UNIVERSITY OF ABERDEEN

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School of Engineering
RESEARCH

Welcome...

The School is recognised as an international leader in engineering education, research and the application of knowledge to benefit society globally. It has established itself as a partner of choice for many world-leading institutions.

The School offers a rigorous engineering education in a distinctive multi-disciplinary engineering environment, with world class fundamental and applied research and outstanding accredited undergraduate and postgraduate degree programmes.

Its size and multi-disciplinary engineering philosophy supports a distinctive sense of community and diversity of perspectives. The School's style of research fosters dynamic close engagement between researchers, industry and users. This mix of activities provides a stimulating and friendly environment in which students and researchers collaborate and flourish as individuals.

Professor Ekaterina Pavlovskia,
Head of School of Engineering

Some of our university collaborations include:

- Harvard University, USA
- California Institute of Technology, USA
- University of California at Berkeley, USA
- University of California at Santa Barbara, USA
- Berlin Technical University, Germany
- Karlsruhe Institute of Technology, Germany
- Wuhan University, China
- Texas A&M University, USA
- Tokyo University of Science, Japan
- University of California, USA
- Tsinghua University, China
- École Polytechnique Fédérale de Lausanne, Switzerland
- Laboratoire des Écoulements Géophysiques et Industriels (LEGI) Grenoble, France
- ETH Zurich, Switzerland
- Indian Institute of Technology (Chennai), India

Some of our industry collaborations include:

- NASA, USA
- European Space Agency, France
- Bosch, Germany
- Halliburton, USA
- Deltares, Netherlands
- HR Wallingford, UK
- Mitsubishi Electric R&D Centre Europe, France
- Thales-Alenia Space, France
- Mozilla, USA
- Cisco Systems, Norway
- Dell-EMC, Ireland
- Simula Research Laboratory, Norway
- RTE, France
- Scottish and Southern Energy, UK
  CNES, France
- PEMEX, Mexico

Applied Dynamics and Structures

The Applied Dynamics and Structures Research Group is a multidisciplinary Research Group conducting interlinked research in the areas of Dynamical Systems, Sustainable Structures, Renewable Energy & Energy Transition, and Energy Systems' End of Life, in close collaboration with Centre for Applied Dynamics Research (CADR) and the National Decommissioning Centre (NDC).

Dynamical Systems research area includes both fundamental and applied research on the theoretical modelling of nonlinear systems, nonlinear oscillations, design methods with applications in passive and active vibration control, vibro-impact systems, rotary and percussive drilling, dynamics and control of smart structures, dynamics of machine tools and cutting processes, and precision ultrasonic machining.

Sustainable Structures research area covers sustainable materials and manufacturing, structural optimisation, structural health, condition and performance monitoring, and risk and reliability analysis, with applications in offsite manufacturing and sustainable mass housing, low-carbon seismic resistant buildings, ground anchorage systems, lightweight structures, smart and adaptive aero-structures, offshore structures and building energy efficiency.

Renewable Energy and Energy Transition focuses on the understanding and development of energy systems in the context of global climate change and the transition to renewable and low-carbon energy production, distribution, and integration. It includes areas such as offshore renewable energy, innovative energy harvesting systems, distributed hybrid renewable energy systems, end-user driven design and multi-objective optimisation of energy systems, green hydrogen and utility-scale energy storage systems, energy management systems, virtual power plants, and energy transition scenario development under uncertainties.

Energy Systems' End of Life with a focus on decommissioning, repurposing, re-use and recycling of offshore oil and gas infrastructures and windfarms. This research cluster conducts both fundamental and applied research in the areas of underwater laser cutting, multidisciplinary modelling and data-driven decision making, and smart energy basin.

Areas of Expertise

- Non-linear Dynamics and Control
- Drill-string Dynamics and Resonance Enhanced Drilling
- Hybrid Renewable Energy Systems and Energy Transition
- Structural Design and Optimisation
- Structural Health Monitoring and Testing
- Lightweight and Sustainable Structures
- Offshore Energy Systems Decommissioning and Repurposing
- Risk and Reliability Analysis and Decision Making Under Uncertainties
- Geotechnics and Soil-Structure Interaction

