The UK's European university

University of Kent

ENERGY FUTURES, DIVERSE, DYNAMIC, DEMAND-DRIVEN, ENVIRONMENTALLY FOUNDED (EF 3D EF)

International thinking – Global impact

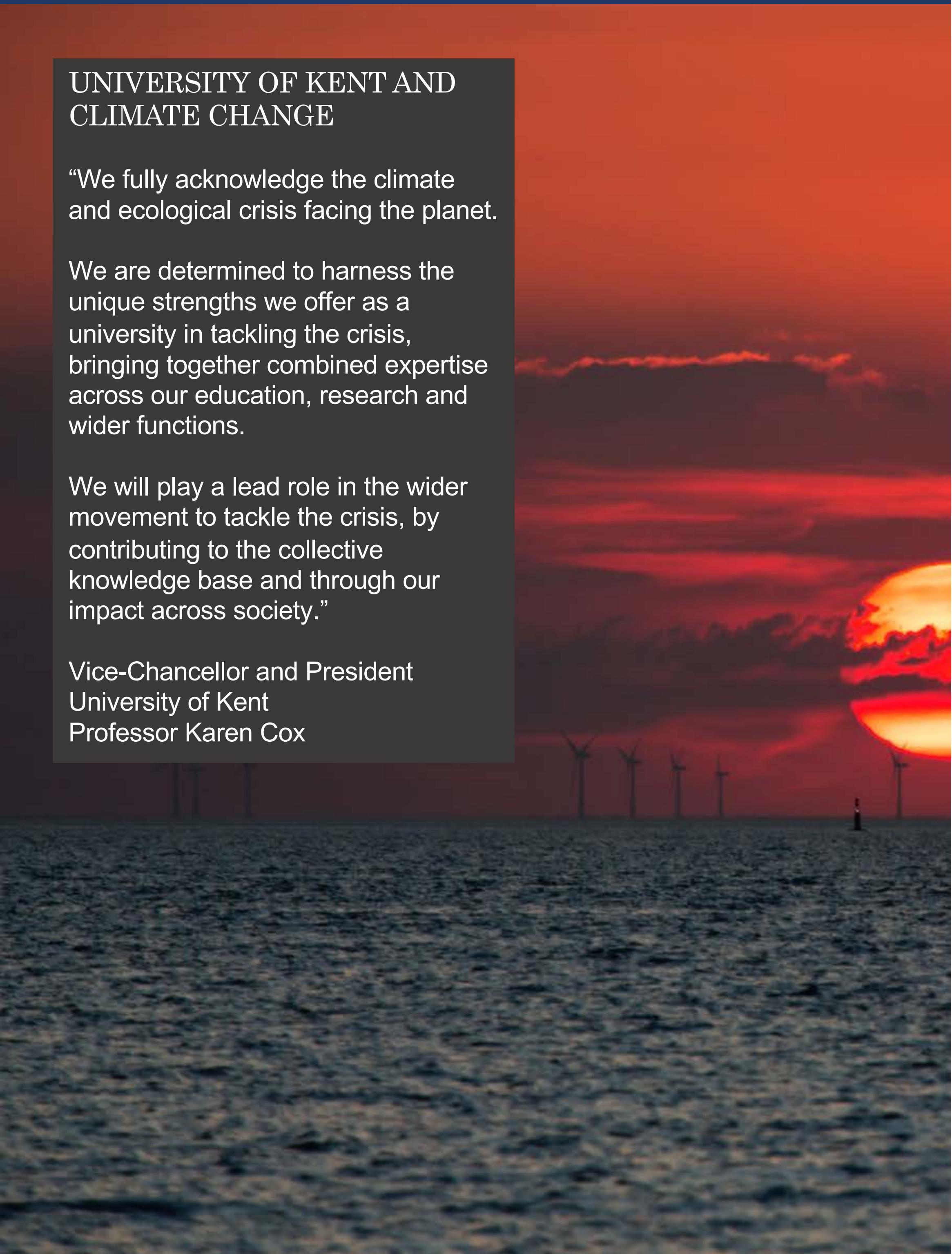
UNIVERSITY OF KENT AND CLIMATE CHANGE

“We fully acknowledge the climate and ecological crisis facing the planet.

