

Wales: the challenge of a low carbon revolution

Prof. Peter Pearson

Low Carbon Research Institute of
Wales (LCRI)

International Conference:

Towards a Low-Carbon Economy in Poland

17 December 2010, Warsaw

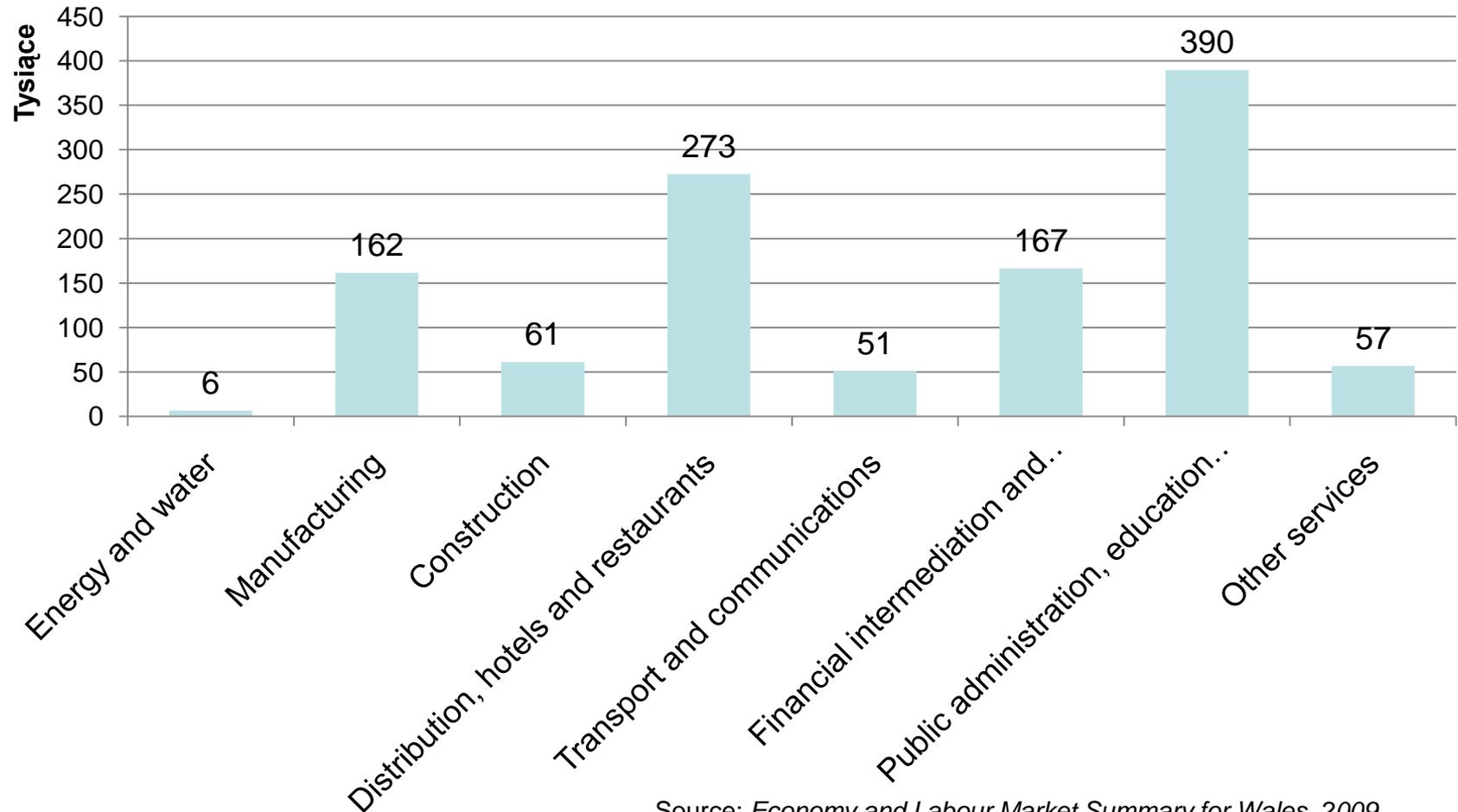
Wales

- Population: about 3 million
- Languages: Welsh & English.
- National Assembly for Wales & devolved Welsh Assembly Government set up 1998
- GDP per head around 90% of EU27 average
- Sustainable development a legal obligation for government
 - *Green Jobs Strategy*, 2009
 - *Climate Change Strategy*, March 2010
 - *Energy Policy Statement*, Nov. 2010



