with:

Global companies of all sizes, from technology start-ups to national industry partners, who need capacity to research new technology and innovations.

Academic research teams wishing to access advanced testing facilities and the opportunity to collaborate.

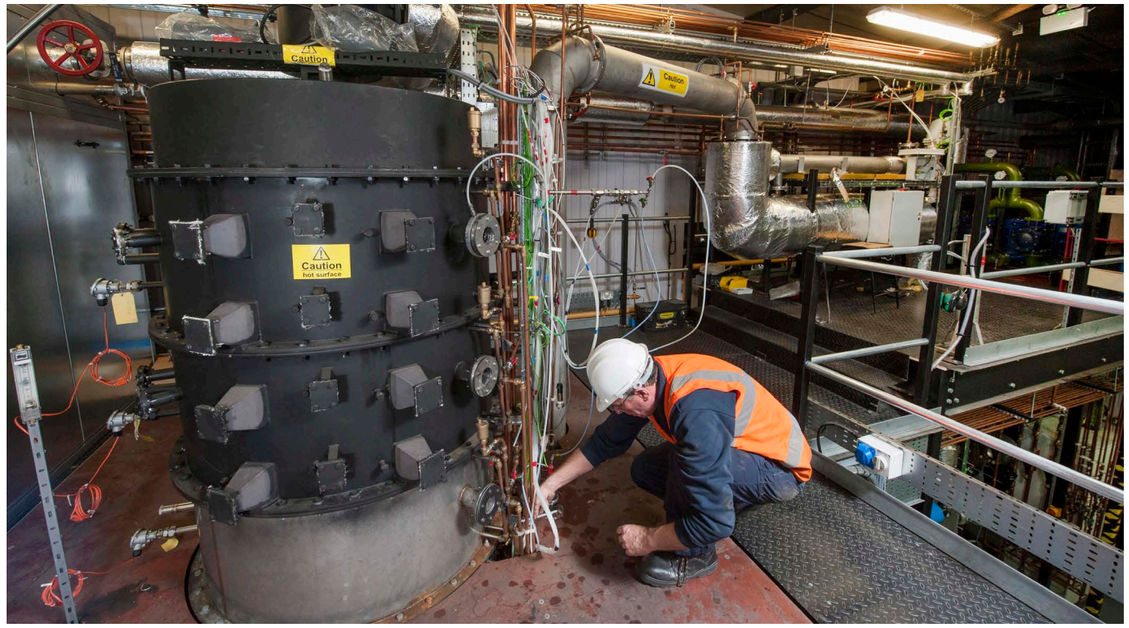
Regional enterprises of all sizes, and in particular SMEs. We work closely with local partners to assess how to reduce the cost of energy for their business and to find solutions to operational energy loss issues.

World-leading research and innovation centres.

Together, we aim to:

- Become a global leader in energy research, with world-leading innovations alongside academic excellence
- Increase the speed that new technologies can transition to market
- Remove the financial risk of large-scale industrial pilot trials
- Find solutions to some of the most complex energy demand and supply challenges
- Help the UK meet its target of net-zero emissions by 2050

Everything you need for commercially-focused R&D



The Translational Energy Research Centre houses a comprehensive range of equipment and full capability to test, optimise and demonstrate technologies at scale.

In order to expand the existing experimental research facilities for zero-carbon conventional energy research, including carbon capture, utilisation and storage (CCUS), the Translational Energy Research Centre features a large number of pilot-scale energy test rigs on one fully-integrated site.

The centre focuses on low carbon energy research at a technology readiness level (TRL) of three to six. By offering the chance to carry out meaningful tests in an industrial setting, results can be scaled confidently and see a faster transition to market.

More than twenty permanent rigs – and capacity for more.

Available at the Translational Energy Research Centre is a comprehensive range of flexible and compatible state-of-the-art equipment for research into, for example:

- Conventional energy
- Carbon capture, utilisation and storage
- Biomass
- Hydrogen
- Renewable energy
- Energy storage
- Smart grids
- Sustainable aviation and transport fuels

The various rigs and facilities, together with the extensive range of online and laboratory analytical equipment, will be integrated for a ‘whole energy system’ approach, using a smart energy management module and low-carbon heat management system, with optimal synergy between the rigs and processes.

Some of the largest and most exciting equipment in Europe

The Translational Energy Research Centre will host key pieces of equipment, some of which will be the first of its kind in the UK.