We are determined to harness the unique strengths we offer as a university in tackling the crisis, bringing together combined expertise across our education, research and wider functions.

We will play a lead role in the wider movement to tackle the crisis, by contributing to the collective knowledge base and through our impact across society.”

Vice-Chancellor and President
University of Kent
Professor Karen Cox



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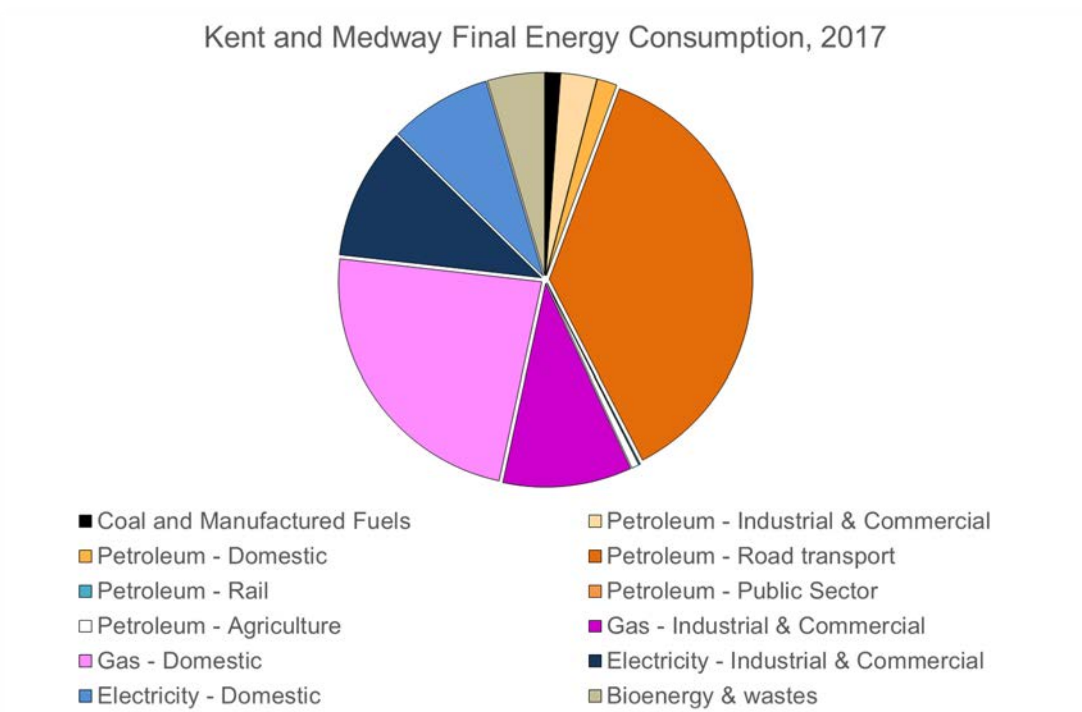
BACKGROUND

The Research Teams at the University of Kent have a long history of research in energy-related topics.

Recent analysis of energy consumption in the county highlighted to us the climate change challenge. Coal (one per cent), gas (33.7 per cent) and petroleum (petrol and diesel, 42 per cent) collectively account for 76.8 per cent of energy consumption in the county. This is not unlike the rest of the United Kingdom.

We know the University of Kent can work and collaborate locally, nationally and internationally to make a significant contribution to addressing the climate change challenge.



