

# Renewable Energy at the University of Exeter

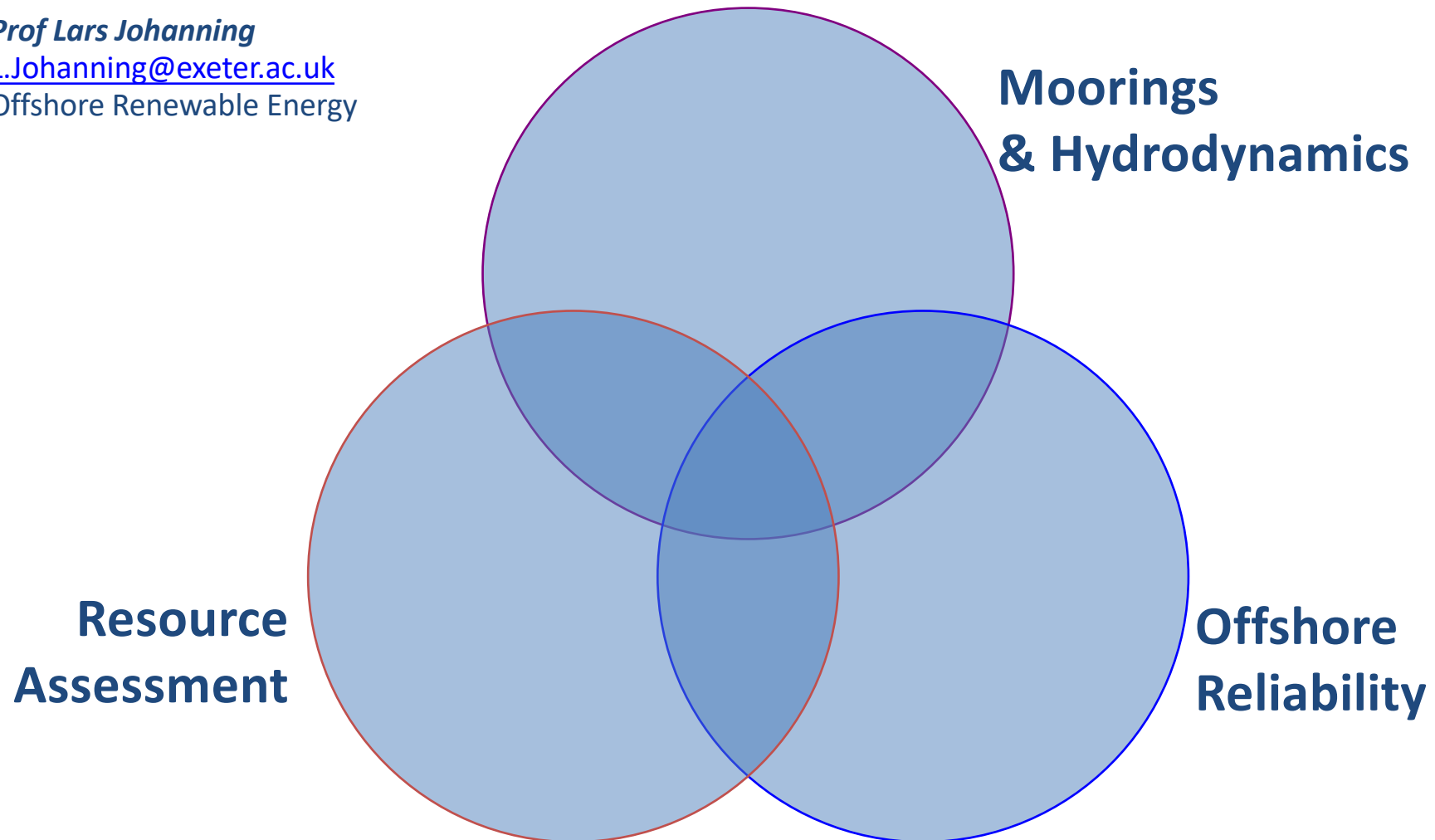
Research and teaching on clean energy solutions