Facilities and Equipment

- Resonance Enhanced Drilling Rig and Drill String Dynamics Laboratories with custom drill bit stick/slip rig.
- LDS V806 and V725 vibration excitation systems (both with optional large load table)
- Custom-made towing tank with sand channel for seabed-structure interaction modelling
- Instron materials testing machines
- Micro CT scanners
- Real-time marine simulator (based at NDC)
- LED Boom Stand Stereo Zoom Microscope with built-in Camera
- Specialised software package MOHRES for design and optimisation of multi-vector energy systems and design of energy transition scenarios
- Wind energy specialised software suite for decommissioning and repurposing of offshore windfarms, design and simulation of wind turbines, and layout optimisation of windfarms
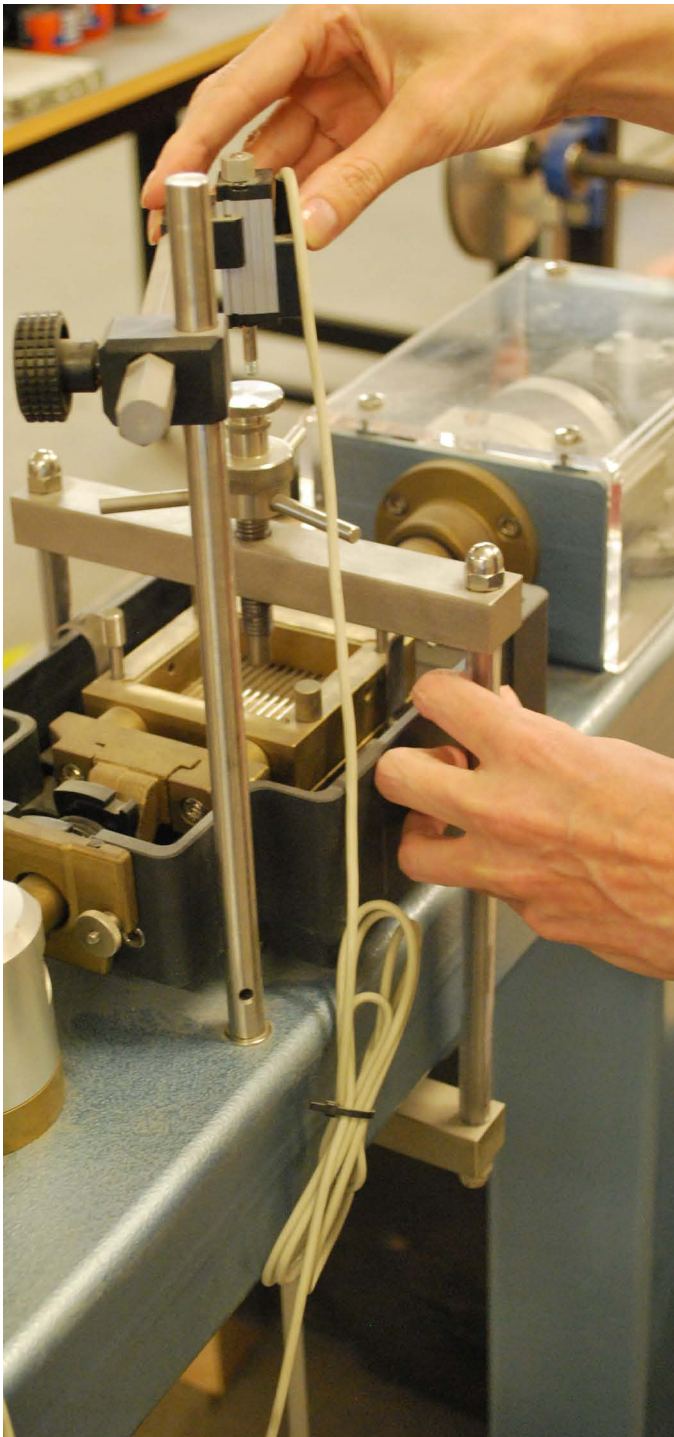
Resonance Enhanced Drilling (RED), a new downhole drilling technology offering significant cost reduction and smaller environmental footprint, is being commercialised.
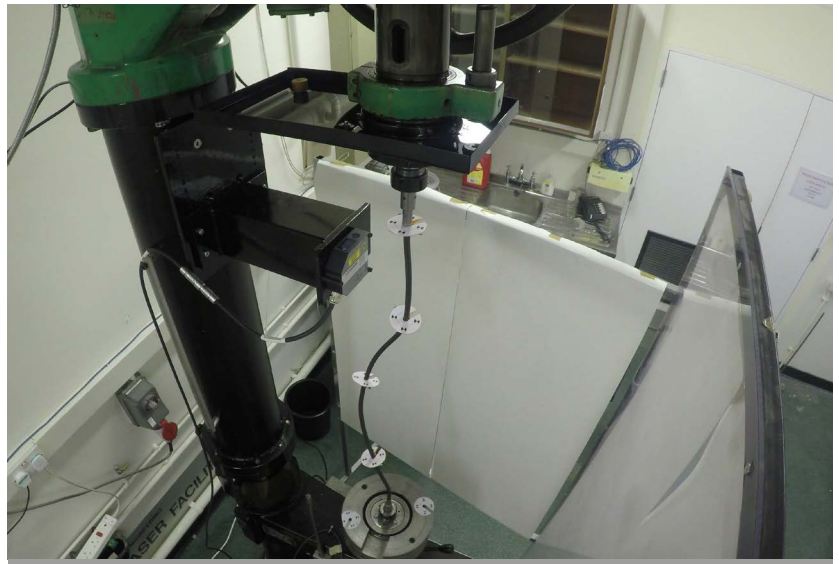
A unique experimental stand is designed to test nonlinear behaviour of drill-strings including stick-slip, bit bounce and whirling.

A multifunctional formation damage test rig designed and fabricated at the School of Engineering is being used to simulate practical drilling and production operation scenarios in shale, limestone and sandstone formations at reservoir conditions.

Chemical Processes and Materials

The research in the Chemical Processes & Materials (CPM) Research Group focuses on applications in energy and sustainability. We work on valorisation of unavoidable waste, turning it into base-chemicals and energy carriers such as hydrogen. We develop carbon capture and utilization processes which are an important component of the drive to net-zero carbon emissions into the atmosphere. Energy storage materials are being designed and improved, for instance in light of the electrification of mobility. Hydrocarbons will remain a part of the energy mix in the foreseeable future. Optimisation – for instance through Artificial Intelligence – of enhanced hydrocarbon recovery is a significant research activity in the group. Large-scale production, storage and distribution of hydrogen comes with vast (engineering) challenges; we are committed to contributing to ways of overcoming these.

These research activities are underpinned by a range of experimental and modelling capabilities that operate on a wide spectrum of length and time scales. From the (large) systems level (the circular economy) to measuring and simulating at the molecular scale. More specifically, we have expertise in catalysis (e.g. non-thermal plasma catalysis), reactor engineering, spectroscopy, electrochemical analysis, multi-scale simulation of transport processes, colloids and interfaces, chemical thermodynamics & process simulation, and various technologies for hydrocarbon production.

Areas of Expertise

- Catalysis
- Reaction engineering
- Kinetic modelling
- Biochemical engineering
- Multiphase flow
- Transport processes
- Molecular dynamics and Granular dynamics
- Ionic liquids
- Energy storage / fuel cells
- Well design and integrity
- Reservoir characterisation, performance and simulation
- Methane production from natural gas hydrates in porous media
- Enhanced oil and gas recovery
- Geological utilisation and storage of CO_2
- Flow Assurance: wax, hydrates, asphaltene and scale inhibition (subsurface and facilities)

Facilities and Equipment

- A state-of-the-art chemical engineering research lab
- Gas chromatographs
- Spectrometers
- Microwave facilities
- Micro activity-effy unit for measuring reaction kinetics
- Solubility measurements of gases and vapours in liquids
- Modular coreflood rigs with custom-made Hassler cells, Teledyne ISCO 1000D pumps, and logged pressure transducers
- Multipurpose EOR rig
- Automated pilot-scale gas lift oil production rig