Sustainable Aviation Fuel (SAF) pilot plant

- A state-of-the-art, fully automatic, first-of-its-kind world class plug and play pilot scale research facility with full solid to liquid and gas to liquid cycle capable of producing liquid fuels from coal, biomass and gas, at a production capacity of 36 litres of fuel per day with 75% conversion efficiency
- Equipped with novel Reverse Water Gas Shift (RWGS) and Fischer-Tropsch (FT) reactors, offers the ability to synthesize sustainable alternatives to current petroleum distillates, enabling research into sustainable aviation fuels from captured CO_2 and green H_2
- Capability to test different reactor designs and catalysts in both RWGS and FT reactors at a wide range of operational conditions
- Able to separate and recycle excess/unreacted gases to enhance conversion efficiency
- Includes a polishing step for CO_2 to remove SOx and NOx to a level which does not hinder the FT catalyst
- Online analysis available to monitor the feed and product gas streams at various locations
- Ability to fractionate FT product into different grades (petrol, diesel, kerosene and heavy oil)

Electrolyser for green hydrogen production

- A fully-automated hydrogen electrolyser which generates pressurised hydrogen, with a purity of 99.999%, from the electrolysis of water using an alkaline electrolyte
- Designed in a fail-safe mode with remote control and monitoring features
- Could produce up to 32 cubic meters of hydrogen per hour
- Equipped with a specialised compressor which brings up the pressure of the generated hydrogen to 200 bar
- The pressurised hydrogen is safely stored in a bank of cylinders with a storage capacity of more than 35 kg (>450 Nm^3)
- Could operate with as low as -10°C ambient temperatures

Polymer Electrolyte Membrane fuel cell system

- Generates a power that could be used by the end user or sold to the national grid
- Provided with an internal bridge power system that enables instantaneous power generation from cold start
- Equipped with frost protection integrated utility that allows for operation at sub-freezing temperatures
- Operates at a wide range of pressure (2.7 to 10 bar) and relative humidity (5 to 100%)
- Has an integrated control and monitoring system
- Real-time monitoring of hydrogen consumption, electricity generation, fuel cell stack voltage and current, to name a few

Molten Carbonate Fuel Cell (MCFC) with next generation CCUS technology

- Next generation technology to capture CO_2 and produce electrical energy simultaneously
- Could lead to an increase in output power of up to 80% and could eliminate up to 70% of NOx emissions as the operating temperature is lower than that of combustion
- Supports extensive current and future research into low carbon energy generation, integrated energy systems and hydrogen economy

Solvent-based post-combustion CO_2 capture plant

- Fully instrumented, 1 tonne/day pilot-scale conventional solvent-based CO_2 capture plant with two absorber columns and solvent redistribution at each of the four packed beds
- Integrated with Gas Mixing Facility, 250kW Air Combustion Plant, 240kW waste to energy boiler, 300kW Gas Turbine and the Fischer-Tropsch plant to enable CCUS research on liquid fuel production from natural gas, coal, biomass and wastes
- Enables the development, evaluation and optimisation of a variety of solvents for energy performance, degradation studies and counter-measures
- Provisions for corrosion coupons and alternative materials test sites, and trace gas injection capability for capturing carbon from any synthesized flue gas compositions
- Integrated with rotating packed bed CO_2 capture plant for performance assessment of individual units (absorber/ stripper)

High pressure heat exchanger (HPHE) test bed with supercritical CO_2 loops

- A high-pressure, high temperature Heat Exchanger (HEX) test bed with fully instrumented fail safe operation
- Includes two supercritical CO_2 loops with operating pressures of up to 350 and 100 bars respectively
- Able to test two heat exchangers at the same time
- Supports research and development in high-efficiency power conversion cycles and their global applications in power and industrial sectors
- Focuses on a wide range of applications including supercritical CO_2 for oxy-fired gas cycles (Allam cycle), nuclear
- Provides performance data for the supercritical CO_2 cycle to model and evaluate designs, for example in fluid passages
- Also suitable for studying heat transfer, pressure drop, thermal stresses, impact of phase changes, impurities, fouling, corrosion and for materials research in heat exchangers using a range of fluids