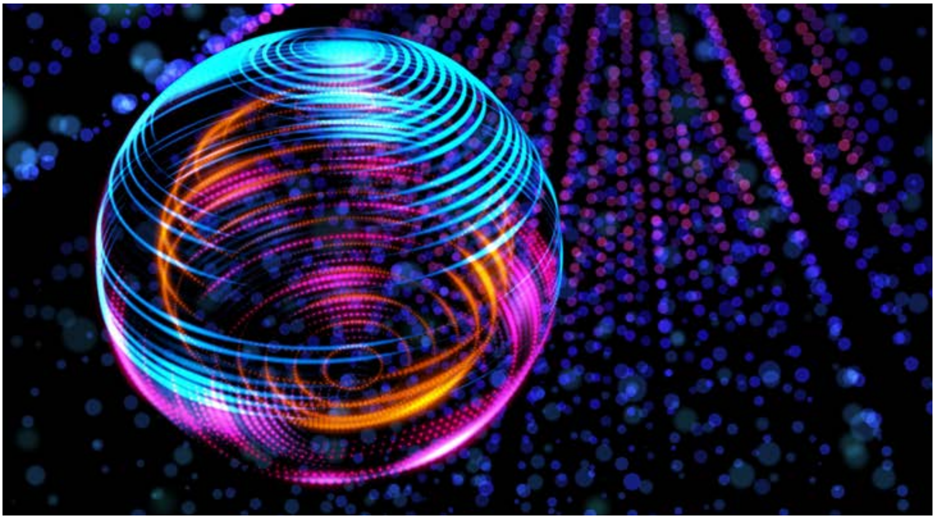
KEY FEATURES OF OUR RESEARCH AND INNOVATION

We want to demonstrate the integrated approach we offer at the University to ensure the transition to low carbon is as effective as possible.

Our approach is differentiated through a cross-discipline combination of:

- Energy - a function of technology and human behaviour
- Future - a timetable to address climate change
- Diverse - a diversity of both type and scale of technology
- Dynamic - a system able to react to changes in supply and demand
- Demand-driven - understanding the demand for new fuels
- Environmental - addressing air quality and environmental impacts
- Founded - based on ours and others research

We are aware that these objectives are not mutually exclusive and will contradict from time to time. We aim to highlight this and learn from international experience to understand this.



KENT AS A PLACE FOR ENERGY RESEARCH

The challenge of transition to a zero economy is a huge one and one that will require significant research, innovation and investment. In Kent and Medway, road transport alone accounts for 36.8 per cent of energy consumption.

Replacing gas as an energy provider for industry and domestic facilities, as well as petrol and diesel in transport, is starting. However, research and investment needs to accelerate significantly to deliver the mid-century ambition of zero carbon.

Through our pan-institutional approach to carbon management we will continue to promote this research – to encourage wider public understanding of global challenges and solutions – and we will test ideas and research on our campuses as part of a living-labs approach, and ensure that all students have the opportunity to understand how their area of study will be impacted by global challenges.

KENT AS A PLACE FOR ENERGY RESEARCH

Technology, route to scale-up, systems and demand profile will have to change. Critically, this needs to be achieved in a sustainable way to ensure the impact of both legacy and new technologies do not compromise wider resource and social needs, to ensure energy remains affordable and precious resources are not depleted.

Our broad collation of academics in the University recognise this scenario and situation. As a single institution, we share the ambition for effective academic and industry collaboration, both nationally and internationally, to deliver our objectives.

Kent has a unique energy mix from nuclear, European interconnectors supplying nine variations of onshore renewable energy to significant offshore energy, hydrogen supported. We believe this is a unique combination, making Kent the ideal location to research and develop integrated, effective technology.

KEY TECHNOLOGY, SYSTEMS AND BUSINESS MODELS

This approach is broken down into six areas of activity across divisions in the University. In each of these areas, we can provide innovation to support public, private and charitable objectives at a range of scales to best suit the programme.

The University has signed an agreement to incorporate the UN's 17 Sustainable Development Goals into its operations and the teaching curriculum it delivers. As part of this agreement, Vice-Chancellor and President Professor Karen Cox has signed the SDG Accord, which sets out the role universities and colleges can play in the delivery of these goals.

1. ENERGY STORAGE TECHNOLOGIES

Batteries - new lightweight small printable, innovation through sustainable materials and power intensive materials to minimise environmental impact.

Post Lithium Ion Chemistries - using new sustainable materials that offer less use of rare resources and can be more easily recycled to make battery and other energy storage technologies.