A multipurpose enhanced oil recovery (EOR) rig developed at the School of Engineering is used in laboratory studies of different recovery methods associated with chemical, thermal and gas injection processes. The rig is unique in its ability to automatically switch between different EOR techniques, separate different phases and treat downstream waste gases for storage and disposal.
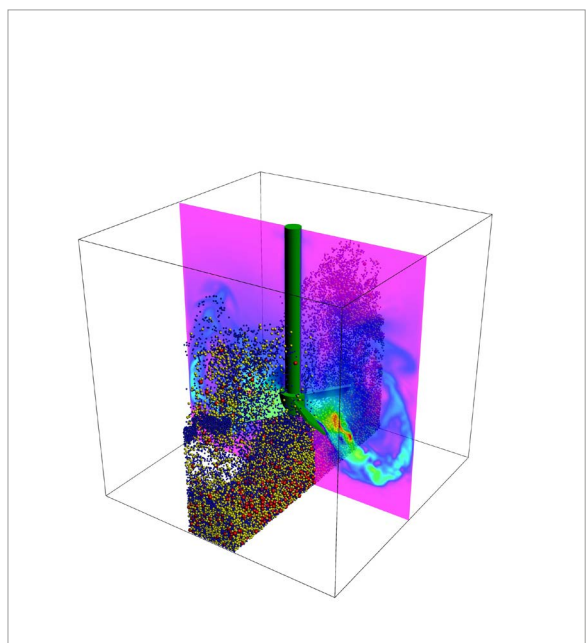
Electrical Systems and Electronics

The Electrical Systems and Electronics Research Group advances fundamental knowledge and innovation across the spectrum of engineering. It enjoys an international reputation that spans new semiconductor devices and laser components for holographic cameras to techniques for high power DC transmission; algorithms for subsea sensor networks; new Internet transport mechanisms and the design and control of novel robotic platforms. Internet Engineering, researchers have defined new transport technologies for the modern Internet, impacting the way networks are designed, and contributed large-scale measurement campaigns to understand how networks are currently operated. Our group contributes to the Internet Engineering Task Force, setting new standards for transport protocols and network architecture.

Research in Artificial Intelligence, Robotics and Mechatronic Systems (ARMS) is leading development for precision positioning systems, active vibration isolation, assistive technologies and explainable AI. This combines machine learning, non-linear control, industrial and soft robotics, and bioengineering applications.

Optronics researchers are developing instruments for subsea applications, including digital holography and laser-induced breakdown spectroscopy (LIBS). We are building the world's smallest pulsed digital holographic camera to enable fast image extraction. Theoretical research is exploring coherent detection for optical fibre transmission and developing ultra-short pulses in silicon waveguides for compact optical systems.

The Aberdeen High Voltage DC (HVDC) Centre is leading the design and analysis of power systems and power electronics. Research includes power electronics applications to transmission systems such as HVDC transmission and Flexible AC Transmission Systems (FACTS), with projects developing new technologies for high power DC transformers and circuit breakers. We have a strong record of engagement with industry, through collaborative multinational projects (e.g. the EC Framework programme, European Space Agency programmes) and industrial funding. Support from industry shapes our research and stimulates research into new topics from modelling and experimentation to design of new systems and evaluation of prototype technologies.

Areas of Expertise

- Electrical Power Conversion
- High Voltage DC Transmission
- Internet Engineering for Protocols and Standards
- Network Performance Measurement
- Image and Video Processing/Transmission
- Sensor Networks, the Internet of Things
- Big Data and data mining techniques
- Mechatronics and Control
- Bio-inspired and Soft Robotics
- Biomechanics and Human Movement
- Photonics, Holography and Laser Applications
- Satellite Broadband Communications Systems

Facilities and Equipment

Extensive simulation facilities supporting a wide range of tools and EEE packages.

- The Aberdeen High Voltage Direct Current research centre provides a platform for power systems, power electronics and control engineering.
- The Internet engineering testbed provides state of the art facilities, and a range of tools to coordinate and perform global measurement campaigns.
- State of the art laser laboratory facilities supporting subsea holographic camera development and new laser applications.
- Soft robotics fabrication and testing laboratory.
- Human movement analysis lab with 3D opto-electronic motion capture and muscle activity sensing capabilities.
- The group is a member of the European Satellite Network of Experts (SatNEx), providing long-lasting integration of key European research centres.
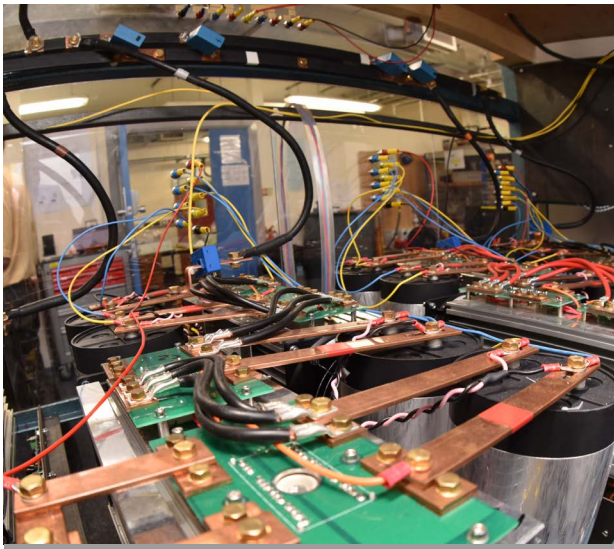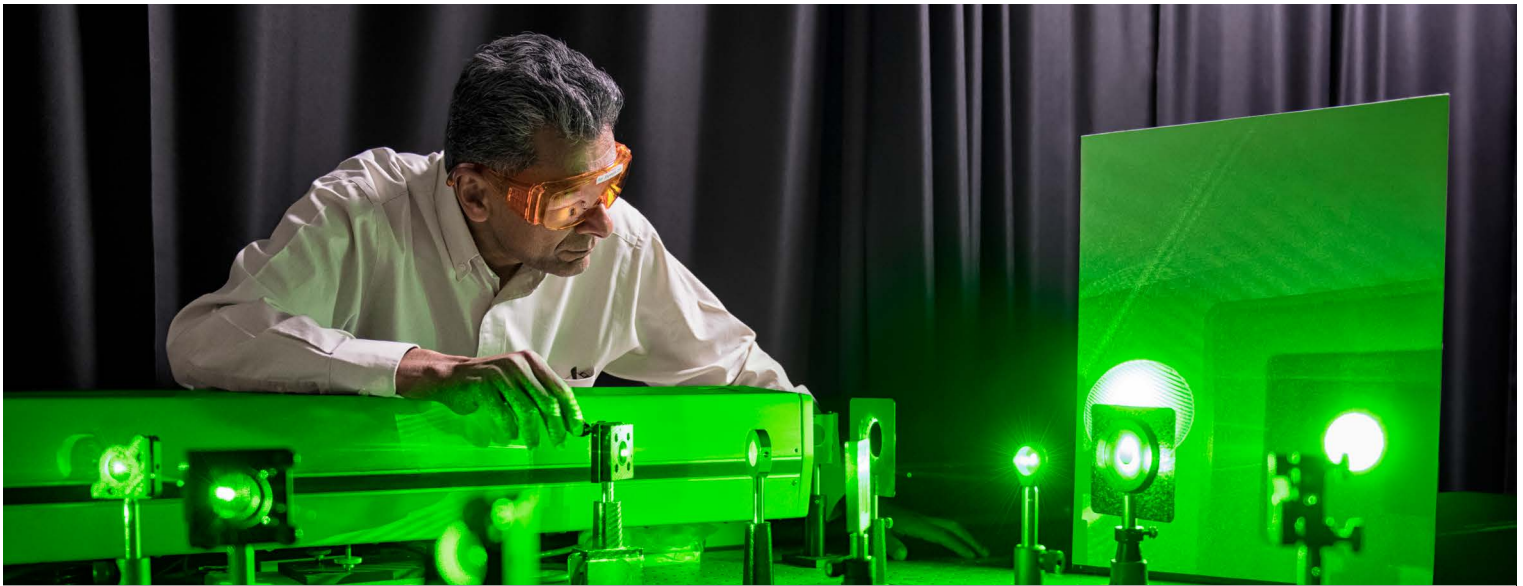
The Aberdeen HVDC (High Voltage Direct Current) research centre supports research and enables testing and capability demonstration of advanced power systems.