- Introduction to the University of Exeter & RE Group
- Research areas
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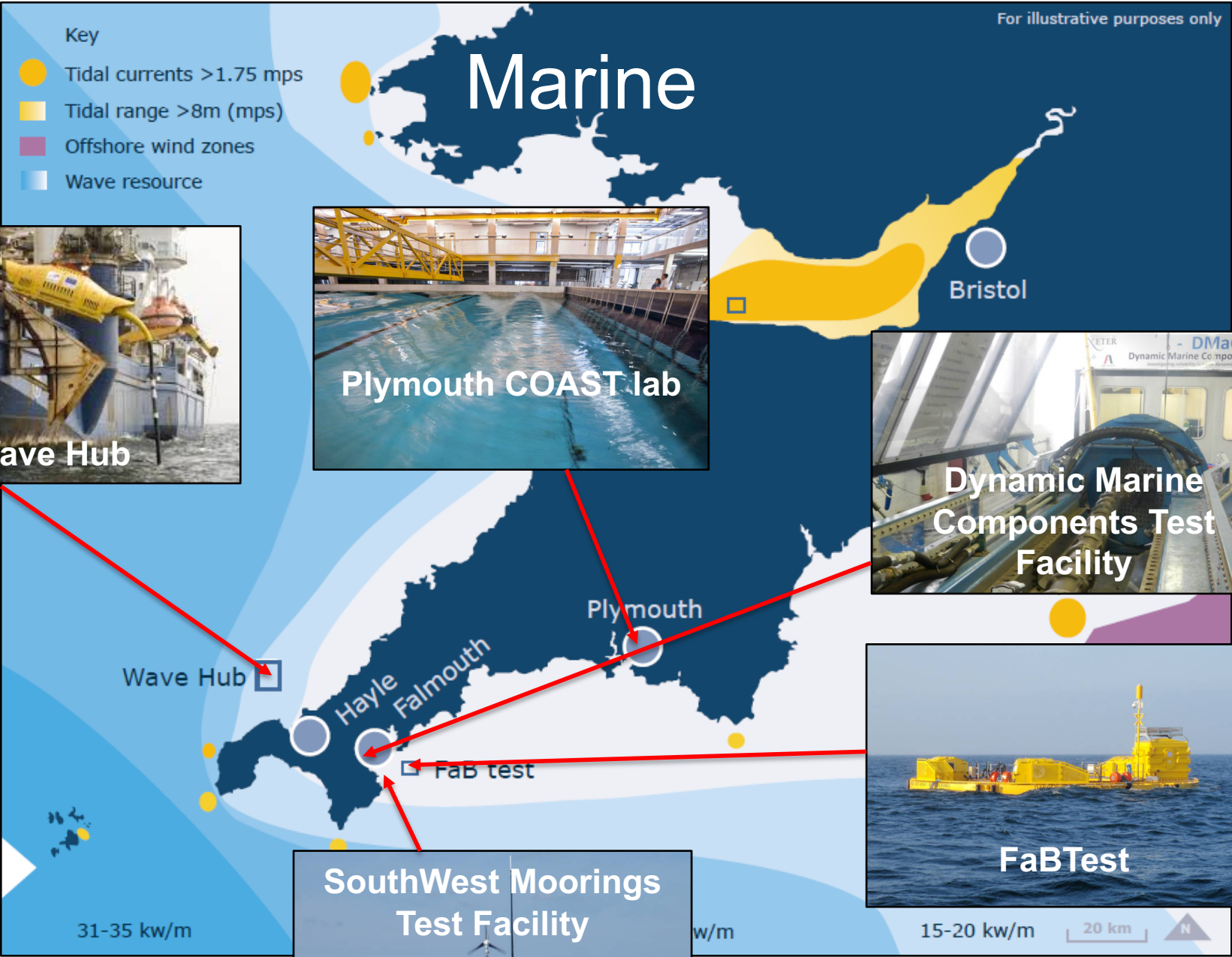


# Offshore Renewable Energy at Exeter University

*Prof Lars Johanning*  
[L.Johanning@exeter.ac.uk](mailto:L.Johanning@exeter.ac.uk)  
Offshore Renewable Energy