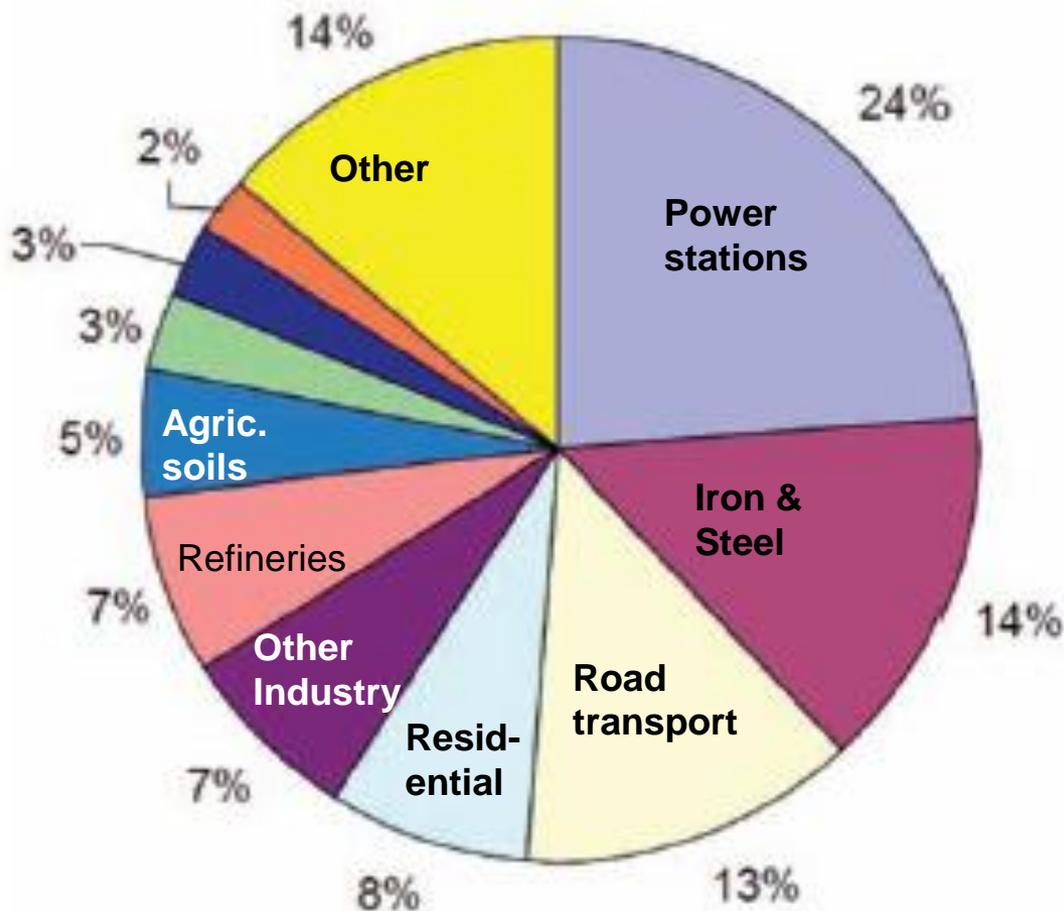
Structure of Jobs in Wales

Wales Employee Jobs by Industry 2008



Source: *Economy and Labour Market Summary for Wales, 2009*

Wales: Greenhouse Gas Emissions 2007

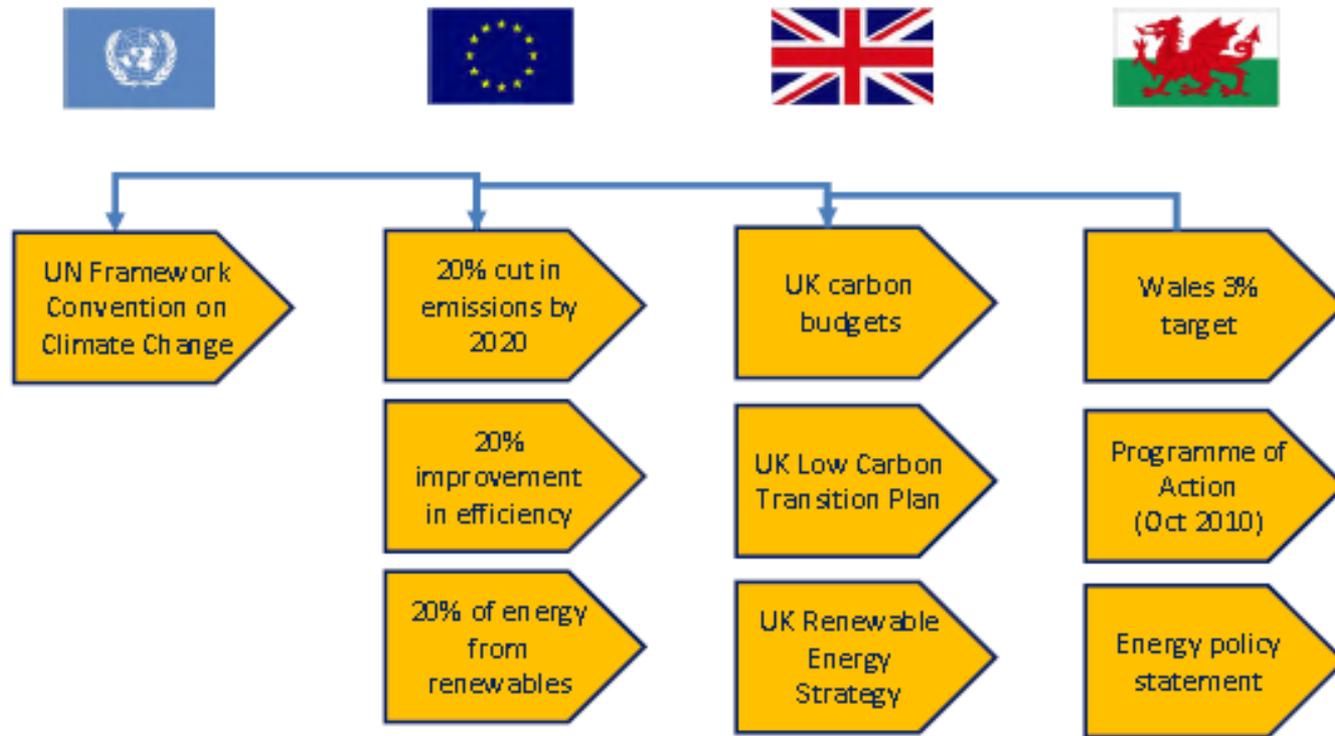


- 46.8 mt of greenhouse gases in 2007
- Emits highest amount of greenhouse gases per head in the UK: >7% of UK emissions
- Industry a key source in Wales: >50%
 - including power generation (24%)
 - refineries (7%)
 - iron and steel manufacturing (14%).

Source: AEA, 2009 p.28

Climate Change Challenge & Context

Wales a devolved Administration, operating in the context of UK and EU legislation & targets



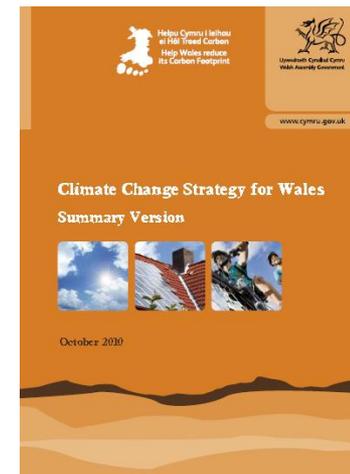
Source: Clive Bates: WAG

UK level, key recent actions and statements

- **Climate Change Act 2008**
 - 80% carbon emissions reduction by 2050, from 1990 level
 - UK government must set 5-yearly carbon budgets, on recommendations from the Committee on Climate Change (CCC)
 - UK Carbon Budgets for 2008-2012, 2013-2017, 2018-2022 and beyond
- **UK Low Carbon Transition Plan (2009)**
 - 34% reduction goal for 2020
 - 40% of electricity to come from from low-carbon sources by 2020
 - 30% of electricity from renewables (mainly onshore and offshore wind)
 - Demonstration CCS from coal plants
 - Facilitate new nuclear power
 - Energy efficiency measures
- **New Government Coalition Agreements, May 2010**