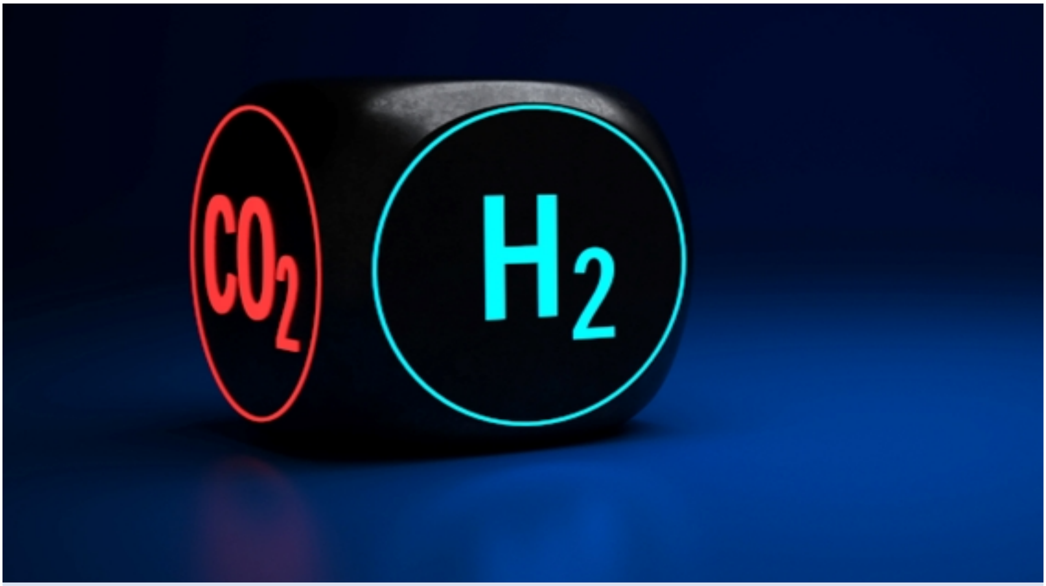
Repurposing and recycling of existing batteries - moving energy storage capacity across from one sector. To ensure partially redundant capacity is not left redundant (automotive to off-grid energy storage for example).

2. ENERGY AND INFRASTRUCTURE EFFICIENCY

Combustion optimisation to maximise performance and respond to new fuels and different combustion performance characteristic. To ensure value and environmental performance is optimised in legacy and toward legacy systems.

Extending life of assets - conventional and renewable to ensure life cycle optimisation. Extending life cycle through innovation in maintenance regimes by increased and optimised sensing for a proactive regime.

Supporting the transition to new fuels identifying where they outperform higher carbon equivalent and offer rapid scale up to quality alternatives.



3. FUEL CELLS

New chemistries that offer innovation in sustainable materials without compromising performance. Developing natural base materials that outperform, in terms of life cycle, their more established chemical equivalents.

4. HYDROGEN AS A NEW FUEL

Production optimisation through transition from different categories of hydrogen (grey, brown, blue and green), ensuring optimised quality and cost for appropriate applications, delivering scale and economic benefits, and transportation formats for hydrogen that deliver long-term cost and safety benefits and increase the viability of non-carbon fuels.

5. RENEWABLES

Offshore renewable energy opportunities for shallow water river basins, traditionally the more marginal opportunities, create regional clusters relevant to local environmental conditions.

Current technology - developing performance enhancement and extended life.

6. SUPPLY CHAIN

Distribution networks for dispersed and diverse new energy technologies. Integration of new fuels into existing supply chains to ensure supply chain performance from a sustainability perspective is not compromised.

Integration of new fuels into transport, logistics systems, planning and programmes. Delivering the one fuel (petroleum) to many fuel (electric, hybrid, gas, hydrogen, ammonia) optimisation.

Carbon capture and storage - systems for integrity and effectiveness.