Rotating Packed Bed CO_2 capture plant

- Next-generation pilot scale, process-intensified solvent-based CO_2 capture plant with a rotating packed bed absorber and stripper, designed to remove up to 1 tonne /day of CO_2 (based on MEA) from an equivalent of approximately 150kW conventional coal combustion flue gas
- Improved energy performance thanks to enhanced mass transfer
- Integrated with Fischer Tropsch plant for CCUS research on liquid hydrocarbon production from captured CO_2
- Integrated with 250kW Air Combustion Plant, 240kW waste to energy boiler and two 300kW Gas Turbines, enabling post-combustion capture research from real flue gases from natural gas power plants as well as pulverised, pelletised and chipped fuel combustion plants including coal, biomass, co-firing and wastes
- Integrated with dedicated gas mixing and trace gas injection facilities enabling carbon capture from any synthesised flue gas compositions, including industrial effluent gas mixtures
- Integrated with conventional CO_2 capture plant for performance assessment of individual units (absorber/ stripper)
- Develop, evaluate and optimise a variety of solvents for post-combustion capture and related technologies, and investigate solvent energy performance, degradation studies and counter measures
- Provisions for corrosion coupons and alternative materials test sites

CHP Biomass Gasifier

- A combined biomass CHP unit with precise control for the gasification process, enabling users to achieve clean syn-gas production for power generation from biomass fuels
- Integration of the syn-gas produced and the onsite Fischer-Tropsch plant for liquid biofuel production, especially jet-fuels
- Extensive analytical facilities for research and development on the syn-gas quality. The flue gas output is fully integrated with the on-site CO_2 capture and utilisation facilities

High Pressure High Temperate Shock Tube facilities

- A unique high pressure (up to 100 bar) single pulse shock tube with extended drivers
- State of the art laser diagnostic facilities
- For chemical kinetics measurement of sustainable alternative fuels
- Investigation into the chemistry which takes place during pyrolysis and oxidation of sustainable fuels
- Kinesics of branched chain reactions to define ignition

Smart Energy system

- Real-time monitoring, control and coordination of the available energy resources
- Flexible design of intelligent energy management system in a centralised, decentralised or distributed manner
- Hardware-in-the-loop capabilities for future energy resources, paving the way towards system ‘scale-up’

Energy storage batteries

- 120kWh, 50Kw Lithium battery with DC and AC interfaces
- The battery can be connected to the AC grid for grid-connected research, or to a dedicated DC bus along with other assets to provide a flexible test bed to facilitate both grid-connected and ‘behind the meter’ energy optimisation

Biodiesel Engine Generator

- A CHP unit capable of green power generation using a range of biofuels and operational conditions
- Equipped with extensive emissions monitoring facilities, and it is fully integrated with the on-site CO_2 capture and utilisation facilities
- It has 188kW grid synchronised green electrical generation capacity, and 352kW thermal output to supply the space heating needs of the whole facility and potentially the surrounding facilities

Gas turbine

- Two Turbec micro gas turbines, highly instrumented. fueled by natural gas/ biogas with electrical output:100kW, thermal output: 165kW
- Modified design to include
- Humidified turbine cycles : steam injections to simulate the operation of a humidified turbine cycle and
- Exhaust gas recycle (EGR & Selective EGR): CO_2 injections to examine exhaust gas recirculation
- Post-combustion CO_2 capture research from turbine systems.
- Modified design to include steam injections to simulate the operation of a humidified air turbine and CO_2 injections to examine exhaust gas recirculation
- Fuel flexibility research including hydrogen blending and sustainable alternative fuels

A full list of the equipment and services available at the Translational Energy Research Centre

There will be 24 pilot-scale permanent test rigs available at the Translational Energy Research Centre, as well as further capability.

Low-carbon generation:
- Biodiesel engine generator
- CHP biomass gasifier
- Organic Rankine Cycle system
- Biomass grate boiler including bioenergy with capture and storage (BECCS) capability
- Gas turbines – with modifications for integration of molten carbonate fuel cell (MCFC)
- CHP engine for multi-sustainable fuel configuration
- Energy-from-waste boiler
- Fuel cell based micro-CHP

Oxy-fuel and high-pressure supercritical CO_2 (sCO_2) technology:
- High pressure heat exchanger test bed and shock tube test facility
- 250kW of biomass air/oxy-fired combustion test facility (CTF) with capability to use coal/biomass/clean wood waste fuels

CO_2 capture and utilisation (CCU) technology:
- Amine CO_2 capture plant – modified for integration with the flue gas and co-product gas manifold systems
- CO_2 capture rotating packed bed
- Molten carbonate fuel cell (MCFC) and gas infrastructure for co-generation & next generation CO_2 capture technology
- Fischer-Tropsch and fuels plant, and product gas infrastructure for utilisation of CO_2