The ARMS group carries out research into the use of machine learning for improving the capabilities of autonomous robotic systems.

State-of-the-art laser facilities provide a unique light source and optical instruments that support research across a range of advanced engineering applications.
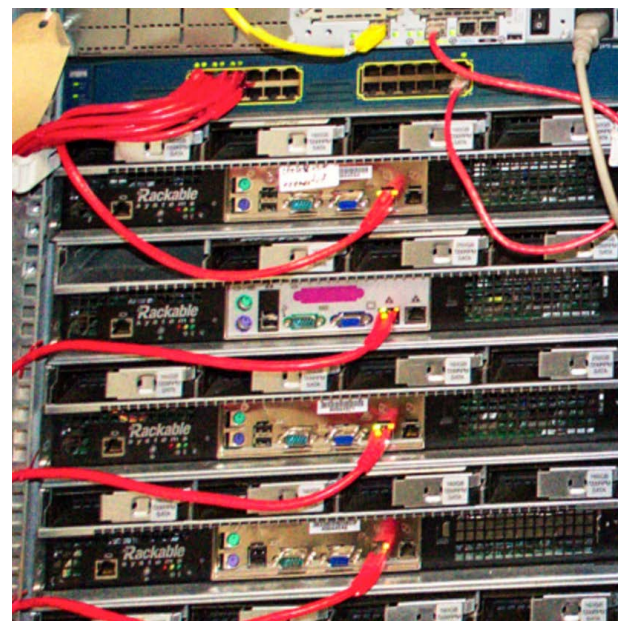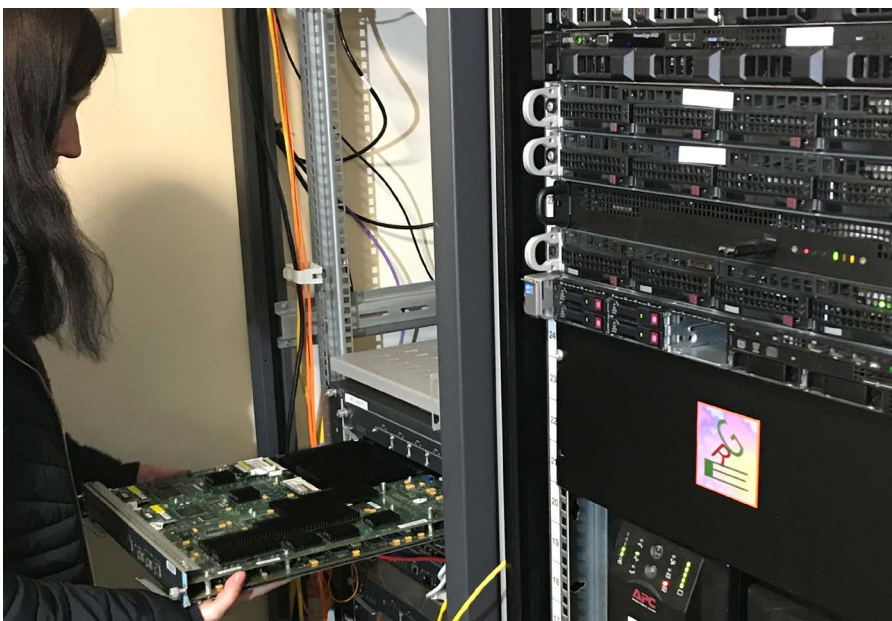
The Internet Engineering data centre houses advanced simulation and emulation of networks, access to radio links, and large scale measurement of Internet path characteristics.

Fluid Mechanics

The Fluid Mechanics Research Group in Aberdeen has a long history that started in 1946 when Professor Jack Allen was appointed to the Jackson Chair at the (then) Department of Engineering. Over the years, the research focus of the group has significantly expanded and currently covers a wide spectrum of present-day topics and problems.

The central goal of the Group is to advance fundamental knowledge of the fluids phenomena to develop better understanding and advanced tools for enhanced design and management of natural and engineered fluid systems and processes, such as rivers, canals, coastal seas, subsurface flows, multi-phase systems, biomedical flows and flow-biota interactions in aquatic systems.

The Group's research combines in-depth theoretical analysis, numerical simulations, and advanced experimentation, underpinned by advanced facilities and computational tools. Among them, the Group is proud of the Aberdeen Fluid Mechanics Laboratory which houses state-of-the-art water flumes, wave tanks and flow tunnels, equipped with advanced instrumentation such as the world-first robotic multi-camera Particle Image Velocimetry System developed by the Group, and other acoustic and laser-based measurement systems.

