

Energy Research and Teaching at Cranfield

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Professor of Energy Technology



Who are we?

- The UK's only **100% graduate** university specialising in science, technology engineering and management
- We have a **global reputation** for inspirational **teaching** and **research**, industrial-scale **facilities** and **first class links** with industry and commerce

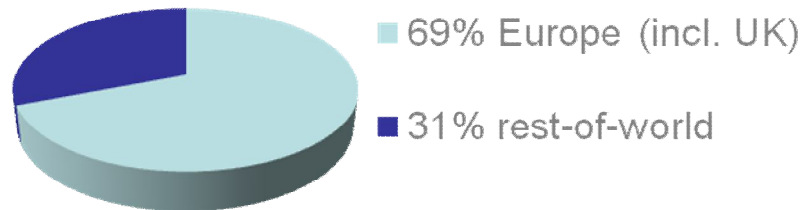
We are one of the UK's top five research intensive universities

We work with more than 750 businesses in 40 countries across six continents

Our MBA is ranked top in the UK and 15th in the World*

International Cranfield

- Cranfield is international in many ways:
- 2,500 students from over 100 countries



- Research recognised around the globe
- Academics from all over the world
- International industry connections including Boeing, GlaxoSmithKline, Unilever, BAE Systems, Alstom, Doosan Power, Rolls Royce, Siemens, BP, Airbus



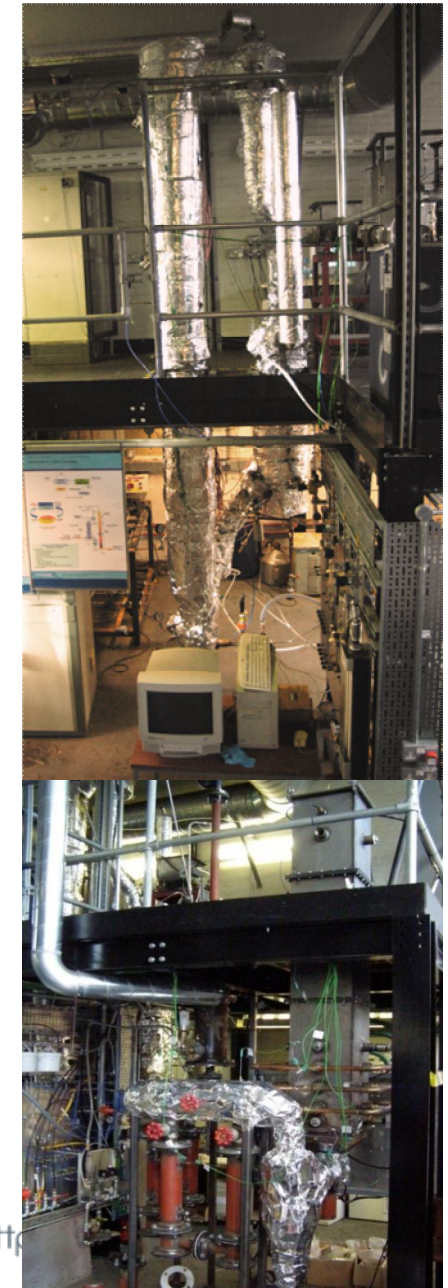
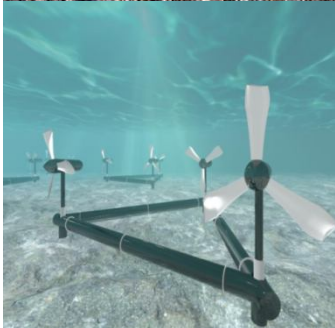
Themes



- Aerospace
- Automotive
- Defence & Security
- Energy
- Environment
- Healthcare
- Management
- Manufacturing

Energy Research Capabilities

- Energy policy and regulation, end-use energy systems, efficiency and life cycle analysis
- Power systems – components, integration and modelling
- CO₂ capture and transport
- Energy from biomass and waste – systems, supply chain and resource efficiency
- Environmental impacts, emissions control and waste management
- Materials, inspection, reliability, asset management and risk-based maintenance
- Conventional and advanced fuels – production and conversion technologies
- Renewable energy technologies – offshore/onshore wind, wave and tidal, solar thermal and photovoltaics
- Oil and gas production, infrastructure and flow assurance
- Electric power machines, control & grid systems