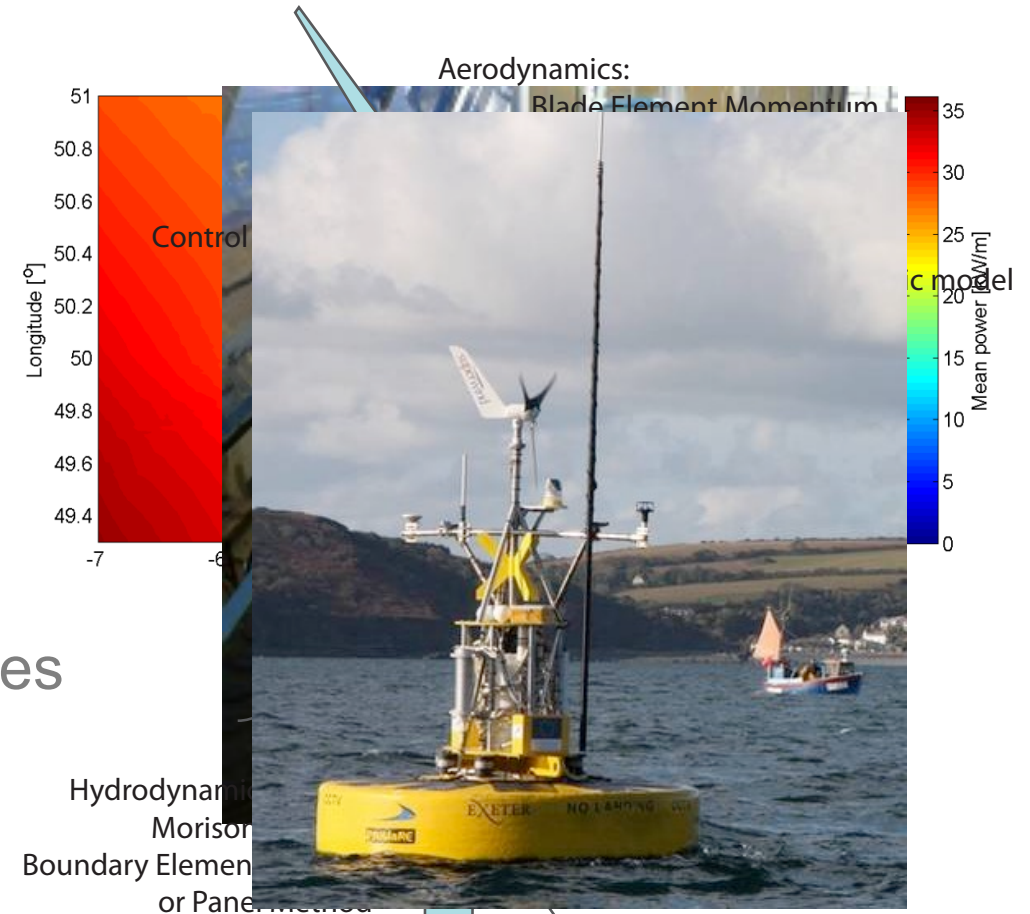
For illustrative purposes only



# Offshore Renewable Energy

Core areas:

- Resource Assessment
- Offshore Reliability
- Component Testing
- Moorings and Hydrodynamics
- Floating Offshore Wind Turbines