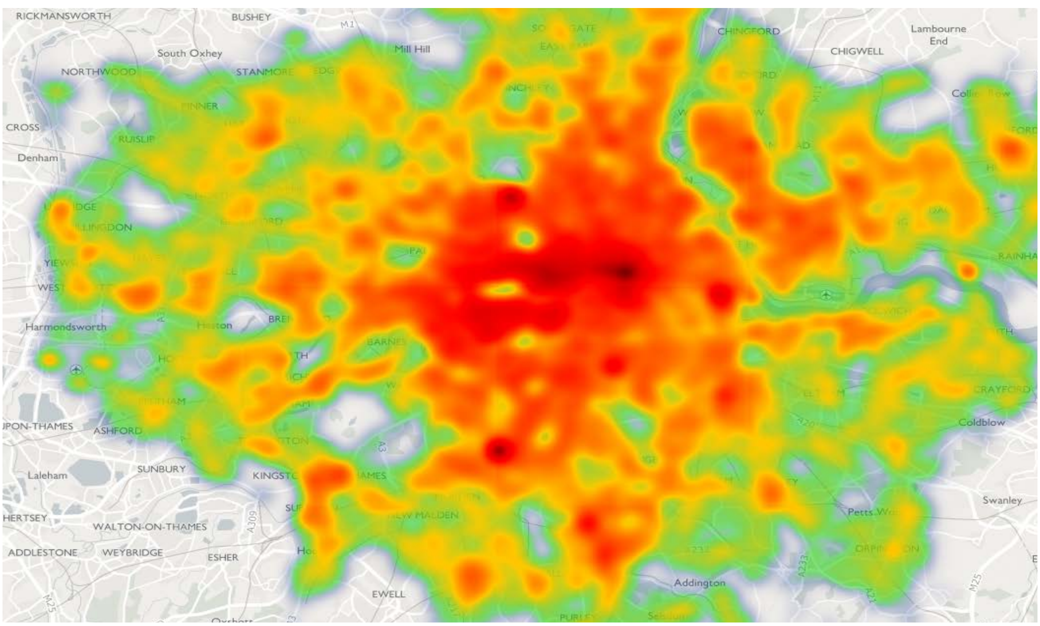
ENERGY DEMAND - LONDON

We believe that understanding energy demand is critically important to determine the pace and scale up to a new low/no carbon energy future.

London offers huge energy demand opportunity - an incentive for clean energy.

London is on the doorstep of Kent and Essex, Thames, Medway and communities resources - offering infrastructure, energy sources from renewables and the chance to develop coastal communities in Kent and Essex and strengthening our energy links to European neighbours.

Air quality benefits too - the continued journey to clean energy will bring clean air for London and the region, offering significant health and environmental advances that will give positive quality of life and health outcomes.



THE CORE TEAM

Computing Engineering and Mathematics	Mahmood Shafiee	Dr Shafiee has more than fifteen years' experience of research and consultancy in different fields of mechanical systems engineering and has worked closely with a wide range of industry sectors, including offshore oil and gas, onshore/offshore renewables (fixed and floating wind power, concentrated solar power, wave and tidal), transport (rail, road and shipping), aerospace, manufacturing, etc.
Computing Engineering and Mathematics	Lijuan Wang	Dr Wang's research interests include electrostatic sensing, multiphase flow measurement, condition monitoring of mechanical systems, sensors and instrumentation systems, data analysis and soft computing.
Computing Engineering and Mathematics	Yong Yan	Professor Yan's main areas of expertise are in sensors, instrumentation and measurement systems for renewable and conventional energy systems, in addition to quality assessment of recycled materials and batteries and condition monitoring of CCS systems.
Kent Business School	Ramin Raeesi	Dr Raeesi's main area of research relates to the development of mathematical models and solution algorithms for Combinatorial Optimisation problems that arise in the context of transport and logistics networks.
Natural Sciences	Paul Saines	Dr Saines' research includes materials with complex and tuneable electronic and magnetic interactions, which play a key role in the function of many modern technologies. Work in the Saines' group focuses on designing new co-ordination compounds as a novel route to developing substances with such functional properties.
Natural Sciences	Alex Murray	Dr Murray's research interest is redox flow cell batteries, the utilisation of synthetic catalysts to probe the mechanisms of biological organic redox reactions, the mechanisms of electrochemical oxygen reduction, the ability of modified carbon materials to promote thermal catalysis and the use of electrochemical mediators in phase transfer catalysis.
Natural Sciences	Robert Barker	Dr Barker's research interest is materials performance, specialising in the replacement of carbon based materials with non carbon sustainable materials. To establish materials that have the performance requirements to substitute their carbon-based equivalents.
Natural Sciences	Maria Alfredsson	Dr Alfredsson is researching the development of small and sustainable batteries that can be used across a range of devices - produced from sustainable materials. An important aspect is that the batteries should be flexible and when possible manufactured from aqueous based processes.