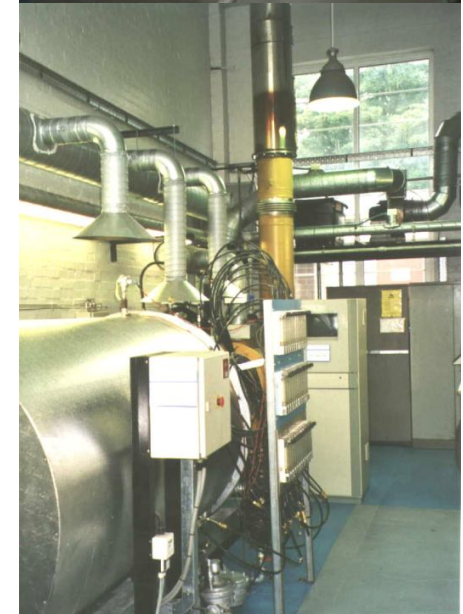


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Large-scale Energy Facilities



- Algae biomass
- CO₂ Capture
- Combustion
- CT Structural Integrity
- Chemical Looping
- Gasification
- Gas Turbines/Burner Rigs
- Offshore Fluids
- HP Steam
- Process Systems
- Wave/Tidal
- Vertical Axis Wind Turbine



Combustion of Solid Fuels

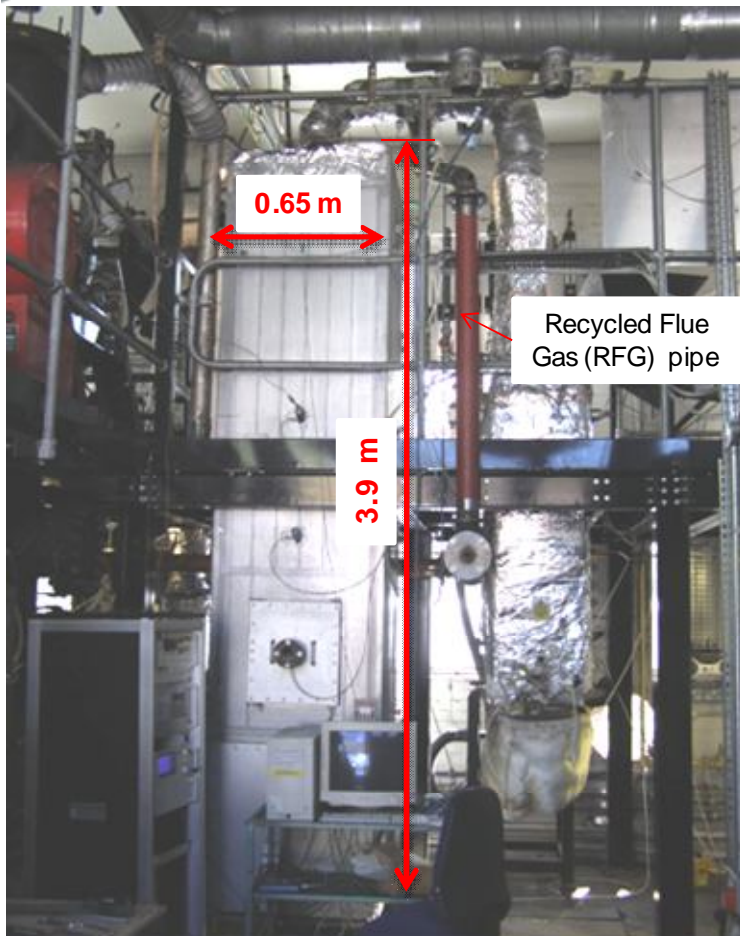
(UKCCSRC – PACT)

Combustion units include:

- Pulverised fuel combustor (100 - 200kW_{th}, air- or oxy-fired)
- Circulating fluidised bed combustor (200-300kW_{th}, air- or oxy-fired)
- Bubbling fluidised bed

Research focussed on:

- Co-firing of Biomass, Energy Crops and Waste with Coal
- Evaporator and Superheater Materials and Coatings
- Deposition and Corrosion
- Modelling corrosion performance
- Gaseous Emissions and Residues
- Component Life Assessment & Boiler Reliability
- Oxy-combustion
- CO₂ Reduction with Sorbent Injection