Wales Climate Change Strategy 2010: Targets

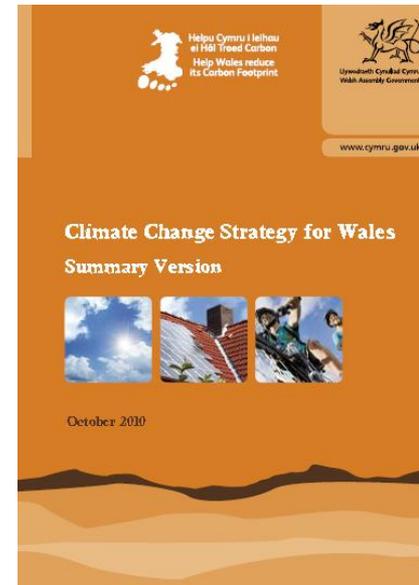
- **Reduce greenhouse gas emissions by 3% per year by 2011** in areas of devolved competence
 - Includes all 'direct' emissions (except from heavy industry & power generation)
 - Covers 69% of all greenhouse gas emissions in Wales
- **Reduce emissions by at least 40% by 2020, against 1990 baseline.**
- **Specific targets cover these sectors:**
 - Transport
 - Residential
 - Business
 - Agriculture and land use
 - Public sector
 - Waste sector.



Wales Climate Change Strategy 2010

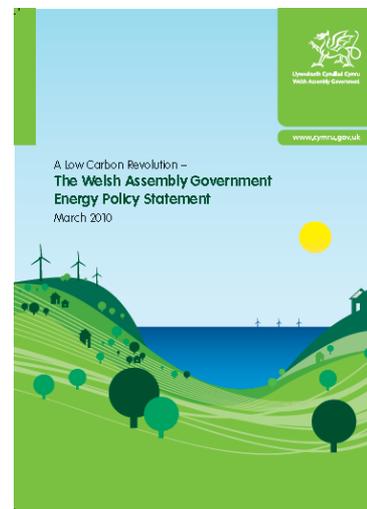
Key areas where action will be focused:

- Behaviour change
- Assembly Government & public sector to lead by example
- Increase energy efficiency & low carbon transport
- Build skills for a low carbon economy
- Cut emissions & adapt to climate change where possible
- Ensure that R&D, technology, innovation & skills help Wales gain maximum benefit
- Support effective adaptation.
- Ensure land use & spatial planning promote sustainable development & a move towards a low carbon economy



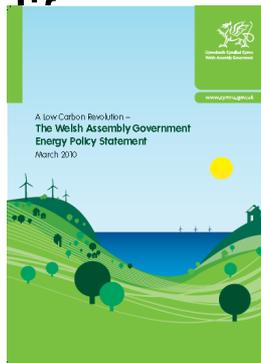
Wales Energy Policy Statement, Nov. 2010

- In 19th century, Wales gave momentum to the industrial revolution through steel industry & coal mines.
 - Europe's largest pumped storage station at Dinorwig.
- A century ago, the world coal price was set in Cardiff.
- Wales has seen energy transformations over the last 100 years:
 - Including coal & gas, oil (ports & refineries)
 - Two nuclear power stations in north Wales
- So for Wales, a moral & practical imperative to move to a low carbon economy