THE RESEARCH RESOURCE

Arts and Humanities	Marialena Nikolopoulou	Professor Nikolopoulou's research interests concentrate on environmental performance of buildings and urban spaces, thermal comfort, along with occupant perception and use of space.
Arts and Humanities	Silvio Caputo	Dr Caputo's research interests include: urban resilience; urban agriculture; urban ecology; design and planning of green infrastructure; environmental justice; co-design and participatory methods of design and planning; self-build urbanism.
Arts and Humanities	Giridharan Renganathan	Dr Renganathan's research focus is on urban morphology and climatology (environmental design), with specific interest in urban heat island effect, outdoor thermal comfort, summer time over heating in buildings, passive ventilation strategies, use of cool materials, urban albedo and dynamic thermal modelling.
Computing Engineering and Mathematics	Gang Lu	Dr Lu's main areas of expertise are in sensors, instrumentation, measurement, digital image/signal processing, 2-D and 3-D visualisation and characterisation for combustion systems, condition monitoring, machine learning for engineering solutions.
Computing Engineering and Mathematics	Moinul Hossain	Dr Hossain's research interests include combustion diagnostics, sensors, instrumentation, measurement, condition process monitoring, digital image processing, deep learning, solid oxide fuel cells and light field imaging.
Computing Engineering and Mathematics	John Batchelor	Professor Batchelor's research interest is RFID based low power sensing technologies including body-worn antennas, platform independent RFID tags, transfer tattoo tags for skin, printed electronics and future manufacturing, and the use of passive wireless sensors for Assistive Technologies.
Kent Business School	Samer Bagaeen	Professor Bagaeen brings both depth and breadth of city expertise, specifically in issues related to project design and working with partners, community planning, regional planning & regeneration, housing delivery, and national urban policy formulation.
Kent Business School	Adolf Acquaye	Dr Acquaye's research interest covers: sustainability research in business practice and CSR, environmental modelling and lifecycle assessments, green supply chains management, sustainable frameworks and resource accounting, climate change policy and mitigation, development of decision support tools, sustainable and renewable energy systems.
Kent Business School	George Chryssochoidis	Most of Professor Chryssochoidis' current work relates to responsible and effective business decision-making aiming to generate lessons for better management practices and public policy actions.
Kent Business School	Huamao Wang	Dr Wang's research interests are theoretical and empirical researches in financial technology and innovation, big data, machine learning, asset pricing, portfolio choice, corporate and entrepreneurial finance and investment, arbitrage and fund liquidity, risk management, financial intermediaries, and financial economics.

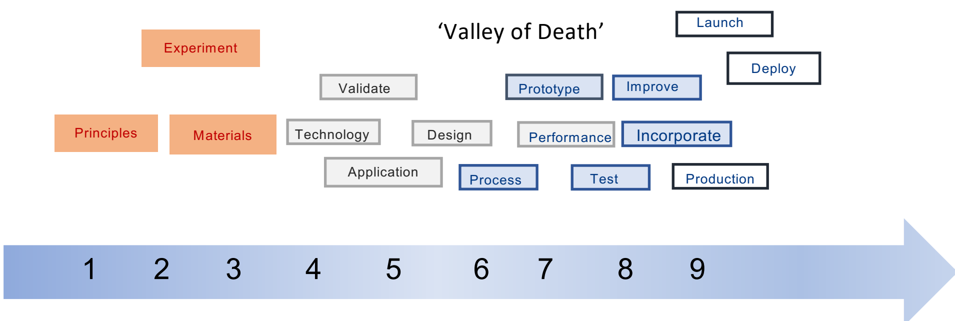
THE RESEARCH RESOURCE

Natural Sciences	Anna Corrias	Professor Corrias's main research expertise is in the field of aerogels, the lightest materials ever made, which find applications as thermal insulators and catalyst supports. Currently, she is working on using silica aerogels to stabilise cerium oxide, also called ceria, in form nanocubes.
Natural Sciences	Emma McCabe	Dr McCabe's research interests lie in the field of materials chemistry and focus on the synthesis, structural characterisation and physical properties of complex transition metal oxides and mixed anion systems.
Natural Sciences	Gavin Mountjoy	Dr Mountjoy's primary field of research is structural characterisation of novel oxide materials. Gavin has concentrated on X-ray and neutron scattering, X-ray absorption spectroscopy, and molecular dynamics modelling.
Natural Sciences	Jorge Quintanilla	Dr Quintanilla is a theorist working on quantum condensed matter and materials physics. His main interests are in the area of strongly correlated quantum matter and include unconventional superconductors, frustrated and quantum magnets, and other materials with strongly-correlated electrons.
Natural Sciences	Nick Bristowe	Dr Bristowe is a lecturer in the Functional Materials Group. Research interests include functional materials; structure-property relations, such as metal-insulator transitions; and interfaces between materials.
Natural Sciences	Mark Green	Professor Green's research interest includes materials and material functionality relevant to the energy sector.
Natural Sciences	Aaron Berko	Dr Berko carried out EXAFS analysis for the Alistore group working on battery materials. This involved collecting and analysing data during beam time.