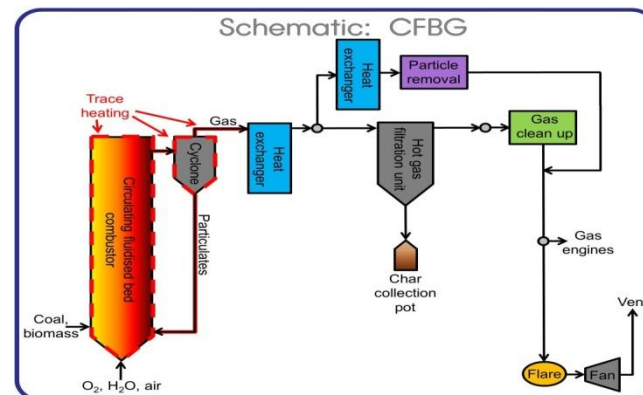
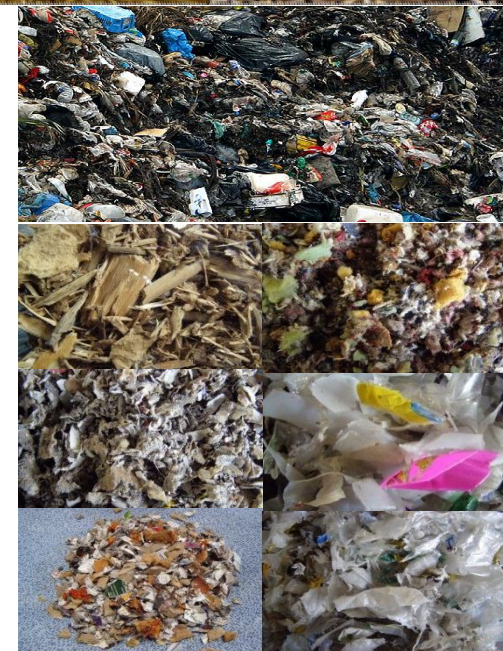


Bioenergy and Energy-from-Waste

- Combustion/Incineration
- Anaerobic Digestion
- Pyrolysis and Gasification
- Resource Estimation
- Co-firing
- Materials and Coatings
- Deposition and Corrosion
- Gaseous Emissions and Residues
- Biogenic Content