# Solar Energy Research Areas

Solar Cell & Materials

Concentrating Solar Cells

Thin film solar cells

System Integration

Perovskite solar cells

Hydrogen Generation

Thermal Energy  
Collection and Storage

Solar Fuels

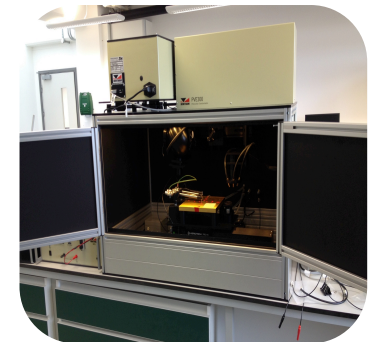
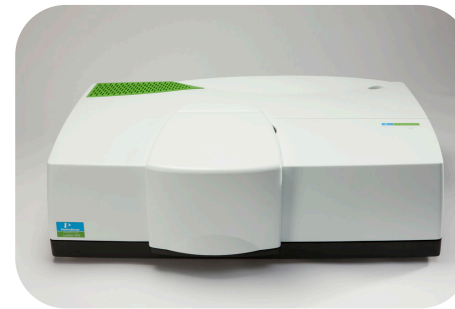
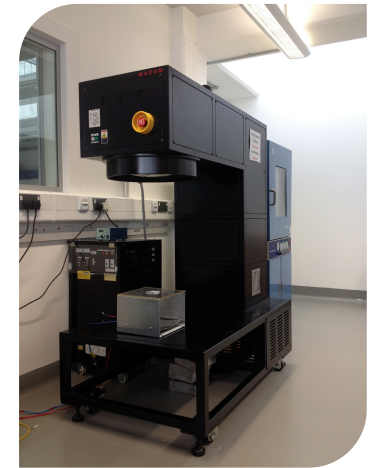
Simulation: Optical & Electrical



# Solar Test Facilities

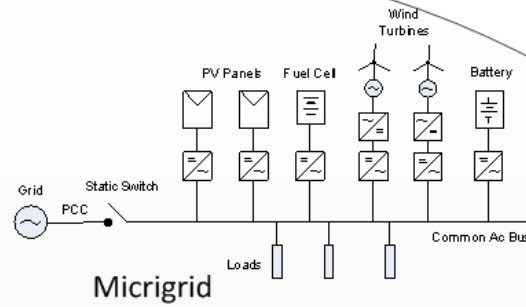
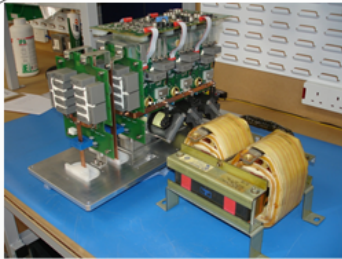
Lab based and outdoor equipment:

- WACOM Solar Simulator
- Pasan SunSim Solar Module Tester
- Bentham PVE300 PV
- LAMBDA Spectrophotometer
- Gas Chromatography
- SOPRA Ellipsometer
- Sun tracker (SOLYS)
- 6 x 6 Tracker



# Power Electronics and Smart Systems

Power Converters Topologies



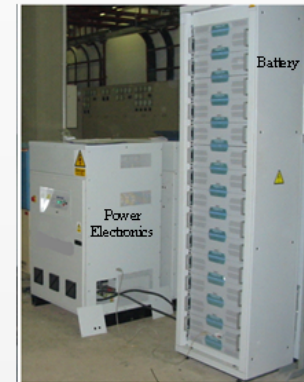
Dr. Mohammad Abusara

Grid Connected Inverters



## Control and Power Electronics

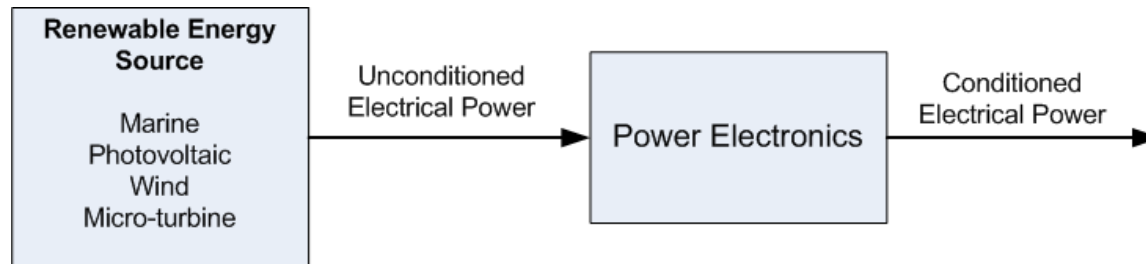
Line interactive UPS



DC/DC converters



# Research Interests



- Grid-Connected PWM Inverters
- MicroGrid
- Plug-in Hybrid Electric Vehicles
- Power electronic converters for photovoltaic farm grid interface
- Grid integration of Wave Converter systems





# Ground Source and Geothermal Energy

New initiatives starting:

- Innovations in GSHP performance
- Interreg Geothermal Energy Project



# Energy Storage – Key Research Areas

- **Redox Flow Battery for Energy Storage**
  - Focus on membrane-free single electrolyte system with a view to industrial scale up and commercialization
  - Examples: Zn-Ni RFB, Metal-Air RFB, soluble lead-acid RFB.
- **Hydrogen Production by Alkaline SPE Water Electrolysers**
  - Further develop efficient and stable catalysts for anode and cathode
  - Fabricate nanostructures of the selected catalysts as to form high surface area
  - Select anti-corrosion substrates
- **Nanomaterials for Energy Conversion and Storage**
  - Waste Water Treatment by Electrochemical Approaches
- **Pumped Hydro Energy Storage**
  - Novel approach to reduce the civil engineering cost and open up new sites



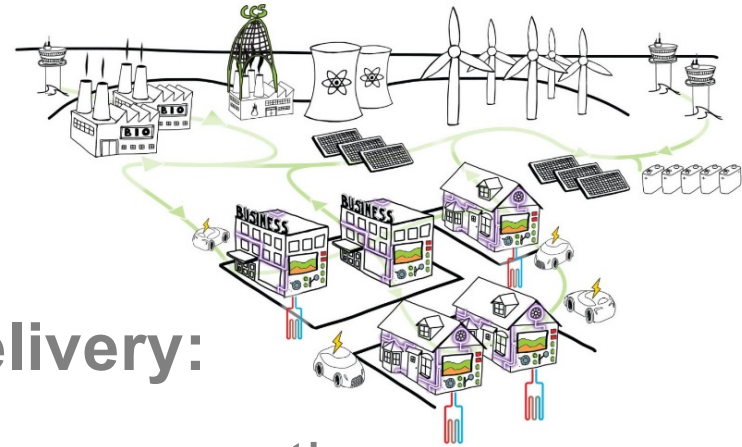
# Energy Policy

## Renewable Energy Policy and Regulation:

- Development of renewable heat policy in the UK and Europe
- Comparative assessment of policies for renewable sources of electricity
- Impacts of regulation on bringing renewable energy to market
- Industrialisation of renewable energy technology



# Energy Policy



## Smart grids and smart energy delivery:

- Lots of new intermittent generation across the grid means new challenges for grid management. We look at new policy and regulation to allow this to happen
- We work with local communities and other stakeholders to maximise the benefit of smart energy technology and on an interdisciplinary basis within and outside our group.



# Intelligent Community Energy

**INTERREG Funded: €8m – Exeter: €1.3M**

- Development of Smart Grid Communities.
- Primary Focus:
- Ouessant/Ushant island

University of Exeter staff:

Peter Connor (PI), Mohammad Abusara, Senthil Sundaram, Xiaoyu Yan, Phil Thies, Helen Smith (all RE/Eng) Bridget Woodman, Patrick Devine-Wright (Both CLES)



# Life Cycle Analysis

- Sustainability assessment of bioenergy pathways, electrical generation technologies, transport options, water systems and mining operations using life cycle assessment (LCA)
- Developing spatiotemporal dynamical LCA methods
- Impact of renewable energy systems on ecosystem services
- Water-Energy-Food-Environment Nexus
- Energy and transport modelling
- Performance of alternative fuels in engines



# Undergraduate Programmes

## Renewable Energy BSc

- Longest running RE specific course in the UK
- Well regarded by employers

## Renewable Energy Engineering BEng/MEng

- Focus on engineering fundamental to clean energy technologies
- Energy Institute - Accredited pathway to Chartered Engineer



# Postgraduate Programmes

## Renewable Energy Engineering MSc

- Pathway for engineers or scientists to focus on renewable energy technologies
- Launched September 2017
- Energy Institute - Accredited pathway to Chartered Engineer





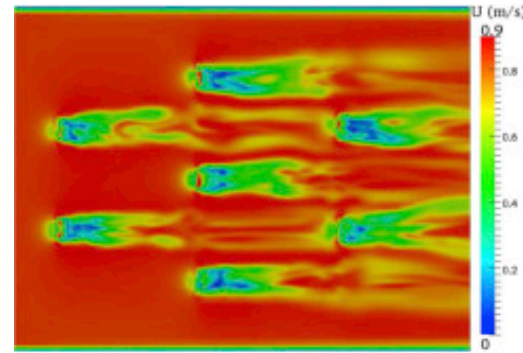
# Applied Mathematics in Penryn

- Open Sea Operating Experience to Reduce Wave Energy Cost
- Power systems control and optimisation