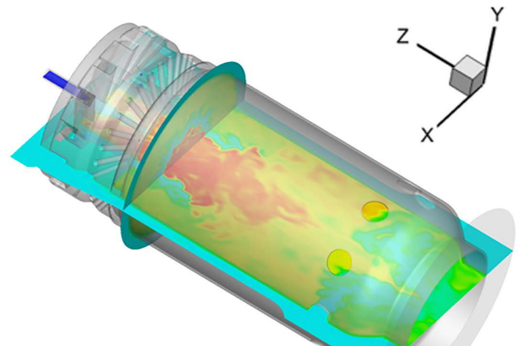
Hydrogen production:
- Hydrogen electrolyser
- Reforming in MCFC
- Biomass gasification
- Hydrogen Fuel Cell Heating system

Clean, renewable electricity generation and storage:
- Electrical energy storage (batteries)
- Solar PV panels
- Polymer electrolyte membrane fuel cell (PEMFC)

General:
- Gas mixing facility – synthetic/model flue/process gas
- Gas analysis and measurement facilities
- Particle, P, and aerosol measurement facilities
- Unique Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) facilities

Integration:
- Smart energy management (SEM) module
- Low-carbon heat management system

CFD modelling and simulation:
- A complementary validating system including advanced computational modelling, experimental testing and detailed imaging
- Multiple modelling stations pre-loaded with relevant software including CAD Drawing, Fluent, Aspen, Chemical Kinetic, Matlab/Simulink
- Ensures a credible output and in-depth understanding and control of the impact of energy system characteristics and integration, critical reaction kinetics, emissions and combustion processes.



CFD modelling of
Instantaneous temperature
In Gas Turbine Combustor

Analytical and measurement capabilities:
- Signal stack gas analyser system (O_2, CO_2, CO, NOx, THC)
- Gasmet FTIRs for flue gas analysis (O_2, CO_2, CO, NOx, SO_2, HCs, HCL, HF) and emissions from the CO_2 capture process (NH3, CH_2O, amines, etc)
- ETG syngas analyser (H_2, CH4, CO_2, CO, O_2, THC)
- Portable Servomex analyzers (O_2, CO_2)
- DMS500 submicron aerosol analyser
- Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) for online multi-metal emissions detection (including K, Na, Hg, Cr, Cd, Pb, V, Zn; as well as Ag, Al, B, Br, Ca, Co, Cu, Fe, I, Li, Mg, Mn, Ni, P, S, Sb, Sc, Ti, Si, Sn)
- Analytical probes: Ellipsoidal radiometer, flame imaging camera probe, suction pyrometer, gas sampling probes, particle collection probe, corrosion and deposition probes

Additional capability:
- Both AC and DC electrical infrastructures
- Grid-tied to enable excess clean and renewable energy to be exported
- The entire facility and its various equipment and systems will be controlled by a smart energy management system, enabling research into integrated grid technologies and enabling a 'whole energy system' approach
- Plug-and-play facilities to enable visiting researchers to bring their own equipment and connect it to our infrastructure to enhance research and testing abilities
- A heat pump which will generate heat for the building itself, as well as heat for additional buildings connected to the Translational Energy Research Centre

Part of something bigger

The University of Sheffield Energy Institute.

The Translational Energy Research Centre is part of the University of Sheffield's Energy Institute. The Energy Institute has been established to highlight the work of over 300 researchers across a wide variety of disciplines who focus on the generation and use of energy and its implications.

As part of the Energy Institute, the Translational Energy Research Centre has access to some of the best minds in energy research, as well as access to successful industry partnerships with global companies such as Siemens Gamesa, Boeing and McLaren. The combination of the work of the Translational Energy Research Centre and the access enabled by the Energy Institute will ensure our focus remains on aligning early stage research with current and future commercial goals.

The Translational Energy Research Centre in the UK.

In order to bring together the technology, research and innovation happening across the UK and, significantly, in the North, the Translational Energy Research Centre will sit alongside other, future centres for research on key facets of sustainable energy.

The facility and its neighbouring research centres will, in turn, make up part of the Northern Corridor for Energy Innovation Growth Centre, which will combine the work of the Translational Energy Research Centre and other Northern energy centres to improve the regional economy and spread innovation.

Get in touch:

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