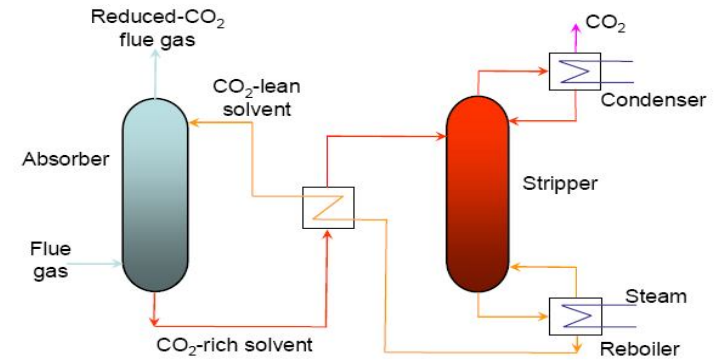
Downdraft Gasifier



CO₂ Capture

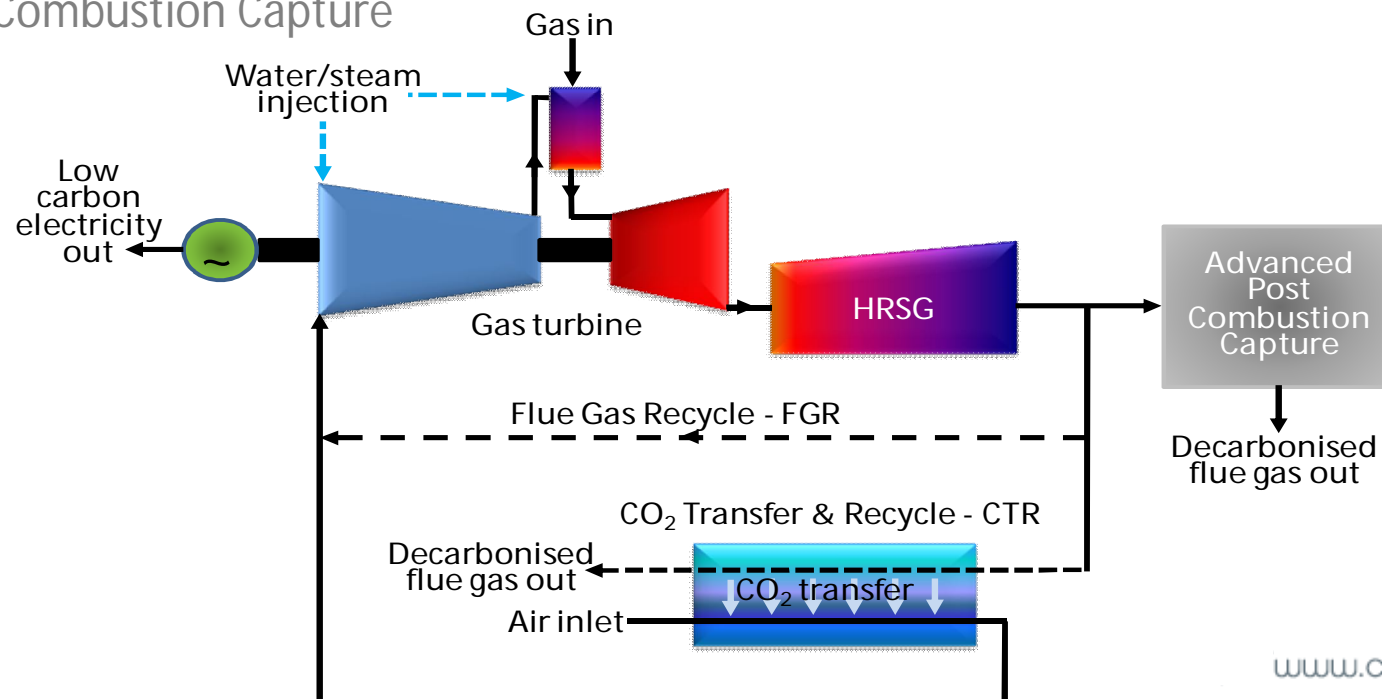
CO₂ Capture Methods

- solid sorbents (CaO)
- oxyfuel
- amine scrubbing
- membrane separation
- process modelling



Amine CO₂ Scrubbing

Gas Post Combustion Capture

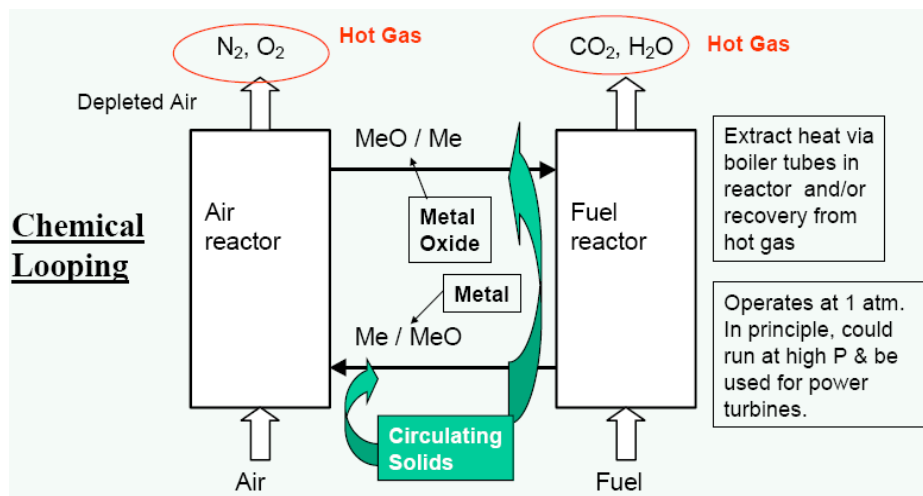


Chemical and Ca Looping

(UKCCSRC PACT)