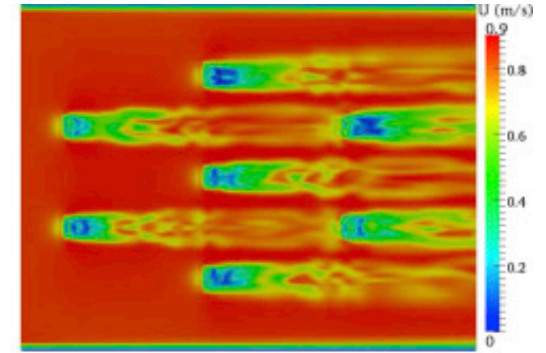


# Core Engineering

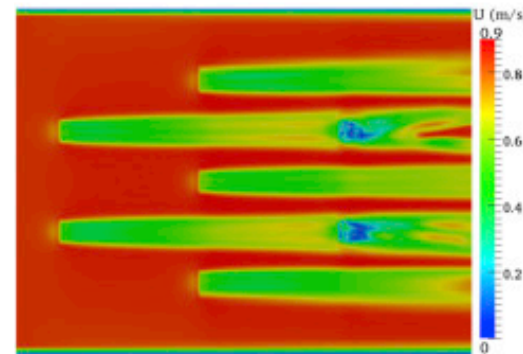
## CFD for Tidal Turbine Arrays



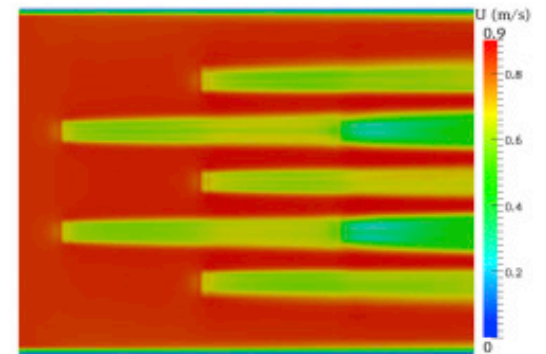
(a) NBF = 1



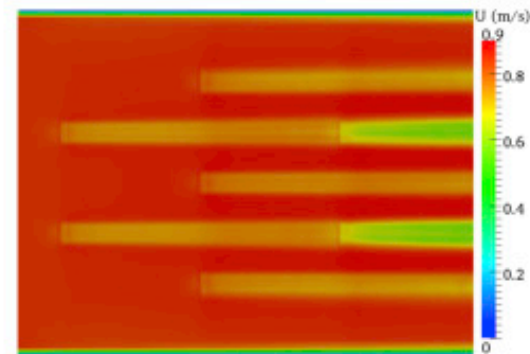
(b) NBF = 0.87



(c) NBF = 0.71



(d) NBF = 0.57



(e) NBF = 0.38



# Energy Harvesting

- Power management
- Modelling and simulation
- Wireless sensing
- Integration and characterisation