Areas of Expertise

- Hydrodynamics of open-channel flows: turbulence structure and transport processes, hydraulic resistance, surface-subsurface flow interactions, sediment dynamics
- Coastal hydraulics: oscillatory boundary layer flow, sediment transport processes, swash hydrodynamics, sea wave interaction with structures and vegetation
- Porous media hydrodynamics: steady and unsteady flows and transport processes in groundwater aquifers, coastal beaches, gravel beds of natural streams, and oil & gas reservoirs.
- Hydrodynamics of aquatic ecosystems and biomimetics: flow-organism interactions in rivers and coastal areas occurring at multiple scales, microplastic transport within coastal and freshwater systems, biomimetics of fish skin roughness
- Mathematical modelling in fluid dynamics: gas-cushioning in liquid-solid impacts, scaling law predictions, porous substrates
- Computational multi-fluids dynamics: multi-physics modelling, adaptive numerical methods, nuclear criticality, reactor physics, heat and mass transfers, fluid-structure interaction
- Biomedical fluid mechanics: blood flow in the circulatory system, interstitial fluid flow and mass transport in tissues
- Renewable energy hydraulics: hydrodynamics of tidal turbines and wave energy converters, stability and survivability of fixed and floating offshore wind turbines
- Geological utilisation and storage of CO_2

Facilities and Equipment

- Aberdeen Open Channel Facility (AOCF)
- Aberdeen Oscillatory Flow Tunnel (AOFT)
- Aberdeen University Random Wave Flume (AURWF)
- Armfield Open Channel Flume
- Aberdeen Streaming Potential Apparatus (ASPA)
- Aberdeen Tilting Lock Exchange Facility (ATLEF)
- Dam-break Swash Facility
- Open Channel Sediment Re-Circulation Flume
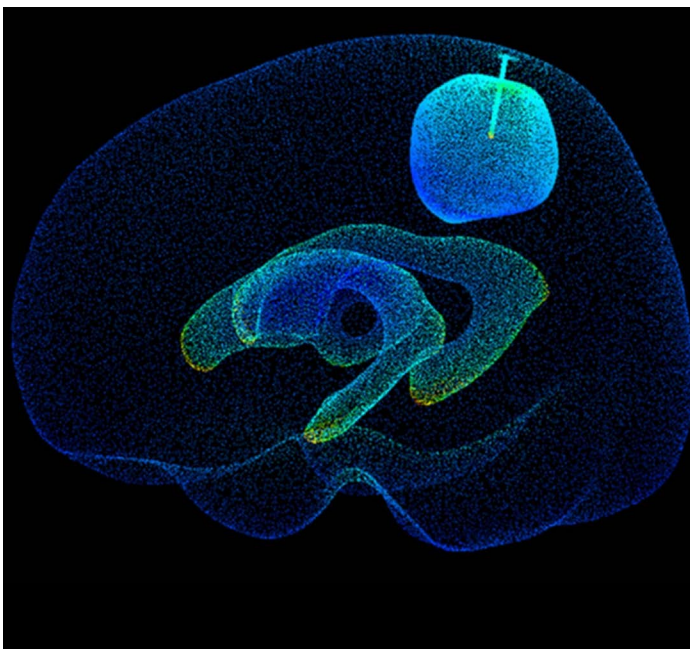- Xray Computed Tomography (CT scan) Facilities
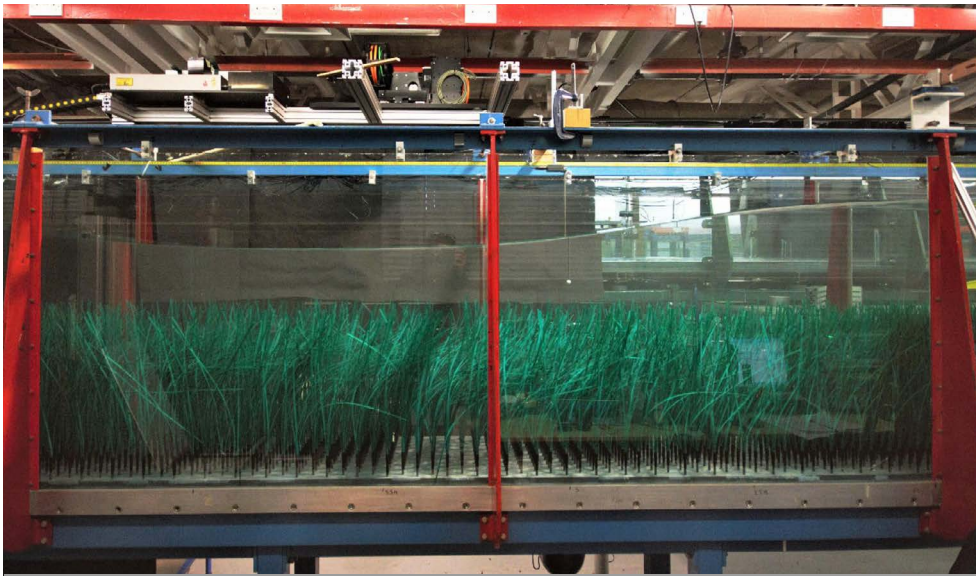
The Group's 20m long random wave flume is used to study wave interaction with coastal vegetation to develop nature-based solutions for coastal defence.
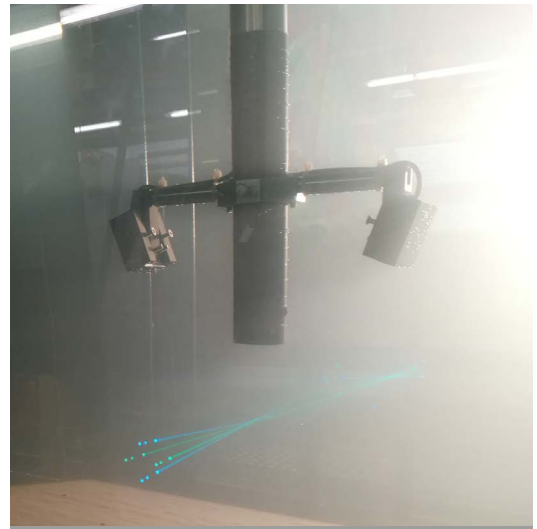
To study wave-seabed interactions Advanced acoustic and laser Doppler instruments are used for flow and sediment concentration measurements.