Pilot scale.(50 KW_{th}) chemical looping facility - largest UK facility

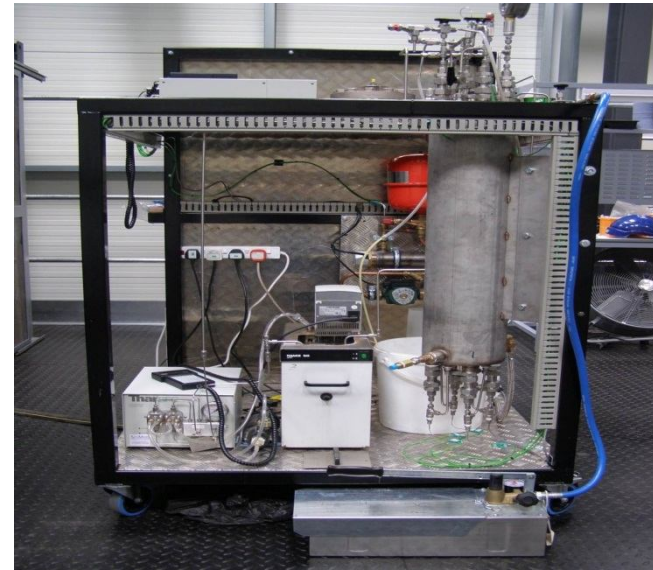
- Flexible in configuration, either as
 - Twin CFB legs or
 - Single entrained flow riser with bubbling bed (2nd reactor)
- Chemical looping mode-either for oxy-combustion, O₂ or H₂ production



CO₂ transport

Pipeline integrity

- Low temperature fracture
- Crack arrest methods



Supercritical CO₂ dynamic flow loop facility (UKCCSRC – PACT)

- operates above 90 bar, 40 deg (capable for up to 700 bar & -50 to 150 deg) in flow mode (fluid flow rates up to 5l/min)
- Measurement of physical properties - density, pH, temp, pressure
- Impurity injection – H₂O, H₂, H₂S, NO_x, SO₂ and O₂

Gas Turbine Engineering

Gas Turbine Engineering Laboratories



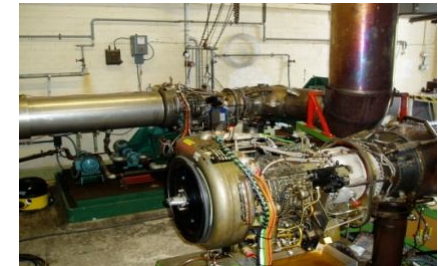
High Pressure Air Plant



CNC facility and workshops



Hot end instrumentation
facility



High Speed Test Houses



HP Regenerative Air Heater



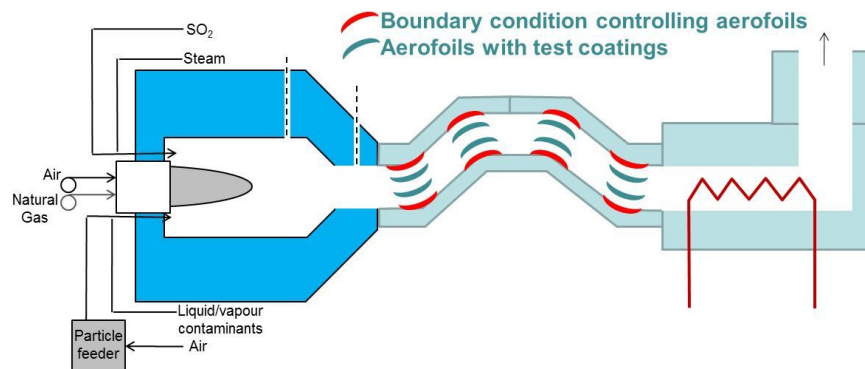
Low Speed Aerodynamics -
Renewables
www.cranfield.ac.uk

Gas Turbine Fuels and Materials

- Deposition, Erosion and Corrosion on Turbine Blading
- Blade Materials and Coatings
- Impact of Plant Cycling
- Thermal Barrier Coatings
- Impact of Gas Contaminants from biomass/waste-derived gases
- Component Life Assessment
- Combustor Materials
- High Temperature Heat Exchangers



Gas Turbine Burner Rig (750kW_{th} , $>1500^\circ\text{C}$)
(UKCCSRC – PACT)

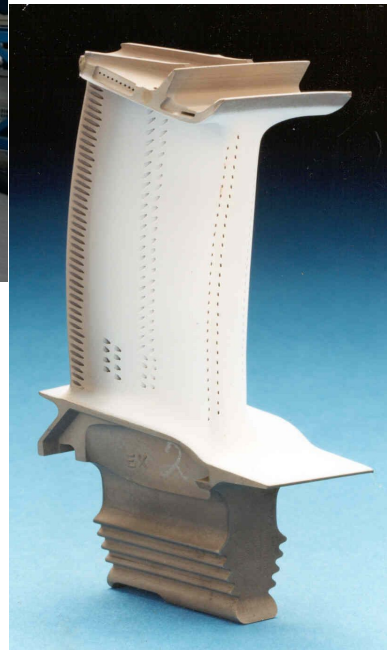


Surface Science and Engineering

- EB-PVD ion plater (1000°C process temp)
- EB-PVD evaporator
- Resistive heated evaporators
- Multi-target sputtering systems
- Single target sputtering systems
- Pack cementation, over pack CVD and gas phase CVD
- Controlled atmosphere plasma spraying
- Hot isostatic pressing
- Electroplating
- Metallurgical and Surface Analysis Suite