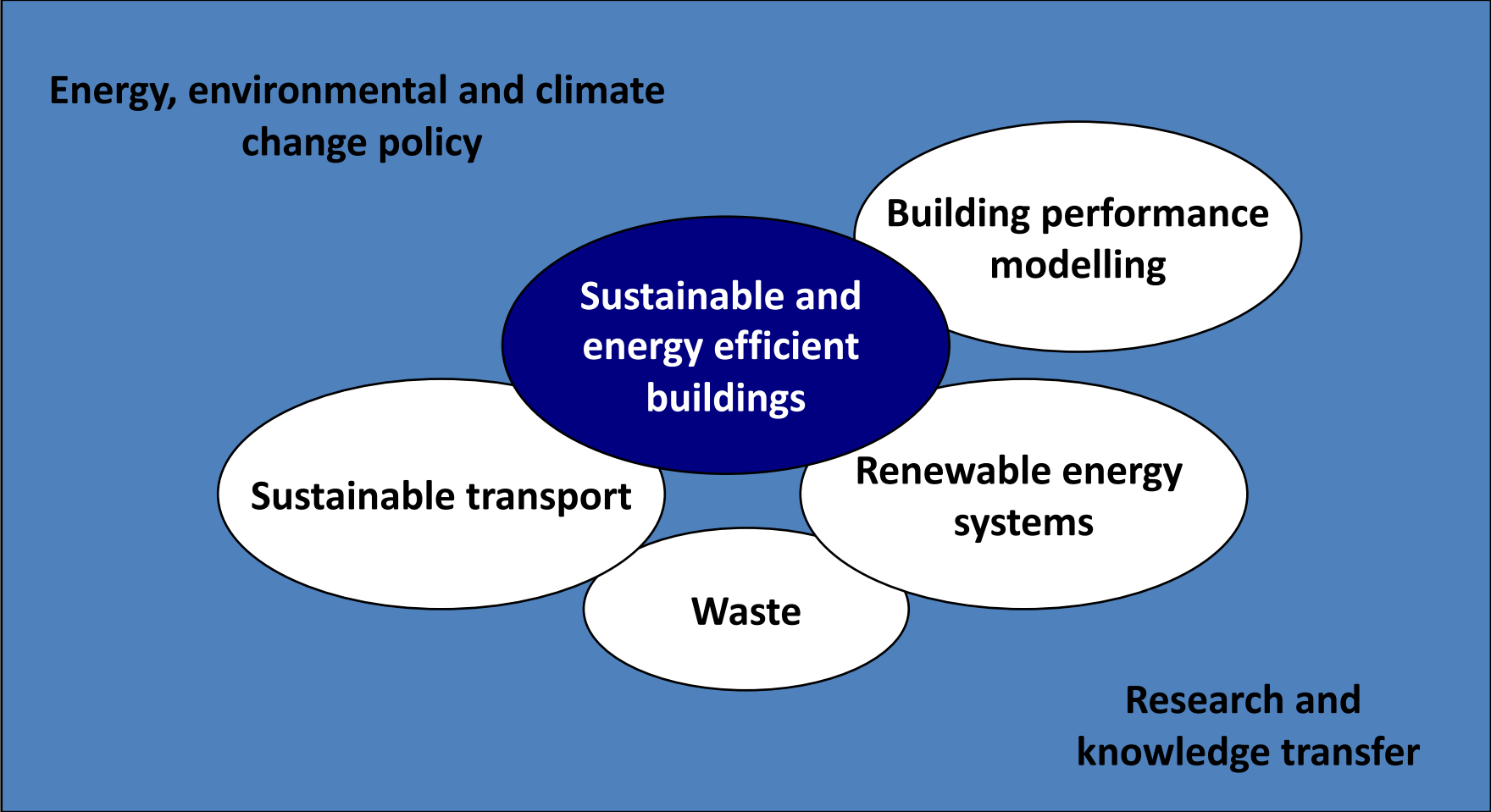
# Material for Energy Applications

Thermal energy storage at Stratham

Metamaterials for energy generation and storage application  
(CDT in metamaterials)

Graphene for photovoltaics and other energy applications





## Climate change and energy policy

- Audits of local energy use
- Audit of greenhouse gas emissions
- Support for carbon reduction strategies
- National carbon and energy policy drivers
- Local evidence bases and wording

## Sustainable buildings

- Advice on sustainable design and policy
- BREEAM assessments / advice
- Building Energy Certification
- Day lighting simulations and calculations
- Energy auditing

## Built environment performance monitoring

- Monitoring of building services performance
- Ventilation measurement and CFD prediction
- Acoustic design advice for buildings
- Measurement of the acoustic quality of buildings

## Sustainable transport

- Local air quality assessments and modelling
- Low carbon transport technology and fuels
- Carbon reduction strategies

## Renewable & low carbon energy systems

- Renewable energy feasibility studies
- Technology evaluation
- Low carbon development policy and advice
- District heating

## Waste

- Energy from waste
- Waste studies

## Research and knowledge transfer

- Climate change and adaptation
- Knowledge transfer partnerships (KTPs)
- Bespoke research and funding bids