Multiscale modelling of drug delivery to brain tumours
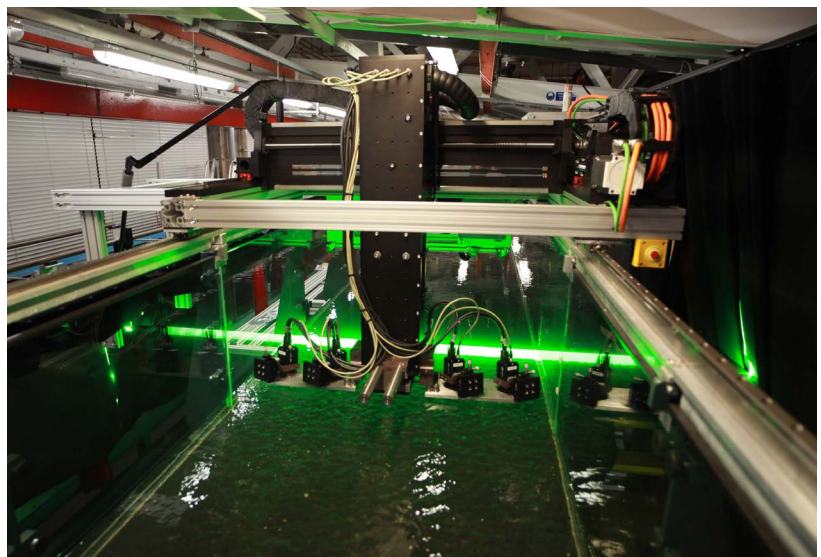
A robotic Particle Image Velocimetry System developed by the School is used in laboratory studies of flow dynamics, sediment transport and flow-biota interactions. The system's unique features include the flexibility to measure velocity fields at multiple locations and at various spatial scales.

In-situ study of river turbulence in the Urie River (Scotland) using an advanced Field Particle Image Velocimetry System developed by the School.
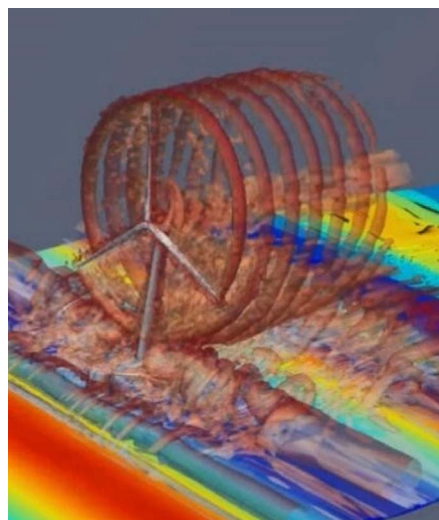
Multi-phase Computation Fluid Dynamics (CFD) simulation of a floating offshore wind turbine
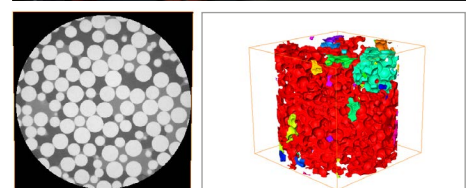
Micro-Computed Tomography is used to study fluid flows in porous media at pore scale (microns). Results are upscaled to laboratory (cm) and field (km) scales.

Solid Mechanics and Materials

The analytical, computational and experimental work of the group covers a wide range of advanced structural and functional materials and material systems. It is aimed at understanding and predicting their mechanical behaviour at different lengths scales, leading to the development of new analytical and computational models that capture complex structure-property relationships in these materials. Ongoing research interests encompass multiscale mechanics of materials and processes, modelling of deformation, damage and failure, contact mechanics, wave propagation, conventional and unconventional manufacturing processes and their optimisation, development of multi-scale residual stress measurement methods, quantification of 3D damage in components using X-ray tomography, topology and design optimisation, data driven computational methods, and material degradation due to different corrosion mechanisms including hydrogen material interaction.

Members of the group are involved in the work of the Centre for Transport Research, which specialises in the sustainability of transport systems with emphasis on environment, society and technology, and the Centre for Micro- and Nanomechanics, which brings together researchers interested in various aspects of micro- and nanomechanics within solid mechanics, mechanical engineering and materials science.

Industry-focused research of the group is increasingly geared towards renewable energy systems and infrastructure and addresses the engineering challenges posed by the decommissioning of offshore oil & gas installations. The work of the group plays a significant role in the University's Energy Transition strategic research theme and the recently established National Decommissioning Centre.

Areas of Expertise

- Advanced Composite Materials and Structures
- Control and Condition Monitoring
- Design Optimisation
- Fluid-Structure Interaction
- Fracture Mechanics
- Impact and Explosion Mechanics
- Materials Processing and Modelling
- Micromechanics and Nanomechanics
- Nonlinear Mechanical Systems
- Novel Materials for Subsea Applications
- Solid Mechanics
- Structural Integrity
- Vibro-Impact Systems
- Wind Energy