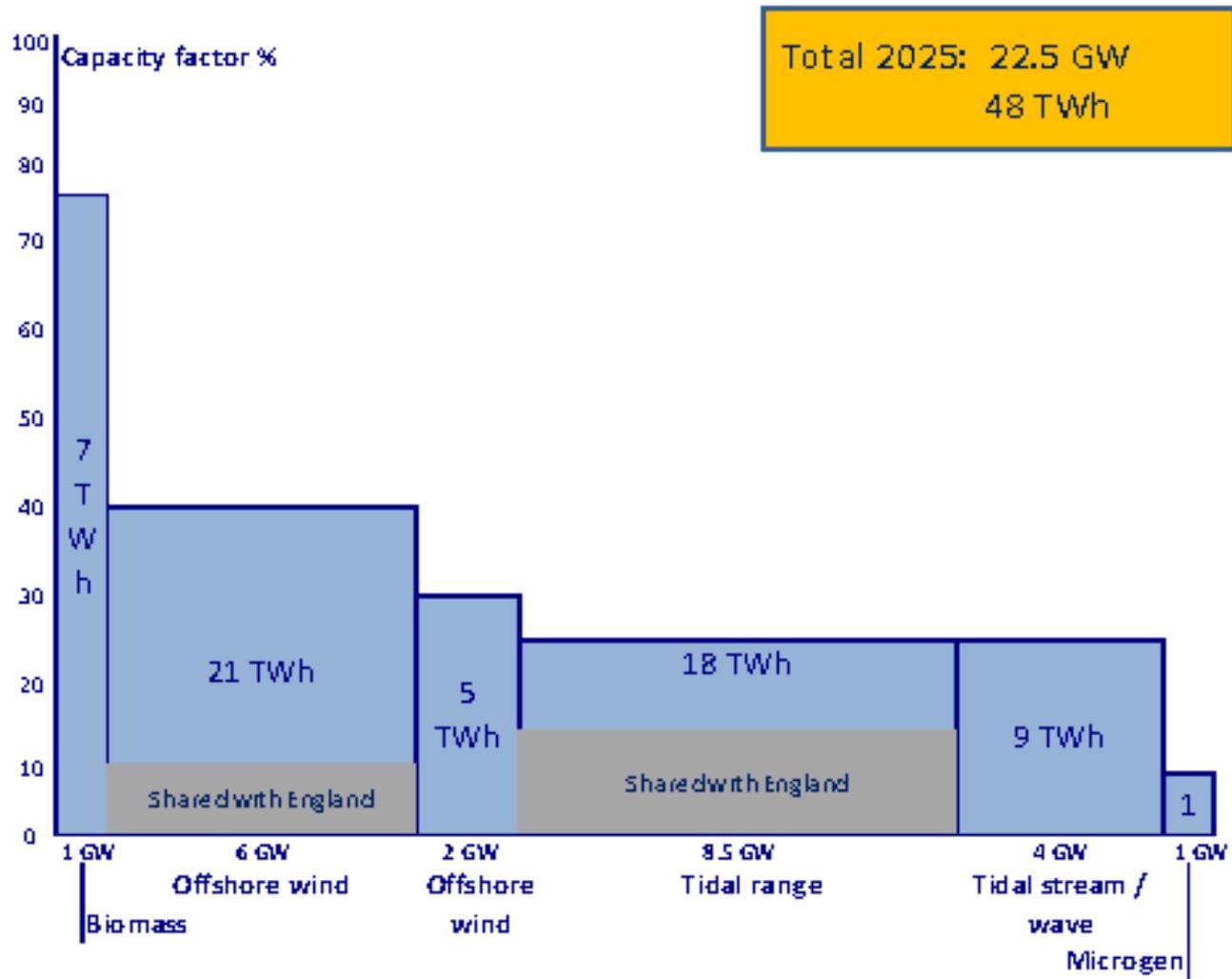
Wales Energy Policy Statement, Nov. 2010

- Maximise energy savings & energy efficiency
- Move to resilient low carbon energy production via indigenous renewables
- Ensure transition maximises opportunities for jobs & skills, strengthens R & D, helps to improve the quality of life
- Based on Wales' natural advantages in areas such as wind & marine
 - **We aim to renewably generate up to twice as much electricity annually by 2025 as we use today**
 - **By 2050, at latest, be in a position where almost all local energy needs (heat, electrical power, vehicle transport) can be met by low carbon electricity**





Wales renewable electricity potential by 2025



Source: Clive Bates: WAG

Introduction to the Low Carbon Research Institute (LCRI)

Low Carbon Research Institute (LCRI)

- Multi-disciplinary LCRI set up to unite & promote energy research in Wales, to help deliver a low carbon future
- LCRI aims to support the energy sector to develop low carbon generation, storage, distribution & end use technologies, and to offer policy advice

The LCRI comprises staff from:

Welsh School of Architecture (WSA), Cardiff University

Cardiff School of Engineering (CSE), Cardiff University

Sustainable Environment Research Centre (SERC), University of Glamorgan

School of Engineering (SoE), Swansea University

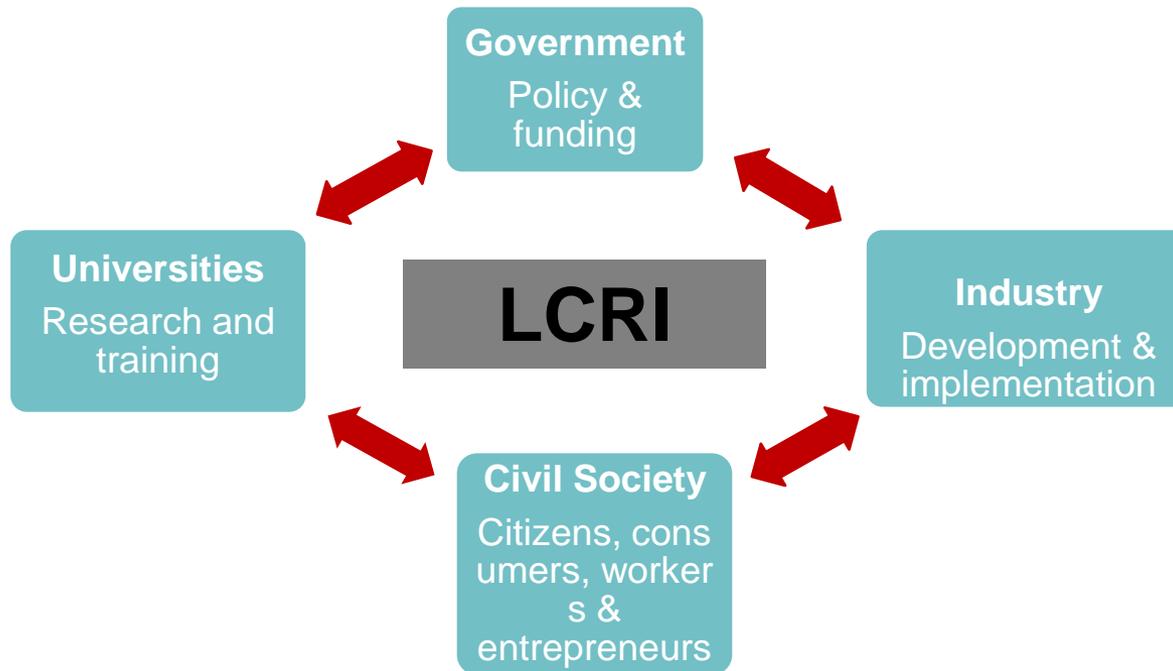
School of Chemistry (SoC), University of Wales, Bangor

The Centre for Solar Energy Research (CSER), Glyndwr University

Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University



Low Carbon Research Institute



Funding

£5.1 million, April 2008: HEFCW

£34 million (inc. match funding), 2009 - EU Structural funds
(Convergence Energy Programme, 2010-2015)

£10 million, 2008/10: other sources, inc. Research Councils, Industry
& Government

Low Carbon Research Institute

The LCRI seeks to achieve:

- Low to zero carbon supply systems
- Reduced energy demand
- Knowledge and skills transfer
- Dissemination & partnership with industry

Project Areas:

- Low carbon buildings
- Marine energy
- Large scale power generation & networks
- Photovoltaic energy systems
- Bioenergy
- Hydrogen & fuel cells
- Education & training
- Policy advice

The LCRI Welsh European Funding Office (WEFO) Convergence Energy Programme

Low Carbon Research Institute

The LCRI Welsh European Funding Office (WEFO) Convergence Energy Programme

- In 2010 LCRI secured £15 million from the Welsh European Funding Office
- With £19 million match funding from the university & industrial partners
- As part of the European Research & Development Fund's Convergence, Regional Competitiveness & Employment programmes
- To enable Wales & its industry partners to lead the way in research to cut CO2 emissions
- And develop energy sector training & promote Environmental Management, Equality & Diversity
- The projects are expected to help create >250 jobs, help existing companies in Wales & stimulate new low carbon ventures

The LCRI Welsh European Funding Office (WEFO) Convergence Energy Programme

Areas

- Photovoltaics
- Hydrogen & Fuel Cells
- Renewable Marine Energy Recovery
- Large Scale Power Generation
- Low Carbon Built Environment
- Scenario Modelling & Energy Atlas
- Energy Sector Training
- Environmental Sustainability & Equal Opportunities

Solar Photovoltaic Academic Research Consortium (SPARC) Cymru

Project aim

- Accelerate research in photovoltaic (PV) materials for solar energy conversion, towards new low-cost PV modules.
- By exploring dye sensitised solar cells (DSSC) & thin film inorganic materials.
- By addressing the power electronics for extracting power from the modules, via DC/AC inverters, smart metering & control systems.
- Make Wales a world leader in the production of new aspects of low cost thin film photovoltaics.