RESEARCH, INNOVATION AND IMPACT

We recognise the diversity of our research at the University of Kent; we see this as an asset. Energy research and innovation can no longer address a single technology, business system or market. Our EF3DEF enables us to share knowledge and experience and grow the opportunity to work with others. Our plan is one of being incremental, additional knowledge and to carry our research, where we can through to deployment.

We use Technology Readiness Level to drive toward impact.



TECHNOLOGY READINESS LEVEL

- TRL - conceived by NASA in 1974 as a method toward a standardised measure in the development of new technologies.
- The TRL concept recognises the need for academic/industry collaboration from TRL 3 to 7.
- The University of Kent supports this collaboration.

A DUAL APPROACH

- We aim to work collaboratively, bringing the requirements for industry and society together with academic research.
- Bridging the 'so-called' Valley of Death of ideas.

COLLABORATION AND PARTNERSHIP

The collective ambition of the group and the University aligns to the Paris Agreement on Climate Change mitigation, specifically:

- Recognising that climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions.

- Accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development.

- Assessing how to increase synergies through cooperation and avoid duplication among existing bodies established under the Convention that implement capacity-building activities, including through collaborating with institutions under and outside the Convention.

OUR DIRECT CONTRIBUTION TO SUSTAINABILITY

- We are currently developing our new carbon management plan which will adopt a whole-institution approach to carbon management. This acknowledges the role that we play not only in contributing to national emissions reduction targets though our own operations but also in contributing to knowledge and understanding through our teaching and research.

- As a University, we have an opportunity to influence the world beyond our campuses. Our world-class academics are working across all fields of sustainability from innovative architecture, radical conservation methods, and sustainable business practices to the research outlined in this publication focused around the future of energy.

RENEWABLE ENERGY IN KENT

Renewable Energy Database March 2020, (MWelec)

	Operational Kent	Under Construction Kent	Planning granted Kent	Planning submitted Kent	TOTAL Kent
Advanced Conversion Technology			10.4		10.4
Anaerobic Digestion	1.2		2.0		3.2
Battery	40.0	49.4	126.0	14.9	230.3
Biomass (dedicated)	41.0				41.0
EfW Incineration	51.0		45.0	75.0	171.0
Landfill Gas	17.6				17.6
Sewage Sludge Digestion	1.1				1.1
Solar Photovoltaics	340.0		0.7	350.4	691.1
Wind Onshore	81.4			15.0	96.4
Wind Offshore	1,069.5				1,069.5
TOTAL	**1,642.8**	**49.4**	**184.1**	**455.3**	**2,321.2**

Source: Renewable energy planning database, including operational, under construction, planning permission granted, planning permission submitted

Kent is now a significant provider of renewable energy and storage capacity.

This capacity is using a wide range of renewables:
- Waste from domestic and industrial sources
- Wind, onshore and offshore
- Solar

The University is seeking collaboration and partnership to extend the range of renewables, for example, to include tidal flow energy.

COAL MINING IN KENT

A little bit of history: The Kent coalfields reached their productive peak in 1936. At the height of production the biggest market for Kent coal was as a fuel for railway steam engines.

In 1975 there were 3,000 miners at Betteshanger, Snowdown and Tilmanstone, producing one million tons of coal per year. By now most Kent coal was used as a coking blend for the steel industry, which was also in crisis. The last colliery, Betteshanger, closed in 1989.

Signs of this era of energy can still be seen in the County, but we look forward to accelerating our progress to clean safe energy.

FURTHER INFORMATION

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University of Kent