Facilities and Equipment

- Instron 8500 250kN hydraulic testing system with fatigue capability
- Instron 1185 and 4483 tensile/compression testing machines
- Hounsfield HENV-0116 testing machine with environmental chamber
- Nikon XT225 microCT scanner
- Zeiss XRadia Versa 410 microCT scanner
- X-ray compatible material testing system
- Cortest HPHT (100MPa, 200oC) autoclave (100MPa, 200oC) for corrosion studies
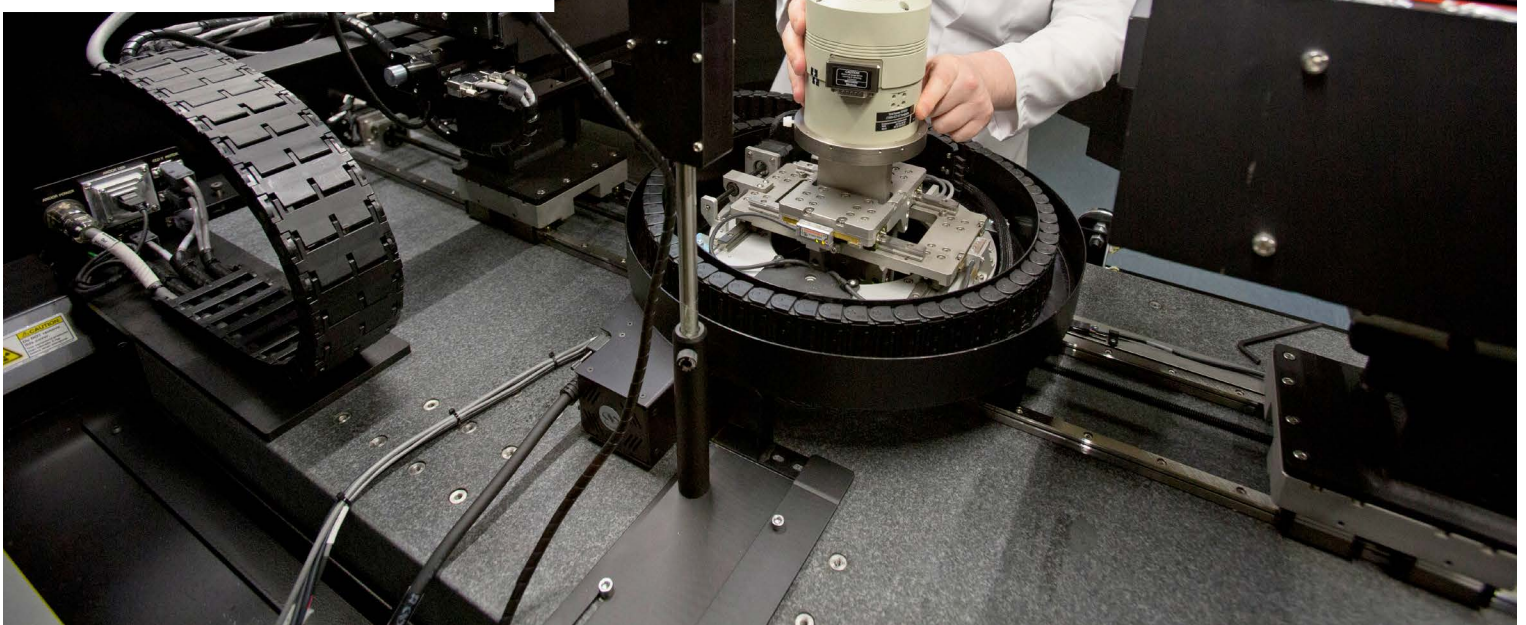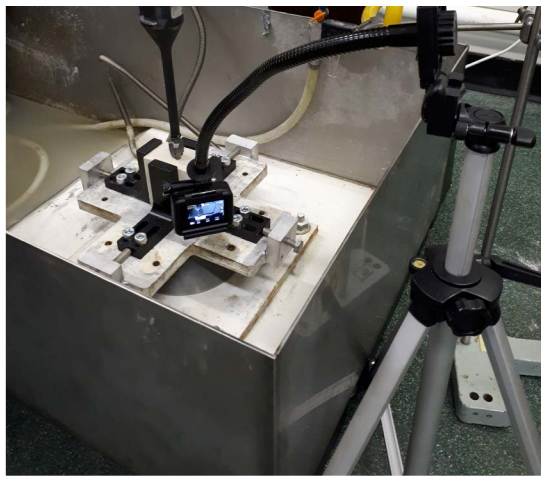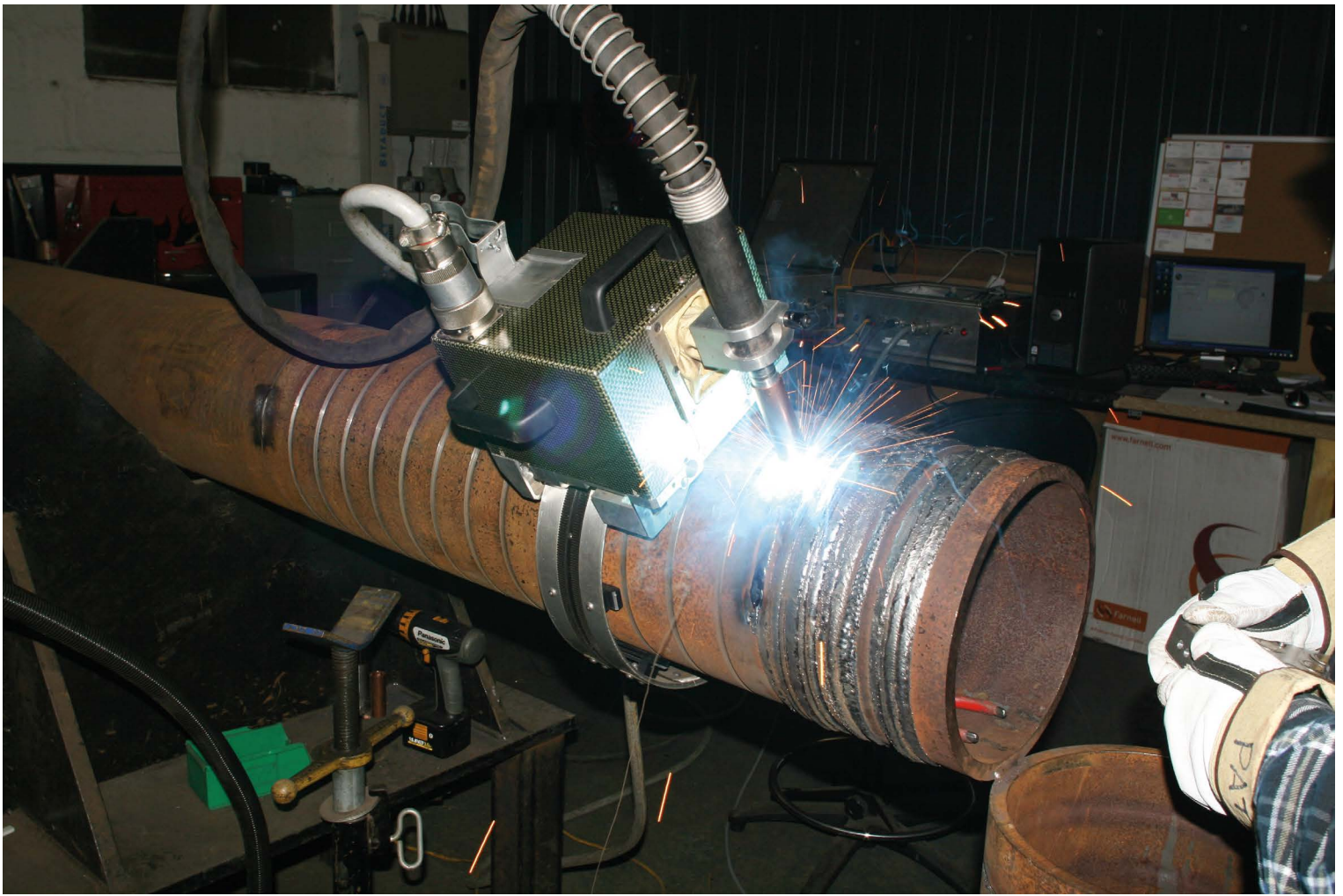
National Decommissioning Centre