Research Areas

- **New thin film PV technology** is the base for test modules to be installed at test locations throughout Wales.
- **Larger test modules** will be developed, with combinations of organic and inorganic materials.

Solar Photovoltaic Academic Research Consortium (SPARC) Cymru

- **Development of dye sensitised solar cell (DSSC) technology on flexible substrates:** will improve substrate manufacture, focussing on barrier coatings, rapid processing of nano-porous titania & new dyes.
- **Working closely with industrial partners:** Tata & Dysol on large industrial applications; G24i on off-grid systems.
- **The power electronics systems work:** developing/testing high efficiency PV inverters to convert the DC produced from PV to AC.
- **Smart metering systems:** to monitor/ control the new PV modules, to maximise power & help consumers best use the generated electricity.

Project led by Prof. Stuart Irvine (Glyndwr Univ.)

- **Academic partners** include Bangor & Swansea Universities
- **Industrial partners** include Tata Colours, Dulas, International Rectifiers, Dyesol, Optek Systems, BASF, Pilkington & Pure Wafer.

Cymru H2 Wales

Helping the industrial development of hydrogen technologies in Wales

Project aim

- Catalyse a significant concentration of academic & industrial H2 expertise in Wales, placing Wales among early developers.
- Interact with a wide range of large & small businesses - in Wales or interested in establishing a Welsh presence.

Research Areas

- **H₂ Energy Storage:** integrating H2 with renewables like wind & solar, for energy storage during excess generation.
- **H₂/ CH₄ Vehicles & Refuelling Infrastructure:** developing vehicle engine test facilities & a refuelling network in S. Wales.
- **Bio H₂/ CH₄ Process Development:** analysis of the potential for H2 produced from local organic resources, of required technologies, supply chains & an optimised production platform.

Cymru H2 Wales

- **Recovery and Clean Up of Product Gases & Intermediates:** investigation of the technologies available / required to clean up biological / industrial waste gases for use in fuel cells, engines & the gas grid.
- **Development of Product Gas, Intermediate & By-Product End Uses**
- **Economic & Life Cycle Assessment** – Quantifying economic & environmental sustainability of processes & products.
- **Disseminating knowledge:** to encourage uptake of H2 products and processes

Project led by Prof. Alan Guwy (Glamorgan Univ.)

- **Academic Partners** include Bangor & Swansea Univs.

Renewable Energy Recovery from the Marine Environment

How to efficiently, consistently generate sustainable energy from tidal & marine resources

Project Aim

- Help enable & build sustainable marine energy sector in Wales
- Evaluate & enhance technologies to recover energy from waves, tidal streams & tidal ranges around Wales.
- Examine the effects of devices on the environment (e.g. seabed communities, sediment transport & marine wildlife); and
- Examine effects of the environment on the devices.

Research Areas

- **Data acquisition:** on marine mammal & cetacean behaviour, fish populations, water quality effects of devices on fish movements, & hydrodynamics., design & testing.

Renewable Energy Recovery from the Marine Environment

- **Near-field modelling:** of environmental effects, device life, location & positioning, blade performance
- **Far-field modelling:** hydro-environmental modelling, long-term effects of climate change on devices, coastal processes
- **Implementation:** investigating public understanding, device siting & economics

Project led by Prof. Mark Cross (Swansea Univ.)

- **Academic partners** include Aberystwyth & Cardiff Univs.
- **Industrial partnerships & links** include Tidal Energy, Swanturbines, Wave Dragon, Npower Renewables & E.ON UK

Low Carbon Built Environment

Project Aims

- **Reduce CO2 emissions associated with the built environment** by bringing Welsh academics & industry together.
- **Targetting the built environment sector at all scales**, from component to building to region.
- **Including all stages of the built environment process**, from planning to design to construction to operation.