- Advanced Coatings
- Corrosion Life Modelling
- Process Simulation - physical/mathematical



Subsea Energy Systems

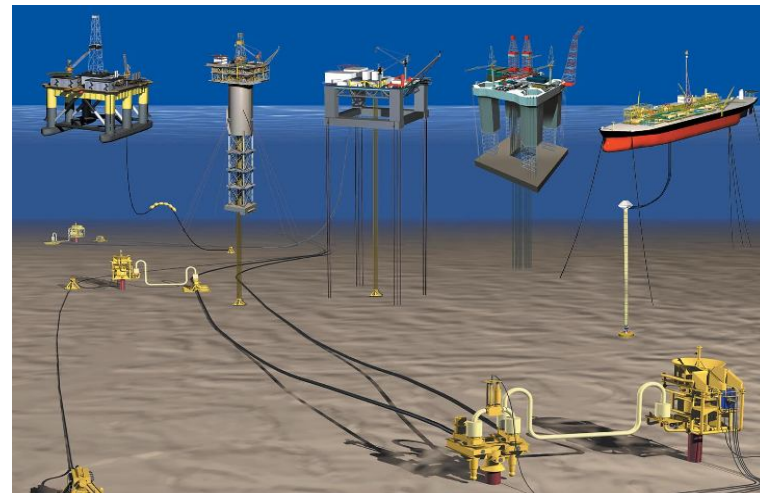


Multiphase Flow and Flow Assurance

- Multiphase flow – modelling & measurement
- Severe and hydrodynamic slug – control & simulation
- Sand transport
- Separation and transport options

Floating Systems

- Wave Spectrum
- Hydrodynamics
 - scattering (FK+Diff)
 - radiation
 - restoring
- Hydroelasticity
- Riser Dynamics
- Fully coupled equation of motion

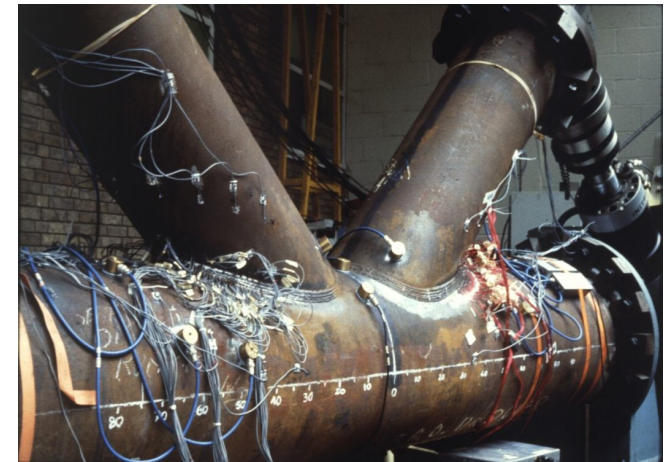


Offshore Structural Integrity

- Fatigue analysis
- Fracture Mechanics
- Materials & Corrosion
- Integrity Monitoring
- Engineering Criticality
- Large-scale testing
- FEA