Combining industry expertise with academic excellence, the NDC is working in partnership with the energy sector to lead research and development that supports the sector to achieve cost and emissions reductions, improve environmental outcomes and transform approaches to deliver sustainable net zero decommissioning.
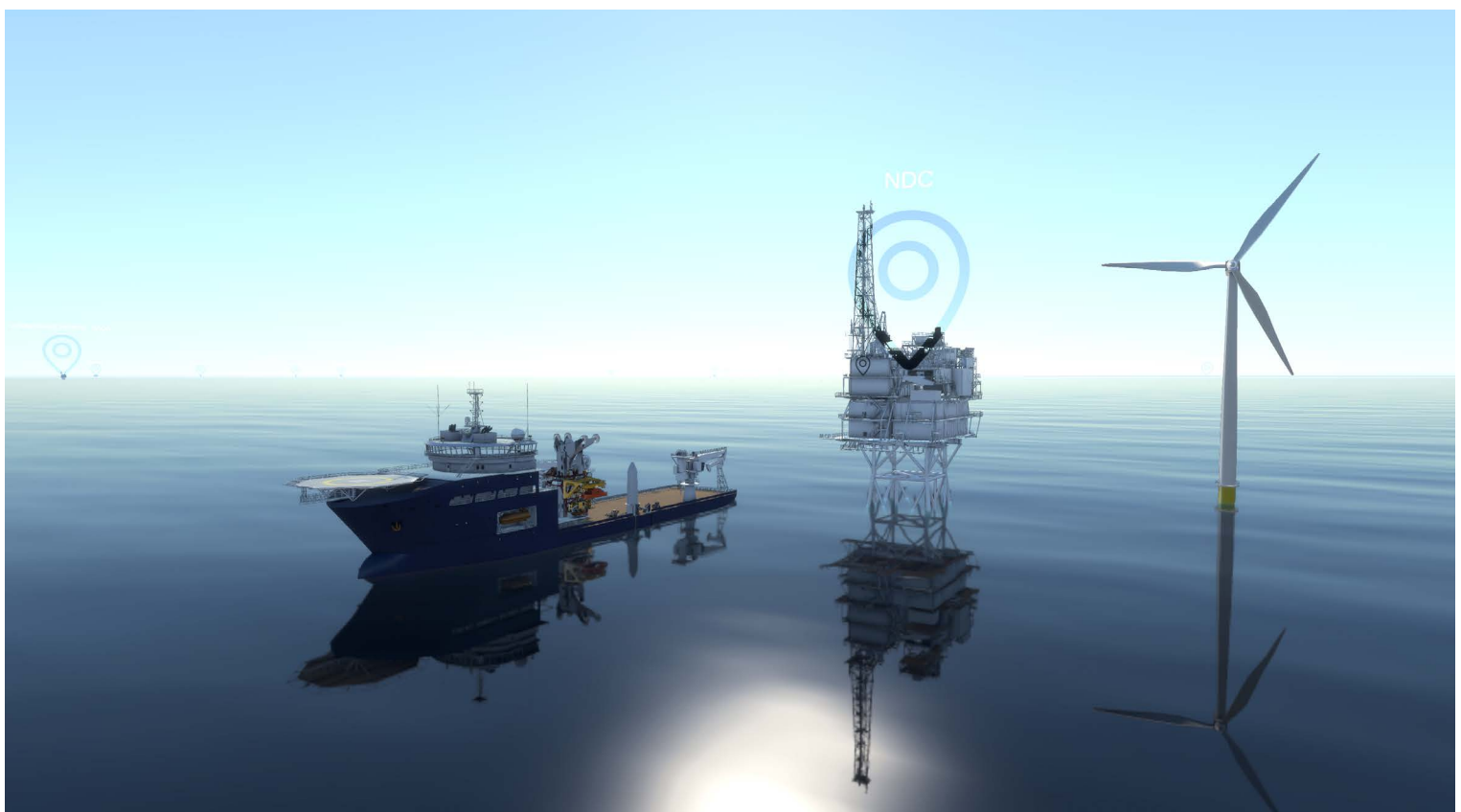
The NDC builds on the world-leading R&D capability at the University of Aberdeen in areas such as decommissioning technologies, predictive modelling, environmental assessment and the economics and regulatory aspects of decommissioning.

Working across the oil and gas, nuclear and renewables sectors the NDC adds value and creates competitive advantage by linking industry demand and expertise with academic capability and skills. The NDC collaborates nationally and globally with universities, R&D institutions, and innovation centres active in decommissioning and energy transition, and partners with fishing, marine, safety and environment organisations.

Based in Newburgh, Aberdeenshire, in the Energetica corridor, the Centre hosts state-of-art facilities, including a Marine Simulator, Underwater Laser Cutting System and a Well Plugging and Abandonment (P&A) Barrier Qualification Test Chamber. Other facilities include a high-tech digital visualisation suite to enable collaboration, high specification engineering laboratories and a large hangar space for the design and development of decommissioning technology, as well as a suite of environmental commercial testing facilities.

The National Decommissioning Centre (NDC) is a partnership between the University of Aberdeen, the Net Zero Technology Centre (NZTC) and industry, part of the Aberdeen City Region Deal.

Find out more at
www.ukndc.com