Research Areas

- ***Sustainable Building Envelopes***: working with Tata to develop energy generating facades & construct the Sustainable Building Envelope Centre (SBEC) in North Wales.
- **Lighting: Design and Implementation of Solid-State Energy Efficient Lighting Solutions**, led by Swansea University, in collaboration with a Welsh SME, Enfis.

Low Carbon Built Environment

- ***Use of timber in building construction:*** using Welsh timber & working with BRE & Wood Knowledge Wales.
- ***Low carbon design solutions:*** combining energy demand reduction with innovative service solutions & renewables. Led by WSA, input from industry & social landlord organisations.
- ***Urban scale demand and supply:*** balancing energy demand reduction & renewable energy supply, led by WSA, working with Warm Wales.
- ***Monitoring the performance of low carbon technologies in domestic & non-domestic buildings in Wales:*** Led by WSA, with UWIC as academic partner.
- ***Innovation, technology deployment & market development***

Project led by Prof. Phil Jones (Cardiff University)

Large Scale Power Generation

Project Aim

- **Experimenting with combustion of gas mixtures** at the Gas Turbine Research Centre (GTRC), Port Talbot, under simulated conditions.
- **Examining the suitability of alternative & renewable** gaseous fuels for power generation via gas turbines (GT)
- **Using gas mixtures** from gasification & biological processes associated with sustainable energy technologies, from natural gas variations & industrial process gases
- Enhancing the potential for these gases & enabling industry to cut costs & enhance supply security

Research Areas

- The design, manufacture & commissioning of the gas mixing facility and the generic swirl burner;

Large Scale Power Generation

Research Areas

- **Analysis of fuel mixtures & combustion experiments;**
- **Computational fluid dynamic modelling** of the generic swirl burner;
- **Design & installation of the swirl burner** in the high pressure optical rig, & experiments at raised pressures & temperatures;
- **Dissemination of the research** to businesses & stakeholders.

Project led by Prof. Phil Bowen (Cardiff University)

- **Industrial Partners** include: E.ON (large scale power generators), Tata (process gases), & Graveson Energy Management (GEM) and RefGas, Welsh SMEs that produce syngas from municipal waste & biomass.

Scenario Modelling for a Low Carbon Wales: *Energy Scenarios & an Energy Atlas*

This is a cross-cutting project drawing on all projects

Overall objective

- **Develop an integrated scenario & modelling framework**
- Enabling LCRI to model the contributions to a low Carbon Wales of emerging energy technologies developed with our industrial partners
- Provide valuable information for policy makers in Wales & wider UK.

The research in this cross-cutting project will:

- **Compile a Welsh Energy Atlas:** i.e. a geographic information system (GIS) database of Welsh energy resources, infrastructure and demand;
- **Critically review energy scenarios & models:** to examine their utility in a Welsh context;

Scenario Modelling for a Low Carbon Wales

- **Specify an integrated 'Welsh Energy Transitions' modelling framework:** to appraise the long-term carbon-reduction, economic & market potentials of the novel technologies developed by the LCRI & its industrial partners;
- **Develop a range of credible socio-technical scenarios:** to explore & inform plausible pathways for a transition to a low carbon Wales;
- **Disseminate & transfer knowledge:** distilling key messages for research, policy & industrial development

Project led by Prof. Malcolm Eames (Cardiff Univ.):

- **With a research team at WSA,** informed by inputs from the LCRI partners & by interactions with a wide range of stakeholders.

Cross-cutting Theme & Training Activities

The Environmental Sustainability & Equal Opportunities theme, led by Helen John, Industrial Liaison Officer

- The team at WSA, Angela Langley & Lara Hopkinson, promote the uptake & development of Environmental Management Systems & Equality & Diversity strategies in Welsh enterprises.

With the Wales Energy Sector Training project (WEST), led from Cardiff by Dr Julie Gwilliam

- These activities offer a unique way to support the development of sustainable low carbon research, industry & jobs.

The Project Management Team at WSA, led by Claire Hobbs

- With key inputs from Cardiff's Research & Commercial Division
- Provides core administrative support & guidance

Thank You!