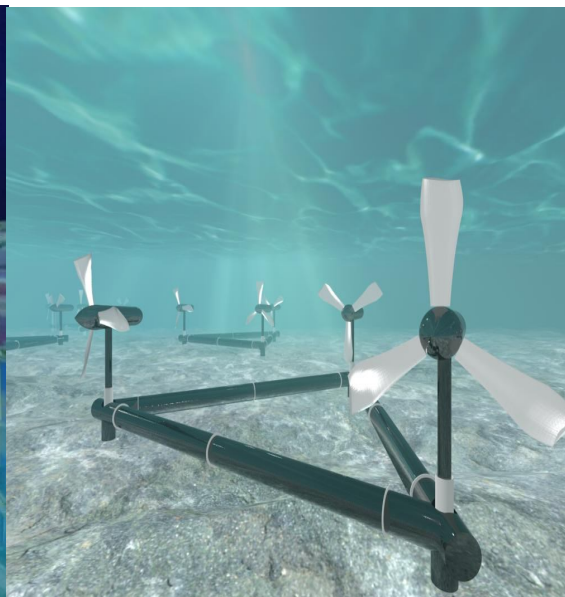
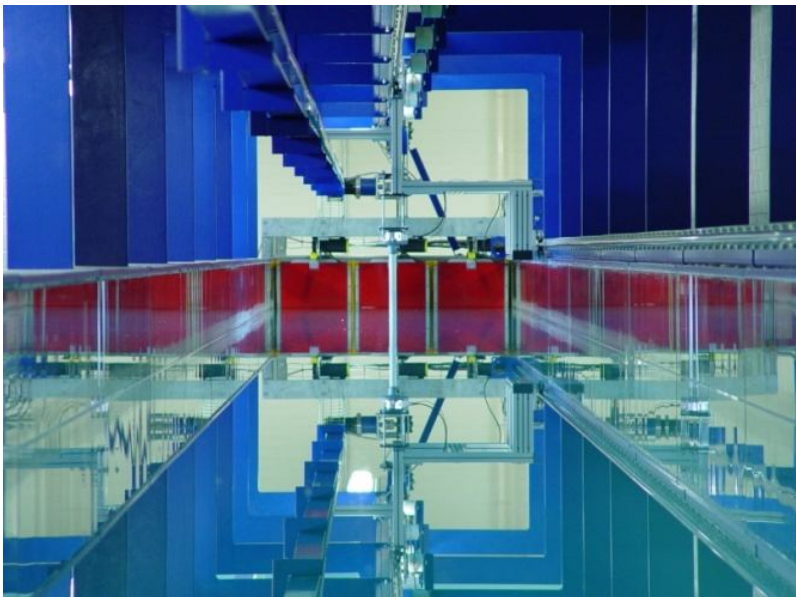
Photo: DONG Energy



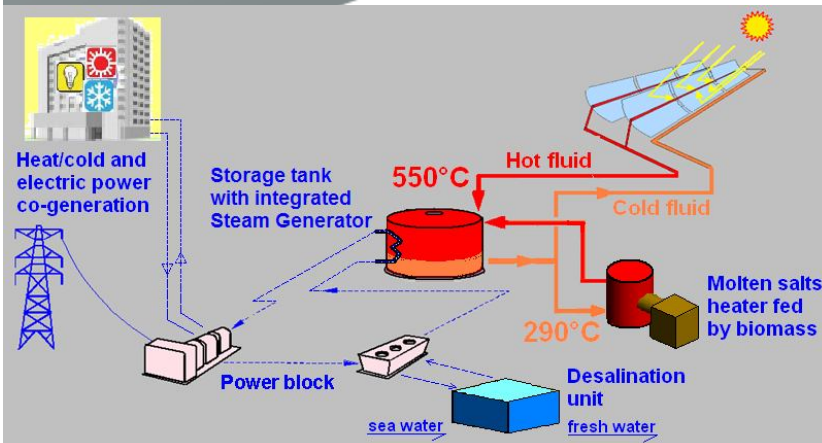
<http://www.cranfield.ac.uk>

Offshore Renewable Energy

- Vertical Axis Wind Turbine Test Facility
- Algae Biomass Laboratory
- Ocean Laboratory



Solar Energy



Solar thermal

- Mirror manufacture
- Chillers
- Cycle modelling

Photovoltaics

- Film deposition
- Surface analysis
- Device characterisation & modelling

Post-graduate Energy Teaching

**Over 200 Masters students across
a range of Energy courses
Over 80 PhD research students**

Energy Masters Courses

- Biofuels
- Carbon capture & storage
- Energy supply for low carbon futures
- Energy systems & thermal power
- Flow assurance
- Materials for energy systems
- Offshore materials engineering
- Offshore renewable energy technology
- Pipeline engineering
- Process systems engineering
- Renewable energy engineering
- Renewable energy technology
- Risk management
- Subsea engineering



Tours - Safety Information

- During the laboratory tours, please keep within the boundaries marked by black/yellow striped lines on the floor
- If a fire alarm sounds, please leave the laboratory through the nearest available fire exit - follow your guides to the closest assembly point